UNIVERSITY OF CALIFORNIA
DIVISION OF AGRICULTURE AND NATURAL RESOURCES

FY 2004
ANNUAL REPORT OF ACCOMPLISHMENTS AND RESULTS

AGRICULTURAL EXPERIMENT STATION
AND COOPERATIVE EXTENSION

PATRICIA M. DAY, WILLIAM E. FROST, JOSEPH G. MORSE,
MAXWELL V. NORTON, AND KAREN P. VARCOE, EDITORS

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SECTION A. PLANNED PROGRAMS

The University of California Division of Agriculture and Natural Resources (UC-ANR) is the major land-grant arm of the University of California, part of a nationwide public university system "built on behalf of the people" (Abraham Lincoln's words) with Experiment Stations established to develop "useful and practical information...and to promote scientific investigations and experiments," and Cooperative Extension programs to "aid in diffusing...useful and practical information." UC-ANR's mission, "... is to serve California through the creation, development and application of knowledge in agricultural, natural and human resources."

UC-ANR members are based on the Berkeley, Davis and Riverside campuses, and in more than 50 regional and county offices throughout the state. The Division is composed of the UC Agricultural Experiment Station (AES) and UC Cooperative Extension (CE), supplemented by 20 statewide special programs and projects, and supported by nine Research and Extension Centers.

The AES has about 700 academic researchers, most of whom also have professorial appointments representing dozens of scientific disciplines.

Cooperative Extension, the principal outreach arm of the Division, comprises academic appointees attached to campus departments as CE specialists or county offices as CE advisors; there are about 120 specialists and 235 advisors.

The following narratives report on California's planned programs for the five National Goals represent a sample of the research and extension efforts conducted by UC faculty, CE advisors and CE specialists.

NATIONAL GOAL 1

Through research and education, empower the agricultural system with knowledge that will improve competitiveness in domestic production, processing and marketing

California's producers of food, fiber, forage, and floral products are under considerable stress from rising costs. The inputs experiencing the largest increases are labor, insurance, and energy (electricity and fuel). This is making it very difficult to compete in the new global economy where most of California's competitors have lower costs. Those foreign competitors who do not have lower costs are sometimes subsidized, giving them a competitive advantage. Even though California is America's largest agricultural producer, it is a crowded urban state. This is putting incredible pressure on farmers to modify practices to accommodate the close proximity of urban neighbors. Normal farming practices that would have been acceptable to non-farm residents in the past are now objectionable. The rapid increase in population is causing a rapid degradation of air and water quality. Agriculture is under pressure to contribute to proposed solutions. This is manifested in stricter air emission rules and the almost complete prohibition of any form of run-off of soil, nutrients, or pesticides.

University of California AES scientists and CE academics have responded to these challenges with a large and diverse body of research and extension work to address all the pressing issues above. The following section provides a sample of projects and programs that directly address National Goal 1. UC-ANR seeks to make California and U. S. farmers more competitive by introducing new technologies that enable them to adapt to the new global paradigm. Innovative research helps to reduce total inputs and reduce costs.

Plant and animal improvements are being introduced that will increase production and per unit cost while at the same time introducing natural resistance to plant pests. Resistance to pests will allow the world's farmers to reduce their dependence on pesticides. Increased yield efficiency will reduce inputs of nitrogen and other nutrients, which will reduce unit cost and minimize environmental impacts. The University of California is a world leader in the introduction and testing of new or improved specialty crops. Many of these crops are especially useful to smaller farmers. Many are targeted to growing ethnic markets, which are a rapidly growing sector of the U.S. marketplace.

With the assistance and leadership of UC researchers and extension academics, California is a leader in new product development and improvement. Farmers, in partnership with processors, are developing new agricultural products that will add greater diversity to diets and provide new marketing opportunities in the world marketplace.

Last year, 478 local extension programs were delivered in this program area. In addition, 37 statewide collaborative workgroups and continuing conferences composed of both AES and CE academics planned and conducted research and extension projects. UC ANR has 6 Statewide Special Programs that brought together AES and CE resources and personnel that addressed critical issues in the state that are included within National Goal 1. California academics received 14 patents, and published 971 peer-reviewed articles and 78 extension publications that addressed Goal 1.

FY 2003-2004 Allocated Resources

Extension Federal Funds (Smith Lever 3 b&c)	Extension State Match	Research Federal Funds (Hatch)	Research State Match
$3,404,449	$16,310,997 [165.81 FTE]	$2,654,828	$51,886,575 [204.52FTE]

Theme: 1.01 Adding Value to New and Old Agricultural Products

Title: ECONOMIC ANALYSIS OF THE WORLD WINE AND GRAPE ECONOMY

Description: Develop the capability to analyze the patterns in world trade, domestic production, consumption and prices. This will permit analysis of various scenarios regarding the level of foreign imports, industry consolidation, and various policy instruments. Based on this information on the five causes given above, analysis will be undertaken of the impact on growers, wineries, location and extent of planting, and growth of imports and exports. This information will be combined with previously developed material into a more comprehensive model to analyze the worldwide wine and grape economy outlook. During 2003, the project resulted in one research paper accepted at a peer-reviewed journal. The paper analyzed the determinants of contract choice and contract provisions for California wine grape contracts between growers and vintners. The analysis used data from a 1999 survey of California wine grape growers. Growers in the premium coastal growing regions are more likely to use formal written contracts than are growers in the Central Valley. The longer a grower had been with a specific buyer the more likely he was to use a formal written contract. Written contracts for high-quality grapes are more likely to include provisions regarding the production process, while written contracts for low-quality grapes are more likely to include explicit financial incentives for sugar content and other product attributes. Wine is one of the world's oldest drinks, but production and consumption remain concentrated in France, Italy, and Spain, which have 3 percent of the world's population, produce 52 percent of the world's wine, and consume 43 percent-an average 22 gallons per adult per year (there are five 750-ml bottles in a gallon). Most Americans do not drink wine regularly, and US wine consumption fell in the 1990s; Americans average 2.2 gallons or 12 bottles of wine a year. The 30 million Americans who drink wine regularly drink 90 percent of the wine consumed in the US, an average 12 gallons or 60 bottles a year. There is a battle fermenting in the wine business between Old World European producers and New World producers in Argentina, Australia, California, Chile, New Zealand, and South Africa. Do consumers prefer the Old World approach to making wine; to mix varieties of grapes and make wine that reflects the local terroir (soil and climate), meaning the wine varies from year to year; or the New World approach of using one variety of grapes and aiming to produce wine with a consistent taste year after year, such as Mondavi Chardonnay? During the 1990s, the price gaps between the major types of wine widened, even though quality gaps narrowed, and Americans and Western Europeans drank less but better and more expensive wine. In California, falling jug wine sales put downward pressure on land and winery prices in California's Central Valley, where 70 percent of the state's wine grapes are produced. Growers received an average

$462 a ton in 2002, or 23 cents a pound for wine grapes, but Napa grapes were worth an average $2,942 a ton ($1.50 a pound), while Fresno-area wine grapes were worth $136 a ton (7 cents a pound). It takes 2.7 pounds or about 600 grapes to make a 750 ml bottle of wine, so the average value of the grapes in a bottle of California wine was 62 cents in 2002, and ranged from less than 20 cents for Fresno grapes to $4 for Napa grapes.

Impact: This analysis provides the wine industry with its first overview of contract design and use, and helps growers and vintners understand the value of grape quality, which plays a key role in decisions about whether or not to use a contract. The market analysis papers explain how the wine industry could evolve to operate at very different levels of profitability, depending on market segment.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.01 Adding Value to New and Old Agricultural Products

Title: MENDOCINO COUNTY REGIONAL MARKETING EFFORTS

Description: Mendocino County's economy is undergoing a fundamental shift. In 1970, 42% of the workforce was employed in timber and fishing. Today, only 7% work in those industries, and both are declining in economic activity. Meanwhile, tourism and agriculture have grown greatly in value. In fact, the two leading industries are wine and lodging, both of which are dominated by relatively small businesses that are family-owned and employ less than 20 people. Food processing and similar businesses are also small and find it difficult to compete. Small businesses seem to do best in market niches that require effective promotion and marketing, but many of them cannot afford that expertise. Recognizing the need to support Mendocino County's many small food producers and processors, a coordinated effort was begun to promote the county as a food and wine region. In the early 1990's, UCCE helped to organize five Mendocino Bounty Food and Wine Showcase public tasting events to demonstrate the diversity and high quality of local food and wine. The events were immensely popular, drawing as many as 3,000. UCCE and Mendocino County were successful in receiving $65,000 for a study on feasibility of promoting regional tourism and agriculture. The study included a very detailed situation analysis looking at the capacity of existing businesses and their ability to grow. It also examined how other regional tourism and agricultural promotions are organized and function, and what would be a reasonable model for Mendocino County.

Impact: The Mendocino County Promotional Alliance has been formed as a non-profit "organization of organizations" to promote the county as a significant tourist destination with excellent food and wine. Participants in the Alliance represent lodging, wine, agricultural producers, tourist attractions and chambers of commerce. Funded with a county lodging bed tax, the program also receives matching funds and in-kind services from its members. Annual budgets are now approaching $700,000 per year, and tourism has substantially increased. Activities include two county festivals during the off season when visitor numbers are down, "FAM Tours" organized for food and wine writers, group advertising in newspapers and magazines, an official Mendocino County Tourism Website (gomendo.com), official visitors guide and a political advocacy group for the tourism and wine industry. The Alliance is now

forming two business improvement districts that will generate additional funding. UCCE continues as occasional advisor, but the group has gained its own autonomy and is functioning very well.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 1.01 Adding Value to New and Old Agricultural Products

Title: NEW USES OF AGRICULTURAL PRODUCTS IN CONSTRUCTED TEXTILE DESIGN

Description: Objectives are: to develop new, creative usage of agricultural waste materials derived from food cultivation applied to constructed textile design; to increase opportunities for conversion of pruning waste to value-added products; to expand available textile construction techniques appropriate to wood-plant and branch-type material; to produce new, improved and/or alternative constructed textiles; and to increase interaction with the agricultural community regarding objectives 1 through 4. The continuing exploration is development of uses for waste from agricultural and sustainable forest, park and garden practices in visual and design arts objects with the potential to help educate the public about, and help alleviate various problems associated with, unwanted tree growth. Work now includes urban/suburban growth and use of woody biomass materials that pose a high wildfire hazard. Though some tree debris is valued as habitat for birds, insects, rodents, fungi, worms, etc., this project assumes excess growth can be put to useful purposes in hand-constructed textile items creating value-added objects introducing ecological and sustainability issues to the field. The project is garnering attention and though it is difficult to show causality, there are increasing numbers of exhibitions, books, articles and programs addressing these materials and issues related to them as the project's results are being exhibited nationally and internationally. Reaching audiences is a goal of the project. A number of exhibitions of research results occurred during 2003. The book, PORTFOLIO COLLECTION: Gyongy Laky, was released by Telos Art Publishers (UK) and, a new major work was requested by an international jury as one of only five US artists for the most prestigious exhibition in the field, Spring, 2004 (130 artists from 47 countries). This will be the first work of its kind to be included in the vast facility and has been solicited for inclusion in the permanent collection - perhaps the most extensive and most significant contemporary collection in the field. A video, Gyongy Laky (Odyssey Video, UK) was up-dated in 2003 and is being re-released internationally. The Smithsonian Institution Archives of American Art has requested to be the repository for original papers and documents associated with the work of this project establishing a Gyongy Laky research collection at the Smithsonian. Objects incorporating use of branch pruning continues, but the project is being altered to explore other bio-based material development and use. The potential to develop recycled paper slurries (with fly ash) as a medium for capturing chip and other small scale debris from woody biomass is being addressed and appears promising. Branch constructions continue to explore ways of combining traditional textile methods with furniture techniques such as pre-molding curves, non-traditional joinery doweling, sections, multiple modules and complex-curve templates -- making possible increased scale and expanded uses. Recent work with older growth parts of trees continues with hopes for adding wood from tree removal due to Sudden Oak Death. Salvaging the infested wood is far

more complex since the material must be treated prior to use in order not to spread disease. Efforts will require working with collaborators who have the scientific background and knowledge to guide handling of infected materials.

Impact: The project's overall impact is promoting conversion and use of excess tree growth into value-added textile objects and products. Discarding woody biomass waste is re-contextualized as resource recovery and utilization rather than waste management, emphasizing creative uses in new and alternative applications for design and art, encouraging and educating an audience for them.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.02 Agricultural Competitiveness

Title: AGRICULTURAL POLICY, TRADE AND ECONOMIC WELFARE

Description: Objectives are to: 1) examine the effects of technological adoption, factor development and policy in developed and developing countries to understand their implications for trade and their domestic and international welfare consequences and 2) examine the implications of economic and particularly agricultural growth in principle US trading partners to better understand the effects on US and California producers and consumers. Work on this project involves the analysis of state trading enterprises, and the importance of the WTO negotiations and other policy developments for California agriculture. A paper with Smith and Marette models the impact of state traders in downstream markets when product quality matters. They identify important distortions associated with state trading agencies that have not otherwise been identified in the literature. Separate research has analyzed the implications of the ongoing WTO negotiations for California agriculture and they find that California has a big stake in further globalization and the reduction of trade barriers.

Impact: Trade is extremely important for California agriculture. This project identified how state traders impact California agriculture and analyzed the implications of increased globalization on California agriculture.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.02 Agricultural Competitiveness

Title: CALAVERAS GROWN PROGRAM

Description: Farming in the foothills of California is a challenging way of life. With the Sierra on one side and the lush Central Valley on the other, the oak woodland of the foothills offers a unique landscape for farming operations. The moderately fertile to poor soils provide for a variety of commodities ranging from livestock on dry rangeland, fruit and nut orchards and vineyards on deeper soils, and annual fruit and vegetable crops in between. Most farms in the

Sierra Nevada foothills are small operations. With an ever-increasing supply of commodities from other countries, many farmers are feeling financial pressure and those on smaller farms even more. Small operations that don't have the money to market their products through commercial channels are usually the first to go under. However marketing in a small community can have its advantages. Many consumers have come to realize the benefits of buying local products. Food that has not traveled hundreds or even thousands of miles will be fresher, riper, tastier and more nutritious. Cooperative Extension advisors provided the leadership and expertise to organize and launch this new program. By obtaining grant funding they were able to develop a logo and numerous marketing materials. They helped the group gain their non-profit status. They organized and presented three educational conferences and have written and recorded 52 weekly educational radio programs supporting the organization.

Impact: Local markets now carry locally produced items bearing the Calaveras Grown logo. Calaveras Grown, which now has about 60 members, has become the predominant agricultural organization and educator. Growers have increased profitability. Four producers have developed new niche products to market under the Calaveras Grown logo.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 1.02 Agricultural Competitiveness

Title: COW-CALF QUALITY ASSURANCE

Description: The objective of this project is to help assure the supply of quality beef for consumers, both small and large beef producers can benefit from training in practices that minimize carcass damage and improve the health and well-being of the animal. A UCCE Farm Advisor worked with the local Tahoe Cattlemen's Association in holding six Cow-Calf Quality Assurance training events for producers in Placer and Nevada Counties. The beef producers received instruction on food quality and safety, animal health, animal handling, record keeping and genetics. They also participated in live animal demonstrations on injection sites for vaccines. Participants review each topic by completing a written quiz. Those who complete all topics and quizzes receive a certificate. Over 500 local producers and youth have completed the quality assurance training.

Impact: When quality assurance procedures are implemented on their ranch, cattle producers may advertise that their animals are treated according to quality assurance guidelines. Once the training is complete, producers have the knowledge and skills needed for understanding of drug labels, proper choice of needle and injection sites, sanitation of the cattle working area, transportation, cattle handling and record keeping.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 1.02 Agricultural Competitiveness

Title: GENETIC IMPROVEMENT OF BEANS (PHASELOLUS VULGARIS L.) FOR YIELD, PEST RESISTANCE AND FOOD VALUE

Description: The objective is to maximize productivity and global competitiveness.

A F2 population of a genetic male-sterile common bean, obtained from M.J. Bassett, was planted in twelve rows, 30 feet long, August 8, 2003. Seeds were 4 to 6 inches apart in the row. Two hives of honeybees were placed near by. Honeybees, cucumber beetles and flower thrips occasionally visited bean flowers. The mean number of spindly-branch plants per row that set one pod was 13, and the mean number with no pods was 10. For fertile plants, pod number ranged from 1 to 13, with a mean of 2.78. Seeds per pod ranged from 1 to 6. Honeybees prefer lima bean flowers. The mean rate of outcrossing of bush baby lima Luna by vine baby lima Mezcla plants isolated 12 to 16 feet away was about 1.0% at Irvine, CA with natural populations of bees. An isolation distance of 50 feet resulted in 0% outcrossing.

Impact: The field experiment demonstrated that insects, possibly honeybees, will cross pollinate male-sterile, common bean plants and produce F1 hybrid seed, though at low frequency. Baby lima bean isolation distance in 2002 for less than 1 percent outcrossing exceeded 16 feet.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AZ, CA, CO, FL, GA, MI, MT,ND,NE,NY,OR,PR,WA,WI

Theme: 1.02 Agricultural Competitiveness

Title: GENETIC IMPROVEMENT OF PEACH AND ALMOND

Description: The program objective is to breed improved commercial varieties of processing peach and almond possessing disease and pest resistance, high yields, and good product quality, including improved post harvest phytonutrient content and fruit textural quality in peach, and self-compatibility and aflatoxin resistance in almond. Improved varieties should be free of epigenetic disorders such as Noninfectious Bud-Failure which plague current extensively planted, vegetatively propagated tree crops. Because of the absence of needed resistance and production traits in current germplasm, required genes often must be transferred from related species. Improved molecular and biochemical/structural markers for these resistance and horticultural traits, thus need to be concurrently developed to allow efficient gene transfer to commercially acceptable varietal types. Processing peach and almond are major agricultural industries in California with a combined farm-gate value of over $1.2 billion. Continued viability of these California commodities is crucial to the economic survival of the mostly family farms producing these commodities, as well as the associated rural communities built around these farming and processing enterprises. A major limitation to the genetic improvement of peach is the genetic uniformity of present cultivars and breeding lines. Almond is readily crossed with peach and interspecific hybrids provide important rootstocks such as the recently released 'Nickels' rootstock. Considerable trait variability exists in the cultivated almond and wild almond-like species that are found wild from North Africa to China. The transfer of these traits to peach by interspecies hybridization followed by several generations to backcrossing to peach, has led to the recovery of a range of potentially useful traits. These include modified tree shape,

size, and structure; modified fruit bearing habit including spur-bearing peaches; and low bruising, long-hanging peaches which facilitate once-over and mechanical harvesting. Field resistance has been observed for the diseases brown rot, powdery mildew, peach leaf curl, and Phytopthora rots. Certain traits, such as brown rot resistance and spur-bearing habit were recovered in locally adapted peach breeding lines using recurrent selection strategies. Several traits occurred as novel variants and are not easily predicted from parent phenotypes. These preliminary observations, based on the transfer of only a very small proportion of the available germplasm, suggests a previously under recognized value of almond germplasm to peach cultivar and rootstock improvement.

Impact: Genetic solutions to problems resulting from the rapid losses in traditional agro-chemicals, productive land, and skilled labor for California processing peach and almond is essential for continued viability of these industries. New rootstocks and scion varieties with improved resistance and productivity results in improved production efficiency, reduced agro-chemical contamination of California ecosystems, and provides a safer product to the consumer.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.02 Agricultural Competitiveness

Title: GENETIC IMPROVEMENT OF WALNUT

Description: The objectives of the Walnut Improvement Program are to breed and engineer new walnut cultivars and rootstocks that serve a need in the California walnut industry and to develop the germplasm, knowledge and tools for future genetic improvement. Traits targeted for improvement for new cultivars include hypersensitivity to the cherry leaf roll virus (CLRV), blight resistance, increased precocity and earlier harvest dates. For rootstock the objective is to develop clonal rootstock and the means to produce it. Traits of interest include resistance to Phytophthora root and crown rots, crown gall, nematodes and tolerance to the cherry leafroll virus. The goal of the Walnut Improvement Program is to breed or engineer new walnut cultivars and rootstocks that serve a need in the walnut industry and to develop germplasm, knowledge and tools for future breeding efforts. Traits targeted for improvement include pest and disease resistance, increased precocity and earlier harvest dates. Materials now under investigation include 7,000 seedlings derived from controlled crosses or supplemental pollen crosses. Over 50 selections have been made from among the progeny of previous crossings. Four of these have advanced as releases for patenting. Over 20 rootstock selections have been micropropagated for field trials and confirmation testing. The SCAR markers designed to aid in selection of progeny with hypersensitivity to the cherry leaf roll virus in backcross populations have been improved with very clear differentiation of bands visible in agarose gels.

Impact: As a result of this program, walnut growers are extensively planting the new cultivar 'Tulare', a vigorous and precocious cultivar with high yields and quality. 'Tulare' has also been identified as a unique source of resistance to aflatoxin.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.02 Agricultural Competitiveness

Title: INVESTIGATIONS OF THE STRUCTURE AND DEVELOPMENT OF ROOTS IN FLOWERING PLANTS

Description: A: Apical organization in flowering plant roots occurs in two patterns - open and closed. In this project, a UC researcher did an in-depth comparative analysis of the root apical structure in dicotyledonous plants. So far he has surveyed approximately 120 species in over 40 families. The intention is to increase this sample size to at least 300 and to expand the project to include monocotyledonous plants. B. Root caps are important structures necessary for root growth. Preliminary work indicated that the root cap is organized in three different basis patterns. In the next phase of this project the researchers will continue the comparative analysis of root cap structure in flowering plants. C. The researchers have determined that in A. thaliana and T. repens that they produce their epidermis and peripheral root cap using a common developmental pathway involving a T-division of the root cap / protoderm initial. They will expand this analysis to as many flowering plants as possible. This will be done in concert with objective #a. The study during this reporting period continued to concentrate on the structure and function of roots of vascular plants. The most important published work concerned the phylogeny of plants using root apical organization as a character (Groot et al. 2003). This is the first time that apical organization was used as a phylogenetic character and it showed quite clearly that roots with intermediate open organization were ancestral followed by a transition to closed at the base of the core eudicots. The other work during this period showed that all roots with closed apical organization tended to change their apical organization pattern during growth and that all roots tended to reach a determinate length. This is a fundamental change in the understanding of root growth because it implies that all roots cease elongation at some point and that roots do not elongate indefinitely. In Bloom et al. (2003) the role of different forms of nitrogen in the growth of roots is discussed. Two other projects that are ongoing concerns Pierces disease and the mechanism for the movement of the bacteria, Xylella fastidiosa, in grape vines and a new project on the presence of border cells related to root apical organization type.

Impact: These studies are aimed at understanding the fundamental principles underlying the development and function of roots in plants. Root tips are involved in regulation of mineral absorption processes and the control of cell development, and root caps protect meristems and facilitate root tip movement in the soil. Understanding these processes will lead to better cultural practices for food crops.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.02 Agricultural Competitiveness

Title: LAKE AND MENDOCINO CATTLE PRODUCERS TRAINED IN BEEF QUALITY ASSURANCE

Description: There is growing concern among consumers about the quality and safety of the beef they consume. The 2000 National Beef Quality Audit listed the top concerns/desires of

consumers as concerns about bacterial contamination and antibiotic residues; desire for "traceback" information, "natural" beef and organic beef; and concerns about animal welfare and the environment. In response, the National Cattlemen's Beef Association (NCBA) has set a series of industry goals to be achieved by 2005. One of the most important of those goals is 100% Beef Quality Assurance (BQA) training for beef producers. (The other goals deal with such topics as grade standards, cattle management, information systems, transportation and handling equipment, and improved eating quality of beef.) The mission of the Beef Quality Assurance program is to maximize consumer confidence in and acceptance of beef by focusing the industry's attention on beef quality through the use of science, research and education. For the past 11 years, a team of UCCE advisors and specialists and Experiment Station scientists (Beef Safety and Quality Assurance Workgroup) has been working to achieve the industry's listed goals. They developed a Beef Quality Assurance curriculum in addition to conducting research and presenting educational training through workshops, seminars and field days. In Mendocino and Lake Counties, UCCE livestock and natural resources advisor conducted a total of eight beginning and advanced Beef Quality Assurance workshops and field days on such topics as Cattle Residue and Contamination Avoidance and Reproductive Efficiency in Beef Cattle. In addition, a special multi-state program on the Cow-calf Producer Manual was delivered, insuring that producers received the best technical manual available.

Impact: In Lake and Mendocino Counties, 426 ranchers are certified as having completed the eight beginning and advanced Beef Quality Assurance programs (100% participation). Of the 115 producers attending a recent field day on vaccination technique in the Covelo area, 70% indicated that they had been giving injections improperly or not disposing of biologicals or medical waste safely, and that they would change their procedures and keep better records. Training in chute inspection and passive handling techniques have significantly reduced carcass bruising and improved animal welfare. Many producers are marketing cattle as meeting beef quality assurance guidelines. Four cattle ranchers in Mendocino are now producing certified organic beef.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 1.02 Agricultural Competitiveness

Title: MOLECULAR MECHANISMS FOR THE MAINTENANCE OF PHOTOSYNTHESIS

Description: The research seeks to investigate the biochemical mechanism of a novel process that utilizes sunlight in photosynthesis to generate hydrogen in the green alga CHLAMYDOMONAS REINHARDTII. The recently developed single-organism two-stage photosynthesis and hydrogen-production method circumvents the severe oxygen-sensitivity of the enzyme `Fe-hydrogenase' by temporally separating photosynthetic oxygen evolution and carbon accumulation (Stage 1) from consumption of cellular metabolites and concomitant hydrogen production in the light (Stage 2). A switch from Stage 1 to Stage 2 will be effected upon sulfate deprivation of the culture, which reversibly inactivates photosystem-II and oxygen evolution in the chloroplast of the algae. The proposal seeks to elucidate the molecular mechanisms that support hydrogen production in the chloroplast of green algae, and to identify

and characterize the genes and proteins that are essential for this process. Physiological, biochemical and molecular genetic analyses are proposed. The research is of both fundamental and practical importance. Fundamentally, the research will address novel metabolic pathways, cellular processes and their regulation, leading to hydrogen production in green algae. Practically, information gained from this research will be useful in efforts to increase the yield of this process. Photosynthetic hydrogen production by green algae may hold the promise of generating a renewable fuel from nature's most plentiful resources, sunlight and water. It will increase the value of the US and world agriculture, as, in addition to hydrogen, scaled-up application of the method would produce substantial amounts of green alga biomass, a multi-purpose and nutritionally useful by-product. To elucidate the mechanism of an irradiance-dependent adjustment in the chlorophyll (Chl) antenna size of DUNALIELLA SALINA, UC researchers investigated the regulation of expression of the Chl a oxygenase (CAO) and Lhcb genes as a function of Chl availability in the photosynthetic apparatus. Following a high-light to low-light shift of the cultures, levels of both CAO and Lhcb transcripts were rapidly induced by about 6-fold and reached a high steady-state level within 1.5 h of the shift. This was accompanied by repair of photodamaged photosystem-II reaction centers, accumulation of Chl a and Chl b (4:1 ratio), photosystem-I, light-harvesting complex and by enlargement of the Chl antenna size of both photosystems. In gabaculine-treated cells, induction of CAO and Lhcb transcripts was not affected in spite of substantial inhibition in de novo Chl biosynthesis. However, cells were able to synthesize and accumulate some Chl a and Chl b (1:1 ratio), resulting in a marked lowering of the Chl a/Chl b ratio in the presence of this inhibitor. Assembly-incorporation of light-harvesting complex and a corresponding Chl antenna size increase, mostly for the existing photosystems, was noted in the presence of gabaculine. Repair of photodamaged photosystem-II was not affected by gabaculine. However, assembly-accumulation of new photosystem-I was limited under such conditions. These results suggest a coordinate regulation of CAO and Lhcb gene transcription by irradiance, independent of Chl availability. The results are discussed in terms of different signal transduction pathways for the regulation of the chlorophyll antenna size by irradiance.

Impact: The goal of the research is to elucidate the molecular mechanism for the regulation of the chlorophyll antenna size in photosynthetic organisms. Research is directed toward identification of those genes that confer a truncated Chl antenna size in green algae. Functional properties of these genes are being investigated. The research is of both fundamental and practical importance. It has been shown that a "truncated chlorophyll antenna size" enhances photosynthetic productivity in microalga mass cultures and will benefit the increasingly important alga biotechnology industry.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.02 Agricultural Competitiveness

Title: NEW WINE GRAPE VARIETALS FOR CALIFORNIA

Description: California's premium wine industry has been based on wine grape varietals from Northern France, primarily the Burgundy and Bordeaux regions, where climates are very cool

and moist compared to most of California. However, in California these varietals perform best only in limited areas because this state has a warmer, dryer Mediterranean climate. Experience with landscape plantings has shown that many Mediterranean plants are much better suited to the warmth and sunshine of California than plant materials from Northern Europe. Thus, it makes sense to look to the Mediterranean region for wine grape varietals that make fine wines. Many of those varietals have not been grown in the state in the past, but winegrower interest suggested an organized way to evaluate them. Mediterranean varietal trials were established in Lake, Mendocino and San Joaquin Counties with cooperating growers and at the UC Hopland Research and Extension Center. Over 35 varietals were evaluated. Measurements included basic vine phenology (bud break, bloom, veraison, and harvest), harvest data (vine yield, cluster number, berry weight, fruit chemistry including percent sugar, pH and titratable acidity), and pruning weights. Experimental wines have also been evaluated for chemistry and taste. Eight conferences over the last six years have brought in specialists from Europe to talk about winegrowing involving many of these varietals. Countries represented include France, Spain, Italy, Portugal and Australia. New Mediterranean varietals have been imported by the UC Foundation Plant Material Service at UC Davis so that growers will have access to healthy, productive, high quality selections for their vineyards.

Impact: The California wine industry now has considerable diversity in its offerings. Ten years ago, most consumers couldn't even pronounce the names of many of the new varieties such as Sangiovese, Syrah, Viognier, Mourvedre and Tempranillo. Now these wines are becoming much more common and production has increased from under 1,000 acres to nearly 25,000 acres today. As winegrowers learn how to grow and make wine from these new Mediterranean wine grape varietals, quality will only get better.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 1.02 Agricultural Competitiveness

Title: STRUCTURE AND DEVELOPMENT CROP PLANTS

Description: Objectives are to**:** 1. Investigate when in cotton seed development specific anatomical events occur leading to embryo and endosperm formation; 2, investigate the frequency, timing and location of aborted and underdeveloped seeds (motes) in cotton fruits and their possible relationship with pollination, pollen tube growth, fertilization, and photoassimilates; 3, characterize the structural differences between seed coats of normal cotton seeds and motes; 4, characterize the structural basis of main shoot and fruiting branch initiation and subsequent growth. Based on the anatomical analyses of cotton seeds, UC researchers hypothesized that the maternal tissues form a symplasmic continuum to support embryogenesis. The integumentary connective tissue and the transition zone of the ovule appear to be essential passageways for nutrients and may control solute translocation and allocation for embryo growth and development. The objective of this study is to trace the movement of solutes in cotton seeds using fluorescent dyes and to analyze pathways for and barriers to solute movement within normal and abortive cotton ovules of various developmental stages. In developing cotton ovules, epidermal layers separate the outer integument from the inner integument and the inner

integument from the nucellus symplasmically in most parts of the seed except at the chalaza. At this point, the integumentary connective and the transition zone are hypothesized to symplasmically connect the maternal tissues. Seeds of the red fiberless mutant were removed from bolls at 25 days postanthesis (25 dpa) and the fluorescent dye carboxyfluorescein was applied to the funiculus. Transverse sections of the ovule chalaza showed fluorescent vascular bundles that diverged from the funiculums through the outer integument. In 25 dpa seeds, the fluorescent dye moved from the vascular bundles in the outer integument towards the inner integument through the opening in the palisade layer via the integument connective. Similar movement of aniline blue confirmed the hypothesized connection. In addition, 29 dpa seeds were cut in halves cross-wise and embryo and endosperm were removed. The vacated cavities were filled with fluorescent dyes to trace symplasmic and apoplasmic transfer pathways. The dye moved from the embryo sac via the hypostase and transition zone into the inner integument, and entered the integumentary connective. The fringe layer and the palisade layer appear to be barriers. Future work will identify abortive seeds and compare translocation pathways with those seen in normally developing seeds.

Impact: Knowledge of the structure and development of crop plants is important to growers, processors and researchers, with ultimate benefit to consumers in the form of lower costs, higher quality products, and fewer environmental costs of production. Cotton is the most important fiber crop in California and worldwide, and occupies many acres of cropland. Methods to improve cotton fiber length, strength, fineness and uniformity depend on a thorough understanding of the initiation, development and maturation of cotton fibers and of growth of cotton plants, as investigated by this project.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.02 Agricultural Competitiveness

Title: UC PARTNERS WITH INDUSTRY IN BEEF QUALITY ASSURANCE

Description: Identification and control of pre-harvest critical control points for the safety of beef are necessary. In particular, the beef industry wants to eliminate residues and contamination in market beef and dairy beef products; enhance food safety and microorganism biosecurity at the beef production level, including prevention of zoonotic diseases; and improve medical care, including appropriate drug antibiotic use, and avoid development of antibiotic resistance. UC and the California Cattlemen's Association (CCA), in response to the growing need for a Quality Assurance Program (QAP) for beef producers, began offering educational programs and certification for beef producers in 1990. The program has proven, by attendance and management-practice improvements, that voluntary, industry-led QAPs can be successful. CCA's Basic Cow-Calf Quality Assurance Program was first offered in English in 1993 and in Spanish in 1994. Most basic sessions are offered by a UCCE livestock advisor at the request of a local cattlemen's association or producers' group. The four-hour program consists of videos and quizzes; most also include a chute-side session on animal handling or injection site lesions. Program development was supported by the California Beef Council with check-off dollars.

Because the basic cow-calf program lasts only four hours, some concepts are not covered in as much detail as producers desire. Therefore, UC and CCA developed three expanded, advanced educational programs: Advanced Animal Health (1994), Advanced Genetics and Value-Based Marketing (1995), and Advanced Residue Avoidance and Reproduction (2000).

Impact: Diseases of significant concern to public health--such as BSE, Brucellosis, E. Coli O157:H7, Johne's and Tuberculosis--were emphasized to inform producers of the potential risk to human health. Other diseases result in an increased use of over-the-counter (OTC) drugs, extra-label doses of OTC drugs and prescription drugs, resulting in major residue problems that occur in market beef at slaughter. Early detection and programs designed to identify and reduce risk have been emphasized. The potential for disease impacts on end product marketing, quality and public perception were discussed. Ultimately, producers who are beef quality assurance certified have the specific knowledge to develop their own residue and contamination avoidance programs--making beef safer.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 1.03 Agricultural Profitability

Title: AGRICULTURAL INDUSTRIAL ORGANIZATION AND LABOR STUDIES

Description: There are five objectives for this project: 1. Demand Estimation: Researchers will extend existing empirical techniques to estimate consumers' demand functions using grocery scanner household data where many families may buy no relevant goods on a given shopping trip. New econometric approaches are necessary because existing approaches cannot handle estimating large numbers of goods simultaneously when censoring (no purchases) are involved. New theories and methods are also need to estimate consumers' demands both across products and across time. To date, virtually all demand research has ignored the time element (which is crucial if they are to study sales activities and other policies that affect decision making over time). The researchers will determine the degree of bias of previous studies that have aggregated over time, over brands or products, and that have ignored sales. 2. Market Power: The researchers will estimate the degree of market power (the ability of firms to profitably set price above cost) in all their major studies taking account of their new work on demand. For example, existing research has largely ignored the role of sales (temporary price reductions) activities and other price discrimination schemes on market power. To accomplish this goal, they will need to develop need theoretical economic models and new estimation approaches. 3. Sales: They will determine the effect of sales, promotions, and various other strategic activities of firms and government regulations on the well-being of consumers. To date, the effects of sales activities and many government regulations have largely been ignored in the literature on foods. Again, to accomplish this goal, they will need to develop need theoretical economic models and new estimation approaches. 4. Milk Marketing Regulations: The researchers will examine which consumers are harmed and which are helped by milk marketing regulations. 5. Labor: They will study the effects of government regulations and transfer programs on labor markets and consumer welfare. The work has been extended using maximum entropy and other information econometrics techniques. The researches have developed a new method of estimating

distributions using only limited summary statistics. This method has been used to estimate income distributions and examine factors causing shifts in these distributions for China and the United States. In addition, they have studied the effects of pollution permit allocations in Southern California on emissions by firms and have also studied the incidence of federal and state gasoline taxes on consumers, retailers, and wholesalers.

Impact: The work on income distributions has influenced researchers at universities and the World Bank. In the first month that it was available, the paper on the income distribution of China over time was one of the top ten most SSRN's Top Ten download list for Transition Economics Recent Hits. Several government agencies are carefully studying the work on estimating densities using summary statistics to determine if they need to impose more safeguards to protect confidentiality. The paper on pollution permits will hopefully influence the debate on how such permits are allocated and on how well the market can handle pollution problems. Similarly, the paper on the incidence of gasoline taxes should affect choice of tax instruments at the federal and state level.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.03 Agricultural Profitability

Title: AGROBACTERIUM PLANT TRANSFORMATION, PLANT VIRUS MOVEMENT VIA PLASMODESMATA, AND FLOWER DEVELOPMENT

Description: Molecular, genetic, and cell biological methods are used to address fundamental questions in three different areas: plant transformation by Agrobacterium, plant virus movement via plasmodesmata, and flower development. (1) Agrobacterium is the most widely used vector for plant transformation, and the basic principles underlying this trans-kingdom genetic transfer continue to provide clues into many basic bacterial and plant processes, from cell-to-cell signalling, to DNA processing, to nuclear localization. Their future efforts are to uncover the structure and function of the trans-membrane channel used by Agrobacterium to transfer DNA from inside the bacterial cell to the plant cell. This channel has become the paradigm for what is termed, type IV secretion, and is utilized also by animal pathogens to transport toxins into host cells. (2) Plant cells are encased in cell walls, so individual cells do not touch. Thus, plants have evolved membrane lined cytoplasmic bridges, called plasmodesmata, to span cell walls, linking the cytoplasm between adjacent cells. The researchers have determined that plasmodesmata are inherently dynamic, changing their aperture in response to developmental and environmental signals. Future work aims to identify and characterize genes that affect plasmodesmata structure and function, as well as to characterize plasmodesmata fluctuations during different stages of plant development. (3) They used mutants with altered floral organs in the model plant Arabidopsis to uncover genes essential for plant reproductive growth. Besides studying overall floral development, their studies are particularly focused on the gynoecium. In addition to its obvious agronomic importance in the production of fruit, there is little information on the molecular mechanisms underlying the complex patterns of morphogenesis during gynoecium development. Molecular, genetic, and cell biological methods are used to address fundamental questions in three different areas: plant transformation by Agrobacterium, intercellular

movement via plasmodesmata, and flower development. (1) Agrobacterium: Ongoing efforts are to uncover the structure and function of the trans-membrane channel used by Agrobacterium to transfer DNA from the bacterial cell to the plant cell. This channel is the paradigm for type IV secretion, and is utilized also by animal pathogens to transport toxins into host cells. Twelve major protein components form this channel. A high-resolution screen testing for interaction between peptide fragments revealed several protein subassemblies. Notably, the researchers demonstrate a complete interaction pathway from the inner membrane to the periplasm and the outer membrane via interactions between B11, B9, and B7, respectively. Further, interaction between B1 and B8 provides a means to localize sites for channel initiation. This information along with other protein interaction data predicts a model of the topology of the Agrobacterium type IV channel. (2) Plasmodesmata: Plants have evolved membrane lined cytoplasmic bridges, called plasmodesmata (PD), to span cell walls, linking the cytoplasm between adjacent cells. While there is increasing fundamental knowledge about the ultrastructure and function of PD, there is almost no information on the genes that control their structure and function. They performed a genetic screen for mutants with altered PD function using embryo lethal mutants in Arabidopsis. One mutant line maintains the ability to traffic large fluorescent tracers throughout embryogenesis, whereas wild-type embryos down regulate PD aperture during the mid torpedo stage. The researchers have fine-mapped the mutation and have a candidate gene currently under investigation. They have also demonstrated that PD of the shoot apex fluctuate in aperture during the transition to flowering, closing down during initiation of the floral morphogenetic program, and then reopening when the program is established. These data imply that regulation of cell-to-cell transport via PD is another important factor (in addition to transcriptional regulation of floral specific genes) in the establishment of floral development. This project links the research on PD to the third area of research. (3) Flower development: The work on flower development focuses on the gynoecium, and on a particular gene, ETTIN (ETT), that profoundly effects gynoecium development. They have found that ETT encodes a transcription factor that mediates its effects largely through the plant hormone auxin. Recent efforts aim to identify mutants that either enhance or suppress ett mutants, and thereby identify other gene products that act during the auxin signaling cascade to program complex morphogenetic programs. To date two loci have been identified two loci, that when over-expressed, enhance the phenotype of a weak ett allele. Mapping of these loci determined that they correspond to previously known genes, SEUSS and FLOWERING TIME LOCUS. However, the data are the first to link the action of these genes to patterning of development in the gynoecium.

Impact: The above studies are basic, but form a foundation for more applied research to block pathogenesis, increase or decrease cell to cell communication in plants, and improve fruit quality and yield.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.03 Agricultural Profitability

Title: CALIFORNIA PROCESSING TOMATO VARIETY EVALUATION

Description: Tomatoes are the leading processed vegetable crop in California. Annual production is about 10 million tons of fruit, grown on more than 260,000 acres and with a total on-farm value exceeding $608 million. Processing tomatoes are grown throughout the state and in many soil and temperature regimes. Under such diverse growing conditions, the performance of different varieties also varies greatly. One that does extremely well along the Central Coast may simply not set fruit out on the West Side in Fresno County. UCCE farm advisors each year conduct coordinated, regional processing tomato variety trials in counties throughout the state. Varieties are selected after extensive discussions among farm advisors, commercial processors and seed companies. The tests are then conducted with a cooperating grower in producing tomato fields, using commercial harvesters. Because the plots are large (100 ft), under the same growing conditions and procedures as the rest of the field, and machine-picked, there is a high degree of confidence that the data represent real world conditions. Yield data are collected using a specialized harvest gondola outfitted with sensitive weight-sensing bars. The harvester conveys the tomatoes to the gondola, pauses while a weight is taken, then continues on to the next plot. All this information is then integrated, analyzed and reported in newsletters, reports, meetings, the California Tomato Grower magazine and other media.

Impact: In 1973, when the trials started in three counties, average yields were 22.3 tons per acre. In 1997, yields had increased to almost 35 tons per acre. As overall production in the state has expanded (9.4 million pounds in 1997), so has the variety evaluation. Trials of both early and mid-season cultivars are now performed annually in six to eight counties. They include both replicated variety plantings and experimental lines not yet ready for commercial release. The results benefit the entire industry by providing unbiased information on which to make variety decisions. Additionally, the trials foster support and cooperation among UCCE, growers and processors.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 1.03 Agricultural Profitability

Title: COMMODITY FORECASTS: METHODS, APPLICATIONS, AND IMPLICATIONS FOR RISK MANAGEMENT

Description: Accurate forecasts of various commodity prices and quantities are of vital importance to the agricultural sector. This project will review existing forecasting procedures for selected representative crops and assess their accuracy. It will also investigate alternatives for improving forecasting accuracy. There are numerous issues surrounding the production and marketing of agricultural commodities, ranging from forecasting the crop to measuring the effects of government regulation and sales promotions to shedding risk via financial markets. Work under this project ranged from improving crop forecasts to analyzing alternative nonlinear demand model specifications to assessing the effects of repeated government policy changes to examining the conditions under which future contracts are settled (see prior progress reports for more specific details).

Impact: The evaluation of forecasting methods has had a direct impact on the procedures of the California Agricultural Statistics Service, which forecasts more than 100 California agricultural

crops. New methods for forecasting prices in interrelated regional markets have been proposed, and issues in the settlement of risk-shedding futures contracts have been identified, with important practical implications. Empirical work assessing market promotion activities has shown the duration of certain types of effects to be far longer than previously believed, a conclusion of great importance to USDA marketing efforts abroad. At a more abstract level, the regulated, deregulated, re-regulated, and re-deregulated microcosm of cable television was used to examine the effects of government policy uncertainty, a major issue in agricultural programs.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.03 Agricultural Profitability

Title: CONTROL OF GENE IMPRINTING IN THE ENDOSPERM

Description: Genomic imprinting in mammals and plants causes genes to be expressed according to their parental origin. In mammals, imprinted genes influence prenatal development, behavior, and human disease. In plants, the endosperm is a critical site for imprinting and, like the extraembryonic membranes where certain mammalian genes are imprinted, mediates nutrient transfer from mother to embryo. UC researchers have discovered that the DEMETER (DME) protein mediates endosperm imprinting. DME has a DNA glycosylase domain that excises 5-methylcytosine from DNA in vitro. DME is expressed in the central cell of the female gametophyte, the progenitor of the endosperm. DME is required for maternal allele expression of the imprinted MEA Polycomb and FWA transcription factor genes in the central cell and endosperm. Ectopic DME expression induces MEA and FWA transcription and analysis of the MEA promoter reveals DME-induced nicking at multiple sites. Mutagenesis of the DME DNA glycosylase active site verifies that base excision activity is essential for DME function in vivo. Thus, DME activates maternal expression of imprinted genes in the central cell. The researchers will perform the following experiments to understand the mechanisms of imprinting. 1) Determine if DME regulates FWA imprinting by excising 5-methylcytosine from direct repeats in the FWA promoter. 2) Elucidate the DNA methylation-independent mechanism used by DME to regulate MEA by delineating DNA sequences essential for MEA imprinting and determining the range of modified bases excised by DME in vitro. 3) Identify imprinted genetic circuits regulated by DME by identifying novel target genes whose transcription is directly activated by DME. 4) Identify proteins that genetically interact with DME by cloning genes that suppress dme mutant phenotypes. 5) Determine if DME functions in a complex to regulate gene transcription by identifying proteins that bind to DME. 6) Delineate upstream components of the plant gene imprinting system by identifying DNA regulatory sequences and transcription factors that restrict DME transcription to the central cell. These experiments will provide insights about the mechanisms used by novel DNA glycosylase proteins to regulate gene imprinting, transcription, and reproduction. They isolated mutations in Arabidopsis to understand how the female gametophyte controls embryo and endosperm development. For the DEMETER (DME) gene, seed viability depends only on the maternal allele. DME encodes a large protein with DNA glycosylase and nuclear localization domains. DME is expressed primarily in the central cell of the female gametophyte, the progenitor of the endosperm. DME is required for maternal allele expression of the imprinted MEDEA (MEA) Polycomb gene in the central cell and endosperm.

Ectopic DME expression in endosperm activates expression of the normally silenced paternal MEA allele. In leaf, ectopic DME expression induces MEA and nicks the MEA promoter. Thus, a DNA glycosylase activates maternal expression of an imprinted gene in the central cell. These results generated four discoveries. First, a novel protein and mechanism has been identified that controls gene imprinting. Second the plant haploid gametophyte generation provides opportunities for the control of imprinting not found in mammals. Third, regulation of gene expression in the female gametophyte profoundly affects subsequent seed development. Fourth, a new link has been discovered that connects DNA repair and gene transcription. They also identified a new gene called raspberry3 that is essential for proper embryo development. Embryos that do no make the raspberry3 protein display raspberry-like cellular protuberances with an enlarged suspensor and are arrested morphologically at the globular stage of embryo development. The predicted raspberry3 protein has domains found in proteins present in prokaryotes and algae chloroplasts. Computer prediction analysis suggests that the raspberry3 protein is localized in the chloroplast. These results demonstrate the vital role of the chloroplast in embryo morphogenesis and development.

Impact: Seed, the end product of plant reproduction, represents the primary nutrient source for humans and domesticated animals. Seeds also produce many industrially important polymers such as oils and starches, as well as vaccines and pharmaceuticals. In plants, imprinted genes control seed size and likely represent a barrier to most forms of parthenogenic seed formation as well as wide species crosses. Understanding the mechanism of gene imprinting improves our ability to control these processes and thereby improve the production of endosperm and seed.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.03 Agricultural Profitability

Title: COTTON PRODUCTION PRACTICES, VARIETY CHOICES FOR INCREASED INPUT USE EFFICIENCY AND PRODUCTIVITY

Description: Objectives are (1) To identify relationships for expected fruit retention patterns for newer Pima and CA Upland Cotton varieties as a function of fruit position and plant developmental stage and compare with known relationships for Acala cotton; (2) to evaluate and document information on varietal performance and regional differences in varietal yield and quality characteristics for Pima, Upland and Acala cotton types; (3) to establish cotton nitrogen uptake and responses to applied N and residual soil N with the goal of assessing utility of soil and plant tissue tests in assessing crop N status and needs for current cotton cultivars; (4) to identify casual factors of bronzing problems with Pima cultivars where possible and identify remedial nutrient applications or other actions for growers; and (5) to evaluate and develop recommendations for management changes needed to utilize transgenic herbicide-tolerant cotton varieties and to improve efficacy of growth regulators in Pima and non-Acala Upland cottons. Cotton variety evaluations were conducted with 6 UC Farm Advisors on Acala, Pima, and CA Upland cotton. Plant growth responses, fiber quality characteristics and yield were evaluated. Data provides growers, seed companies and industry with information on varietal improvements, yield and fiber qualities important to marketability, price. Information was widely distributed

using University newsletters, popular press, and a recently-developed cotton web site where new and older results are archived. New variety screening work was initiated in cooperation with a University of CA Plant Pathologist and a USDA-ARS Geneticist to evaluate a wide range of germplasm for susceptibility/resistance to a newly-recognized strain of a fungal disease, Fusarium. Multi-location trials in the San Joaquin Valley (SJV) were continued with Acala cotton for the 4th year in evaluations of potential impacts on yield and crop earliness of a change from single planted rows of cotton on 30 inch beds to double planted rows placed 7 to 8 inches apart on 30 inch beds. Work in northern SJV showed consistent 5-9 percent yield increases with double row plantings. In ongoing studies, slight improvements in crop earliness (2 to 5 days) with double row plantings have been observed. Multiple trials in central and southern SJV, though, have not been as consistent as north valley locations in improving yields, with average yield improvements in central and south SJV across years being less than 2 percent. In current study, sites with largest percent yield increases with double row plantings have been where establishment of moderate plant populations (40 to 50,000 plants per acre) under single row plantings has been difficult, such as saline soil locations or with large early stand losses to seedling disease. A long-term Pima growth regulator, irrigation management study concluded this year, demonstrating strong interactions between Pima cotton variety, water stress management and relative need for plant growth regulators. Irrigation delays causing moderate stress as indicated by infrared thermometry or leaf water potential measurements could reduce or eliminate need for growth regulators such as mepiquat chloride in more determinate Pima cultivars. Long-term studies of Acala cotton nitrogen (N) requirements and relative utility of soil nitrate monitoring were concluded during reporting period, and guidelines based on the research are in preparation. Results showed at many farm sites and crop rotations in the SJV, residual soil N estimates can be a useful tool to improve nitrogen management. This was based on findings that significant amount of cotton N needs were supplied by residual N at many test locations, reducing fertilizer application requirements. Planting time soil sampling in the upper 2-4 feet for soil nitrates was recommended as a tool to improve estimates of residual soil nitrogen and likely crop yield responses to applied N.

Impact: Variety evaluations provide information on yield performance, fiber quality, important for impacts on profitability. Information gained on newly-recognized fungal organism, including potential varietal susceptibility and resistance. Studies provide basis for new nitrogen management guidelines with potential to improve nitrogen use efficiency using measured soil nitrate. Improved irrigation, growth regulator recommendations for Pima improve best management practices.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.03 Agricultural Profitability

Title: CROP PHYSIOLOGY OF CALIFORNIA TREE CROPS

Description: Objectives: 1. Continue refinements of the computer simulation model for crop and dry matter production of fruit trees with a particular focus on root growth and interorgan competition between like organs. 2. Develop physiological understanding of fruit tree responses

to horticultural practices such as the use of size-controlling rootstocks based on the integrated concepts in the PEACH model. 3. Continue using organ growth potential concepts to investigate cropping responses to environmental stresses. In 2003, UC researchers continued collaboration with a modeling group in Canada to develop a functional-structural simulation model to simultaneously simulate dry matter partitioning and structural development of fruit trees. This work has yielded new experimental approaches for studying and communicating information regarding factors that control dry matter partitioning, tree growth and fruit quality parameters in the field. The evaluation and characterization of size controlling rootstocks for peach and nectarine has also continued. Previous results regarding the role of plant water relations in determining the size controlling behavior of experimental rootstocks were confirmed with controlled laboratory experiments. Studies investigating additional physiological characteristics that may be involved in size-controlling were initiated. Studies of the behavior and control of vegetative shoot growth and its interaction with reproductive growth have continued in pistachio and almond. The respective carbon budgets of spring shoot growth and early reproductive growth have been characterized and studies of environmental factors that influence these interactions have began.

Impact: The modeling project has identified key factors controlling fruit tree growth and fruit yield and indicated what growers can do to optimize crop production and fruit quality. The rootstock research has generated significant grower interest and two rootstocks are being released for commercial use to the California industry. A third rootstock that is already available to growers has been identified as having significant size-controlling potential. Information on the mechanism of dwarfing is being made available to assist growers in optimizing use of these rootstocks.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.03 Agricultural Profitability

Title: GENETIC IMPROVEMENT OF BEANS (PHASEOLUS VULGARIS L.) FOR YIELD, DISEASE RESISTANCE AND FOOD VALUE

Description: Objectives are to broaden the genetic base of common bean through: (a) use of wild bean populations; (b) increase cross-pollination; (c) use and conversion of promising tropical and sub-tropical germplasm; and (d) intra-racial and inter-racial gene pool hybridizations. Yield is a focus of many common bean breeding programs. Up to now, it has been difficult to obtain substantial yield increases in this crop, compared to advances in crops like corn and sorghum. The limited extent to which genetic diversity has been utilized in the development of common bean cultivars could be a major factor explaining this situation. In this study, a wild and a weedy accession were evaluated to determine their potential contribution to increase yield of an elite common bean cultivar. The researchers developed recombinant inbred (RI) populations for the analysis of the inheritance of yield and yield components via quantitative trait loci (QTL) analysis. Inbred backcross (IB) line populations were also developed to assess the value of these wild and weedy accessions for yield improvement. Due to the plant morphology of wild and weedy parental lines, phenotypic evaluations presented field

management challenges that were addressed during the course of this study. Two genetic linkage maps were developed in the RI populations. Approximately 140 markers (AFLPs, ISSRs, CAPS, and RFLPs) were assigned to each map. Genome coverage was about 500 cM per genetic map. At the phenotypic level, none of the IB progeny lines resulting from the cross with the wild accession had yields significantly higher than that of the elite cultivar. However, two QTLs from this accession had a positive effect on yield and/or yield components. Additionally, two IB lines in the progeny of the weedy accession had yields significantly higher than that of the elite cultivar. These results confirm the suitability of the IB method to evaluate the potential of wild and weedy accessions to increase the yield of elite cultivars. Furthermore, the QTL analyses revealed the presence of beneficial wild loci with no discernible undesirable effects that could be further evaluated and introgressed into the domesticated gene pool. The benefit of some of these wild QTLs would not have been detected by a purely phenotypic analysis of both RI and IB populations. These results demonstrate the potential that wild accessions have for improving the yield of domesticated common bean.

Impact: The use of wild beans to broaden the genetic basis of common bean will allow breeders to introduce additional genes not only for disease and pest resistance, but also most importantly for yield. The markers developed here will assist in transferring those traits and simultaneously eliminate undesirable traits from the wild parent.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AK,AZ,CA,CO,GU,HI,ID,MT,MICRONESIA, NM,NV,OR,SAM,UT,WA,WY

Theme: 1.03 Agricultural Profitability

Title: IDENTIFYING COTTON GENOTYPES WITH SUPERIOR PERFORMANCE IN COMMERCIAL PRODUCTION

Description: The goal of this project is to identify cotton genotypes with superior performance in commercial production of the San Joaquin Valley (SJV). The objectives are to: 1) improve yield and quality 2) estimate the relationship between yield and quality parameters and 3) develop new methods and tools to characterize yield and quality parameters. Profitability is the bottom line for California cotton growers and selecting the best varieties for each environment and management practices should help them in making this very important decision. An Acala variety was approved by the San Joaquin Valley Cotton Board and released for commercial production in 2003: C-104 (marketed as Cierra) from California Planting Cotton Seed Distributors. Cierra was a high-yielding Roundup Ready resistant variety. It averaged 1,659 lbs of lint per acre, 119 lbs more than the standard, Maxxa. Its key beneficial trait is resistance to the herbicide glyphosate. 9 on-farm variety trials (four Acala, three Pima, two A1-screening) in 201 acres were planted in the San Joaquin Valley. 10 Acala, 11 Pima varieties and 16 advanced-generation lines were planted on commercial fields in Randomized Complete Block (RCB) designs with four replicates.Acala Tests - 2003 The Acala lint yields in 2003 growing season were from 10 varieties grown at 4 locations. Yields ranged from good to very good, averaging 147 lbs lint per acre (1511 lbs/acre) lower than those obtained in the 2002 season. The highest yielding Acala variety was Olvey and Associates OA-265 with 1643 lbs per acre. At the highest

yielding location near Los Banos in Merced County, 4 varieties yielded more than 1700 lbs or more than 3.4 bales per acre. 5 of the varieties have completed the 3rd year of testing and will be eligible for approval by the SJVCB on March 2. Top-yielding varieties include O&As OA-265 and OA-270 and CPCSDs C-702. The Acala gin turnouts ranged from 0.316 percent (OA-262) to 0.37 percent (C-402). Of the 5 varieties up for approval, all had either equal or significantly lower gin turnouts compared to the standard, Maxxa (0.339 percent).Pima Tests - 2003 Pima lint yields for the 2003 growing season were from 11 varieties grown at 3 locations. Generally, the yields were good, averaging 114 lbs lint per acre (1305 lbs/acre) lower than those in the 2002 season. The highest yielding Pima variety was O&As OA-356 with 1426 lbs per acre. The highest yielding location near Huron in Kings County, 3 varieties yielded more than 1,800 lbs per acre, or 3.6 bales per acre. 2 varieties have completed the 3rd year of testing (OA-353, OA-354) and will be eligible for approval by SJVCB on March 2. Top-yielding varieties include O&As OA-356 and OA-353 and Phytogens PH00P-601. The Pima gin turnouts ranged from 0.282 percent (E-203) to 0.322 percent (OA-356). 5 varieties up for approval, both O&As OA-256 and Phytogens PH00P-612 had a significantly higher gin turnouts compared to the standard, S-7 (0.312 percent).Screening Tests - 2002 The screening lint yields for the 2003 growing season were from 16 varieties grown at 2 locations. Lint yields were good, averaging 389 lbs lint per acre (1437 lbs/acre) less than those obtained in the 2002 season. At the Five Points location (WSFS), one variety yield was estimated to be more than 1800 lbs per acre, or more than 3.6 bales per acre. The screening gin turnouts ranged from 0.307 percent (OA-280) to 0.381 percent (C-603). The top 4 varieties were significantly higher for gin turnout values compared to Maxxa (.339 percent). Based on the lint yield results, there is great potential for new varieties to out perform the current standard. The new varieties offer great promise for SJV cotton producers.

Impact: Continuing to maintain a strong cotton industry is vital to the economic well-being of the San Joaquin Valley where more than 95 percent of the crop is grown. The SJV Cotton Board relies entirely on this cotton variety testing program for data used in making decisions for approving cotton varieties for the SJV. Cotton approved by the Cotton Board has long maintained a world-wide reputation for high-fiber quality. Improved varieties and enabled CA to remain a world leader in high quality cotton production and export.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.03 Agricultural Profitability

Title: PRODUCTION COST DATA IN HIGH DEMAND

Description: Besides farmers, Californians from many disciplines need and use cost-of-production data for California-grown agricultural crops. Before investing in a crop, the farmer needs to calculate the cost of each operation including seed, water, fertilizer, land rent, etc. The sum of these investments is used to estimate the cost of production and the potential profit or loss of the farming venture. A break-even value of each unit of production, such as a carton of lettuce or ton of alfalfa, can be estimated as well. Chief users of the information include farmers, investors, money lenders, government agencies, students, accountants, county and state planning agencies, water districts, environmental groups and a myriad of agricultural businesses. Two UC

Advisors have developed a current spreadsheet-based cost-of-production program for 14 vegetable and eight field crops grown in the Imperial Valley of California. Commodities listed include lettuce, melons, onions, broccoli, cauliflower, carrots, alfalfa, wheat and sugar beets. The bulletins, providing a complete summary of costs from planting through harvest, are available in both electronic and hard copy formats. Upon request, the Excel spreadsheets may be obtained so the budget can be modified to reflect the actual cost to farmers. This allows the farmer to play the "What If" game: What if I change the cost of land rent or what if I use more costly hybrid seed? The spreadsheet automatically recalculates changes and the profit-or-loss table. The bulletins also contain current information on yield, acreage and value of each commodity. There are sections on planting dates, varieties, irrigation, fertilizer, pest control, harvest and post-harvest requirements for each crop. The bulletins may be compared to a cookbook for growing vegetables and field crops.

Impact: The bulletins, titled Guidelines to Production Costs and Practices, are one of the most valuable publications offered by UC Cooperative Extension. Data for 2002-2003 are available at Imperial County Cooperative Extension website http://ceimperial.ucdavis.edu and at the UC Davis Department of Agricultural and Resource Economics website at http://www.agecon.ucdavis.edu/outreach/crop/cost.htm. These websites received requests for over 240,000 downloads from the public in 2002, up from 132,000 downloads in 2001. This number of downloads demonstrates the popularity and demand for current and accurate cost-of-production data on California's agriculture.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 1.03 Agricultural Profitability

Title: REGULATION OF FLOWER SENESCENCE

Description: Objectives are: To develop and utilize the VIGS system in Petunia for functional analysis of genes associated with flower senescence; to examine the temporal and spatial/temporal expression of unknown and putative regulatory genes whose abundance increases during petal senescence; to test the effects of down-regulation of selected senescence-associated genes on petal senescence, using VIGS in Petunia; and to confirm the effects observed using VIGS in stably-transformed Petunia plants. Although the UC researchers are continuing to test a range of strategies (including novel selectable markers) for stable transformation of four o'clocks, their model system for ethylene-independent floral senescence, they have focused considerable effort in the past year on the use of Virus-induced gene silencing as a strategy for testing the function of target genes in species that are recalcitrant to transformation. Initial studies have used petunia as a model system because of its well-studied senescence patterns and its close relationship to Nicotiana, the genus in which the current generation of gene-silencing vectors has been developed. Petunias are infected with tandem constructs where the RNA2 of tobacco rattle virus (TRV) is modified by insertion of chalcone synthase and the target gene. Where virus infection occurs, the plant's silencing mechanism also silences chalcone synthase (a key enzyme in anthocyanin biosynthesis), resulting in white sectors on the otherwise purple flowers. The effect of the test gene on flower senescence can be determined by comparing the

pattern of senescence in the purple and white sectors in individual flowers. Since it is likely that the senescence process is coordinated through control elements such as transcription factors, kinases, and DNA binding factors the studies have focused on transcription factors identified in a large EST database housed at the University of Florida. The results of VIGS silencing of selected transcription factors on flower senescence will be reported. Future studies will extend this technology to flowers where ethylene is not involved in the coordination of flower senescence.

Impact: Previous work has identified tools for preventing floral senescence in ethylene-sensitive flowers. In the current period the researchers have also demonstrated that daffodils, previously considered ethylene-insensitive, do in fact respond to exogenous ethylene. In the future, the life of daffodil flowers handled through mass markets will be substantially improved by pre-treating them with inhibitors of ethylene action such as 1-methyl-cyclopropene. The North American market for cut flowers, presently about $1 billion, represents a consumption per capita of $3. This is similar to that in Russia, 1/15th of that in the U.K., and 1/30th of that in Switzerland. The potential for increasing the market depends on providing consumers with longer-lasting flowers, the primary goal of their project.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.03 Agricultural Profitability

Title: ROOTSTOCK AND INTERSTEM EFFECTS ON POME AND STONE FRUIT TREES

Description: Objectives: To evaluate the field performance of pome- and stone-fruit rootstocks in various environments and under different management systems, and to optimize experimental design for such evaluations. To develop and improve pome- and stone-fruit rootstocks through breeding and genetic engineering, and to acquire new rootstocks from worldwide sources. To understand the developmental and abiotic stress physiology of rootstock/scion interactions in pome- and stone-fruit trees.

Impact: California fruit growers are struggling economically because of poor prices and high labor costs. New dwarfing and disease resistance rootstocks can greatly reduce labor and pest management costs as well as improve productivity. Therefore, they are very interested in the potential this project offers for the future survival of their industry.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AR,CA,CO, GA ,IA, IL, IN, KY, MA, MD, ME, MI, MN, MO, NC, NJ, NY, OH, OR, PA, SC, TN, UT, VT, WA, WI

Theme: 1.03 Agricultural Profitability

Title: SEED DORMANCY AND THE REGULATION OF GERMINATION: THE ECOLOGICAL IMPLICATIONS OF NO SYNTHESIZED IN SOIL

Description: Among the objectives to be addressed are the following. How much NO is required to stimulate germination of dormant seeds? NO is a ubiquitous gas in the soil and atmosphere, and NO can be synthesized by plants and by soil bacteria. To understand the significance of these sources of NO, it is crucial that they know how much NO is required to break dormancy of dicot and monocot seeds. Is NO produced in soil effective in stimulating germination? Do N rich soils form a favorable environment for dormancy breaking because of enhanced NO generation? Is an increase in NO synthesis by seeds associated with stratification, light perception or GA treatment? If NO is a conserved, endogenous regulator of seed dormancy, then a change in NO synthesis or sensitivity to NO must occur in dicot and monocot seeds at a time when dormancy is broken. Does NO break dormancy by utilizing components of the GA, ABA, or phytochrome signal transduction pathways? ABA, GA and phytochrome mutants of Arabidopsis will be used to uncover interactions between signals resulting from NO that break dormancy and signals from other treatments that break or promote dormancy. What genes are specifically up or down regulated by dormancy breaking or dormancy promoting treatments, and which of these promote or reduce dormancy? Transcriptional profiling experiments will be carried out with dormant and nondormant seeds, and with Arabidopsis mutants that are defective in their response to NO using the Arabidopsis oligonucleotide microarray. What gene functions are essential for cPTIO to promote dormancy or for NO donors to break dormancy in Arabidopsis? By identifying mutants that have defects in the response to NO, the role of NO will be understood more precisely. The UC research program emphasizes the way in which the plant hormones abscisic acid (ABA) and gibberellic acid (GA) regulate the function of the cereal aleurone. The activity of the aleurone is important for the processes of germination and early seedling growth. GA is synthesized by the embryo of the germinating grain and it regulates the synthesis of key enzymes such as a-amylases. ABA is also synthesized by the embryo, especially under conditions of environmental stress, and it suppresses the synthesis of hydrolytic enzymes such as the amylases. The researchers have taken several approaches to investigating how ABA and GA regulate cereal aleurone function. The development of the mature barley aleurone cell has been particularly well studied by us and others using light and electron microscopy. The aleurone cell undergoes dramatic structural changes in response to GA and after 24 h of exposure to this hormone the aleurone cell enters a programmed cell death (PCD) pathway. PCD is accompanied by changes in the structure, pH and enzyme content of the vacuole. The small, protein storage vacuoles of the aleurone cell coalesce to form a large central vacuole having an acidic pH and containing a spectrum of acid hydrolases including cysteine and aspartic proteases. Aleurone cells undergoing PCD also show a dramatic change in the concentration of reactive oxygen (RO) molecules particularly H2O2 and in the activity of enzymes that catabolize RO. More recently the researchers have shown that another important signaling molecule, namely nitric oxide (NO) also plays a key role in aleurone PCD. NO can be synthesized by aleurone from nitrite along a novel non-enzymatic pathway that they have recently described. NO can also slow GA-induced PCD. NO acts as an antioxidant in arresting PCD in aleurone cells, emphasizing one of the functions of NO in cells. They have also recently shown that NO stimulates germination of dormant barley and Arabidopsis seeds, and the future research program will emphasize how NO acts to overcome dormancy in seeds of these species. They have been carrying out global RNA profiling analyses of gene expression in rice using an oligonucleotide microarray having >24,000 oligomers representing half of the rice genome. This microarray allows them to simultaneously monitor the expression of a large number of rice aleurone genes after exposure of the aleurone to ABA and GA. More than 1,000 genes show changes in their pattern of expression in rice

aleurone during the first 8 h of exposure to ABA and GA. The analysis of the gene expression profiles showed a highly unexpected result. Whereas previous work on aleurone showed that GA stimulated the activity of this tissue and brought about strong up regulation of gene expression whereas ABA caused down regulation of genes in this tissue, global RNA profiling showed an entirely different picture. RNA profiling shows that far more genes are up regulated by ABA during the first 8 h of treatment than are up regulated by GA. Similarly, more genes are stimulated in their expression by ABA than are stimulated by GA. This result alone shows the value of the global RNA profiling approach.

Impact: Seed germination and its control are crucial to cereal growers. The depth of dormancy determines whether grains germinate in the ear or whether they will germinate after planting. Precocious germination of cereal seeds in the ear causes large economic losses in cool temperate growing regions. On the other hand deep dormancy will cause losses for both growers and maltsters. Their program aims at an understanding of the process of cereal grain dormancy and germination by examining the role of endogenous hormonal regulators of this process. Their investigations of nitric oxide action in dormancy and germination control will also allow growers to devise improved methods for weed control.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.03 Agricultural Profitability

Title: SIGNALING PATHWAYS FOR STRESS RESPONSES IN HIGHER PLANTS

Description: The long term objective of the proposed research is to elucidate the molecular and cellular mechanisms underlying stress perception and response in higher plants and to engineer food crops with stronger tolerance to stressful environmental conditions. Environmental stress conditions such as drought, salinity, and cold temperature (frost) are major factors for reduction in agricultural production worldwide. It is the dream of all farmers to work with crops that can use less water, are resistant to saline soil, and are more tolerant to cold temperature. The conventional breeding procedures have made very little progress in generating stress-tolerant crops. Recent work using molecular techniques has just begun to provide critical information about the mechanisms underlying plant response to stress factors. The researchers have made significant contributions to the development of this research field by identifying molecular components involved in stress perception and response in Arabidopsis, a model higher plant. The proposed research activity herein seeks to continue this effort and further characterize the function of several proteins in the signaling pathways that link the stress signals to the cellular response in plants. This project has made significant progress in the past year. Several important areas of research have been expanded into productive activities. These include genetic analysis of calcium signal transduction and its role in stress tolerance, further study of immunophilins that function in photosynthesis and plant development, and identification of the detoxification transporters.

Impact: Several areas of agriculturally important research have been expanded. These activities will have impact on engineering stress tolerance of crop plants, photosynthesis and crop productivity, and environmental remediation.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.05 Animal Health

Title: CONTROL OF PARASITES IN SUSTAINABLE AGRICULTURAL SYSTEMS

Description: Objectives: Control of parasitic diseases using biological and chemical agents and physical methods. The effects of a crystal protein from Bacillus thuringiensis were tested on the maintenance of the intestinal parasitic stages of Heligmosomoides polygyrus in mice. Cry5B was administered at 1 mg per mouse by mouth for three consecutive days and the mice were necropsied on the fourth day after initiation of the treatment. The worm recoveries were the same in both control and treated groups. This data suggests that, unlike Nippostrongylus brasiliensis, Heligmosomoides polygyrus is does not feed on lumenal contents in the small intestine and thus is resistant to chemotherapy that requires particle ingestion.

Impact: Crystal toxin proteins are important in insect control and these efforts represent an innovative approach to control of lumenal nematode parasites in the vertebrate intestine.

Funding Source: Hatch Multistate Research and State

Scope of Impact: CA, GA, IL, KS, LA, MN, MO, MS, MT,UT, TX, VA, WA NY

Theme: 1.05 Animal Health

Title: EVOLVING PATHOGENS, TARGETED SEQUENCES, AND STRATEGIES FOR CONTROL OF BOVINE RESPIRATORY DISEASE

Description: Objectives: 1. Identify emerging and re-emerging agents and develop diagnostic methods for BRD. 2. Characterize mechanisms and intervention targets in pathogenesis of BRD at the molecular, cellular and host level. The California station in this regional research project has focused on construction and testing of a cDNA vaccine for bovine respiratory syncytial virus. A pilot experiment has been completed. There were four groups of calves: one received fusion protein gene in the plasmid IM, another received the nucleoprotein gene in the plasmid IM, a third group received the F protein gene in the plasmid IM and sublingual, the fourth group received the plasmid with green fluorescent protein as control. After challenge with virulent BRSV the calves in the control group were most severely affected. The N protein group has least severe disease. All calves shed virus, so no vaccine was completely protective. Lymphocyte stimulation showed most stimulation with N protein. IgG1 responses to BRSV were observed in vaccinates. The vaccine has potential for usefulness with some modification.

Impact: This research should yield improved vaccines for prevention of bovine respiratory disease.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AL, CA, GA, IA, KS, LA, MI, MN, MO, MS, OK, SD, TX, WI

Theme: 1.05 Animal Health

Title: GENETIC BASIS FOR RESISTANCE AND IMMUNITY TO AVIAN DISEASES

Description: Objectives: 1. Characterize the functions of genes and their relationships to disease resistance in poultry with an emphasis on the major histocompatibility complex as well as other genes encoding alloantigens, communication molecules and their receptors. 2. Develop and evaluate methodologies and reagents to assess immune function and disease resistance to a) enhance production efficiency through genetic selection in poultry, and b) identify relationships between genes underlying disease resistance and genes underlying production. Previously, the UC researchers reported on changes in serum chemistries that accompanied MD in both vaccinated and non-vaccinated / challenged birds. MD was associated with decreases in alkaline phosphatase (AP), creatine kinase (CK) and gamma glutamyl transferase (GGT) that were prevented by vaccination. This is completely the opposite of changes that they would expect to see in mammals. They have expanded their work to evaluate both other diseases and the effect of bird type on serum chemistry values. In the past year, they have conducted trials to observe the effects of Infectious Bursal Disease virus (IBD) on SPF chickens and Newcastle Disease Virus (NDV) on both SPF and commercial broilers. Sera were collected via the wing vein and were separated from RBCs within 2 hours post collection. Samples were frozen at -20 degrees until analysis. Sera were analyzed using either a Kodak DT-60 dry chemistry analyzer (MD trials) or a commercial wet chemistry analyzer (IBD and NDV). Eighteen different parameters were initially screened for useful information. Blood urea nitrogen (BUN) and alanine aminotransferase (ALT) were eliminated after initial MD studies. For IBDV, a single bird trial using SPF chickens was conducted as follows: Two groups of 40 birds each were used, one group challenged and one unchallenged. Birds were reared in Horsfall Bauer isolation units. Blood was collected from 10 birds / group 3 days PC for serum chemistry analysis. Birds were challenged with NVSL standard challenge virus at 10 days of age and were examined for lesions at days 13, 17, 21 and 25. All challenged birds had typical lesions of acute IBD including bursal edema and hemorrhage by 3 days PC. Significant increases of aspartamine aminotransferase (AST), CK and LDH were observed in challenged birds. Two trials were conducted examining the effects of NDV on serum chemistry values. Both trials used commercial broilers and trial 2 also used SPAFAS SPF chickens. Each trial had positive and negative control groups and a vaccinated group of 30 birds each. Trial 2 used age matched groups of broilers and SPF chicks. Birds were floor reared in isolation rooms. Blood was collected from 10-15 birds / group. Birds were in ovo LaSota complex vaccinated, challenged at 21 (Trial 2) or 28 (Trial 1) days of age with NVSL Texas GB virus and were terminated 2 weeks PC. Blood was collected at time of challenge and at 3 days PC. All positive controls died by 7 days PC while all vaccinates were clinically protected. There was no effect of vaccination on serum chemistry values in either broilers or SPFs. Broiler pre challenge TCO2 was significantly higher than SPF TCO2. Changes in serum chemistry values PC were more dramatic in SPF birds than in broilers. In Trial 1, significant changes were observed in CK and AP. Challenge controls CK was 6191 versus 3117 observed in vaccinates. Challenge controls AP was 3116 versus 7264 observed in vaccinates. Significant changes were observed in AP, uric acid (UA), CK, LDH, and cholesterol.

Impact: Little work has been published on the effects of disease on serum chemistry values in domestic poultry. Since alkaline phosphatase appears to dramatically decrease in multiple

diseases where an increase would be expected, there may be a fundamental difference in the expression of that enzyme in chickens.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AL, AR, CA, DE, IA, MS, NC, NH, NY, SC, TX

Theme: 1.05 Animal Health

Title: REPRODUCTIVE PERFORMANCE IN DOMESTIC RUMINANTS

Description: Objectives: Investigate molecular, cellular and endocrine mechanisms that limit or control reproductive efficiency in domestic ruminants. Since the last report, UC researchers have experimentally infected virgin heifers with Tritrichomonas foetus or with one of two previously described non-T. foetus trichomonad isolates from the bovine prepuce, namely Tetratrichomonas species and Pentatrichomonas species. Heifers were slaughtered 6 weeks after infection, and reproductive tract tissues were collected. Culture results from weekly cervico-vaginal mucus (CVM) aspiration showed that - contrary to expectations - 2/6 heifers had positive CVM cultures for the Tetratrichomonas species as much as five weeks after infection. This finding does not agree with two previous trials in which they attempted to infect virgin heifers with non-specific preputial trichomonads that they had not characterized at the time. In those trials, none of 15 heifers inoculated at estrus with one million organisms had a positive CVM culture at any of the weekly samples collected before slaughter at 6 weeks. The only element that they are aware of that may explain the discrepancy between these trials is that they used both the InPouch T method and Schneider's eggshell medium in the most current trial, whereas they used InPouch and Diamonds TYM in the previous trial. The positive cultures were detected only in Schneiders. They will further study the histopathology of the experimentally infected heifers, including immuno-histochemical analysis using monoclonal antibody for a T. foetus-specific lipo-phospho-glycan surface molecule.

Impact: If there is detectable pathology in the reproductive tracts of heifers inoculated with non-specific trichomonads, it will suggest that extensive characterization of this group of organisms be undertaken. At the moment, if the diagnostician can say that the trichomonad seen in InPouch-cultured smegma samples is not T. foetus (by PCR assay), the bull is presumed to be uninfected, i.e., to be free of trichomonosis. They need to be certain that is true.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AK, AZ, CA, CO. HI, ID, KS, MN, MO, MT, ND, NE, NM, NV, OH, OR, TX, WA, WY

Theme: 1.07 Apiculture

Title: HONEY BEE BREEDING AND GENETICS

Description: Bees that are more responsive to sugar, as demonstrated by a simple proboscis extension reflex test, are more likely to forage for pollen than those that are less responsive. Why? What links these seemingly different behavioral traits? They have bred strains of bees that

differ dramatically in their foraging behavior and responsiveness to sugar. They also differ in other traits, such as the age they initiate foraging behavior, performance on associative learning assays, and the sizes of the loads they collect as foragers. The UC researchers will continue studies of the behavioral differences between the selected strains and try to determine the underlying genetic and physiological mechanisms that link these behavioral traits. They completed 5 QTL maps of the honey bee and mapped economically important traits including the age of initiation of foraging behavior, foraging behavioral traits, and sensitivity of bees to sugar. The maps are being used to assist in the assembly of the now complete honey bee genome sequence. They are looking for candidate genes in the regions of the QTL. They also isolated and characterized the complementary sex determining (csd) gene for the honey bee.

Impact: The maps constructed will greatly aid in assembly of the honey bee genome and the identification of major genes of economic importance. The csd gene is the single most important gene for honey bee breeding. Identification will lead to better methods of breeding.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.08 Aquaculture

Title: FARMING CAVIAR SAVES WILD STURGEON

Description: Historically, North America was an important source of sturgeon flesh and caviar, but over-fishing and habitat degradation decimated sturgeon populations, at which point the caviar trade shifted to the Caspian Sea region. Caspian Sea caviar production is plummeting, however, due to ill-managed harvesting, poaching and water pollution problems.

The first successful spawning of wild-caught white sturgeon began in 1980 at UC Davis. Since then, techniques for managing domestic broodstock have been established, including sexing sturgeon, monitoring final maturation, spawning induction by injection of exogenous hormones, egg incubation and larval rearing. Nutrient requirements and utilization have been established, as well as optimum feeding rates of sturgeon under different conditions. These allow feed mills to produce cost-effective feeds and fish farmers to feed sturgeon optimally. Genetic studies were conducted to estimate heritabilities and genetic correlations for body conformation and caviar-production traits. These results allow sturgeon producers to develop long-term breeding strategies to enhance growth rate and caviar production. Furthermore, using molecular markers, relationships among the broodstock have been established to prevent inbreeding.

Impact: The aquaculture of white sturgeon is fully established, including the closing of the reproductive cycle in captivity and spawning of domestic broodstock, intensive rearing of juveniles and adults, and marketing of food fish and caviar. Currently, annual food fish production is about 700 tons, and the first processed caviar from farmed sturgeon was made in 1995. By 2002, production was 5 tons. Production goals in the near future are estimated to be 15 tons, and this could increase. The current retail price for domestic white sturgeon caviar is comparable to the traditional osetra grade caviar (wholesale approximately US $300/kg and retail up to US $1000/kg). A stable supply of caviar from fish farms would relieve fishing pressure, thus allowing wild sturgeon stocks to recover.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 1.08 Aquaculture

Title: GENETIC ASSESSMENT, DEVELOPMENT, AND IMPROVEMENT OF SHELLFISH STOCKS FOR WEST COAST AQUACULTURE

Description: Objectives: To construct a moderately dense linkage map for the Pacific oyster and associate this with the cytological map through studies of trisomic oysters; to localize chromosomal regions and modes of gene action associated with heterosis for growth and its physiological components (QTL mapping); to make recombinant inbred lines from hybrid populations to elucidate the transmission and expression of lethal genes; to begin to locate candidate genes underlying growth heterosis; to continue testing hybrids at a commercial growout scale; to test microsatellite DNA markers developed for the Pacific oyster on other species, particularly the Kumamoto and Suminoe oysters. Crossbreeding to improve farmed Pacific oysters was explored, using experimental crosses among inbred lines from the Molluscan Broodstock Program (MBP), Hatfield Marine Science Center, Oregon State University. Progeny from factorial crosses of inbred lines, which were planted in 2001 and 2002, were harvested in 2003. Analysis of yield data shows highly significant differences among crosses, accounting for 90.1% of variance in mean body size at harvest in one cross. Body size is the chief component of yield, as mortality was negligible in all families. Although the regression of final yield to seed yield is not significant (but positive), the top inbred parents identified at the seed stage are nearly the same as those identified at the harvest stage. The ability to top inbred lines for crossbreeding at the seed stage obviates the expense of evaluating yield at harvest age. For each cross, parental pedigree was confirmed, before spawning, by sending biopsies from brood stock to BML for analyses of microsatellite DNA markers. Mixing among families occurs, but is readily identified by genetic markers, and poses no threat to the integrity of experiments. Controlled crosses among the most promising inbred lines from previous trials produced millions of diploid and triploid hybrid seed for large-scale tests commercial of yield. Two of the most promising lines will be put into production in 2004 by one large commercial hatchery. Construction of a moderately dense genetic linkage map was completed, using 24 previously published and 79 new microsatellite DNA markers developed for this purpose. This map is presently being used to map quantitative trait loci (QTL) for yield.

Impact: A larger program for selecting and crossbreeding elite inbred lines, which should rapidly improve commercial oyster seed, has been initiated by the industry as the result of this research. Application of functional genomic tools should increase the efficiency with which elite inbred lines for crossbreeding can be found.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.08 Aquaculture

Title: PHYSIOLOGY OF CRUSTACEAN GROWTH AND STRESS

Description: Objectives: 1) Characterize crustacean hyperglycemic hormone (CHH) as a neuropeptide stress hormone in crustaceans; 2) characterize induced thermal tolerance in crustaceans; 3) determine the informational cascade in the regulation of the molting gland in crustaceans; 4) determine which hormones are involved in the regulation of molting and reproduction in crayfish. UC researchers continued their studies on heat-shock (stress) proteins in lobsters (Homarus americanus). Lobster claw muscle undergoes atrophy in correlation with increasing ecdysteroid (steroid molting hormone) titers during premolt. In vivo molecular chaperone (constitutive heat shock protein 70 [Hsc70], heat shock protein 70 [Hsp70], and Hsp90) and polyubiquitin messenger ribonucleic acid (mRNA) levels were examined in claw and abdominal muscles from individual premolt or intermolt lobsters. Polyubiquitin gene expression was assayed as a marker for muscle atrophy. Both Hsc70 and Hsp90 mRNA levels were significantly induced in premolt relative to intermolt lobster claw muscle, whereas Hsp70 mRNA levels were not. Hsp90 gene expression was significantly higher in premolt claw muscle when compared with abdominal muscle. Polyubiquitin mRNA levels were elevated in premolt when compared with intermolt claw muscle and significantly elevated relative to premolt abdominal muscle. Another project has focused on aspects of lobster behavior. In lobsters, the presence of one's offspring is an important variable in the level of maternal aggression. Ovigerous American lobsters show a territorial advantage against non-maternal females, even though no post-hatch care is provided. The eggs are attached to the pleopods (swimmerets) throughout embryogenesis. My laboratory evaluated the effect of stripping ovigerous female lobsters of their eggs on maternal territoriality. In one treatment group, maternal females were stripped of all eggs. Twelve days later, including being individually isolated for an additional 48 h in a test tank, each resident was serially intruded upon by four non-maternal conspecific females. An identically treated control group of ovigerous female residents was left intact prior to the serial intrusions. The intact ovigerous residents showed a significant territorial advantage over the intruders, whereas the contest outcomes of stripped residents were reduced to chance. The presence of eggs in maternal lobsters is therefore necessary for the maintenance of the shelter-related territorial advantage.

Impact: Crustaceans are important species for aquaculture and fisheries. The characterization of heat-shock proteins in crustaceans is significant since they have shown that these HSPs can act as indicators of physiological stress. In particular, both exogenous environmental factors (elevated temperature) and endogenous physiological factors (steroid hormone control of the molt cycle) affect the expression of HSP genes. HSP gene expression may be a useful indicator of environmental health. Their work on lobster behavior will provide insight into the physiological regulation of aggression, mating, and maternal care in this species. These studies have important implications for the successful and sustainable aquaculture of decapod crustaceans.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.09 Biobased Products

Title: BIOCHEMICAL AND STRUCTURAL STUDIES OF THE RAD17 PROTEIN FROM S. CEREVISIAE

Description: Objectives: Cloning of the RAD17 gene from S. cerevisiae. Large scale expression of the protein in bacteria or eukaryote. Development of a biochemical assay to determine exonuclease activity. Assay in presence of other checkpoint proteins to determine whether other subunits are necessary for activity or regulation. Crystallization and x-ray structural determination of the overexpressed protein. Understanding and optimizing the conversion of carbohydrates such as xylans contained in agricultural wastes resulting from harvest to ethanol has been a major goal of a UC lab. In collaboration with a colleague at the University of Agricultural Sciences in Vienna, Austria, the UC researchers are studying enzymes involved in a heterologous pathway that has been inserted into yeast to mediate this conversion. The first of these enzymes is xylose reductase (XR), a dual specificity (NADPH/NADH) dependent aldo-keto reductase that catalyzes the reduction of xylose to xylitol. Xylitol is reoxidized by xylitol dehydrogenase (an NAD+ specific enzyme) to xylulose. Xylulose is then phosphorylated by xylulose kinase and is then able to enter conventional yeast fermentation pathways. When xylose passes through this pathway in a high flux manner, a substantial quantity of NADPH is converted to NADH signaling a redox imbalance in the cell. Their aim is to change the cosubstrate specificity of XR to NADH specific that that this cosubstrate can be efficiently recycled in the xylitol dehydrogenase step of the pathway. To provide a rational basis for these mutations, they have earlier determined the crystal structure of the enzyme in complex with NADPH. More recently, a researchers in the lab has also determined the structure of the enzyme in complex with the desired cosubstrate NADH (ref. 1). This structure revealed conformational changes in both the protein and the cosubstrate that could not have been predicted. They are now using this knowledge to engineer improved versions of the enzyme (ref. 2). In addition, they are also structurally characterizing the other members of the pathway, xylitol dehydrogenase and xylulose kinase and are also determining structures of an unrelated enzyme useful to the food industry, mannitol dehydrogenase (M2DH). Mannitol is a sweetener which is safe for diabetics and does not promote tooth decay. Currently, it is produced chemically by reducing D-fructose to produce equal proportions of D-sorbitol and D-mannitol which are then separated in an expensive chromatographic step. Using M2DH, it may be possible to produce pure mannitol more economically. The researchers have previously determined the structure of this enzyme and understood substrate and cosubstrate specificities. More recently, they have probed the catalytic mechanism of M2DH (ref. 3) and are also beginning to systematize the long chain dehydrogenases/reductases, a somewhat divergent family of enzymes that it belongs to.

Impact: Straw is a major agricultural waste product that is often burned, releasing pollutants into the air. An environmentally preferable option is to ferment xylose (a major component of straw) to produce ethanol. Protein engineering experiments based upon the XR structure are altering this so that the overall efficiency of the conversion process is improved. The M2DH structure has characterized an enzyme converting fructose to mannitol. Mannitol is a tooth-friendly sweetener safe for diabetics and is currently produced through a chemically inefficient process which will be improved using the structure.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.10 Biofuels

Title: THE SCIENCE AND ENGINEERING FOR A BIOBASED INDUSTRY AND ECONOMY

Description: Objective are to: 1) Reduce the cost of harvesting, handling, storing and transporting biomass increasing the competitiveness of biomass as a feedstock for biofuels, biomaterials and biochemicals; and 2) Expand the scientific knowledge leading to significant economic improvements in biofuel production processes. Biogasification of mixed organic wastes (food waste, green waste, animal waste) was studied using an Anaerobic Phased Solids Digester at 55-60 C. Digestion of individual waste streams yielded methane production potentials of 292, 284, 431, and 138 L/kgVS fed for animal bedding, green waste, food waste, and dairy manure, respectively, and mixed waste yielded 282 L/kgVS fed. The test data were used to design a digester for converting 30 tons of mixed wastes per day. The economic analysis showed high feasibility for the anaerobic digestion facility. Psychrophilic digestion of dairy manure was also studied to compare anaerobic sequencing batch reactor (ASBR) and anaerobic mixed biofilm reactor (AMBR) at different hydraulic retention time. It was found that both types of reactors could treat the dairy manure of 1-3% total solids at short retention time (5-10 days) but the AMBR performed better than the ASBR. Combustion of rice straw and rice straw-wood blends was studied and agglomeration of fluidized bed media was investigated. It was found that blending rice straw can retain alkali in slag with the potential of reducing volatile losses and fouling of the furnace. Blends containing up to 8% rice straw may be feasible in commercial boilers without requiring leaching or other pretreatment. Studies were also initiated on coupling of an anaerobic digester to a thermal gasification system for gas cleaning and combined biogas generation in remote and developing nation applications. A two year study of rice straw bale storage was completed yielding dry matter, composition, and fuel value changes under various storage treatments ranging from fully exposed to fully enclosed conditions. An investigation of more fundamental mechanisms in spontaneous combustion of straw was initiated with the objective of identifying possible chemical processes contributing to thermal runaway. Utilization of compost products produced from biomass materials was studied. Research was carried out to assess the potential for compost incorporation to produce higher soil temperatures during solarization. Experimental studies were carried out using insulated 1-L bioreactors placed in an incubator to approximate diurnal soil temperature fluctuations typically achieved during solarization. The bioreactors were filled with soil mixed with compost substrates at various loading rates. Temperatures in aerated bioreactors with compost substrates were up to 3-10 C higher than bioreactors with soil alone. Increased respiration in aerated bioreactors with compost substrates suggested that increased temperatures were related to increased aerobic microbial activity. However, the temperature of bioreactors receiving oxygen by diffusion through solarization tarp was not greater when soil was amended with compost substrates.

Impact: Advanced conversion technologies researched in this project, including anaerobic digestion, combustion, and gasification, will lead to development of efficient methods to convert biomass materials into bioenergy and biofertilizer products. Combining compost application and soil solarization will result in utilization of organic wastes in agriculture and improved agricultural production efficiencies.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AR, AZ, CA, FL, HI, IA, IL, IN, KS, KY, LA, MI, MN, MS, MT, NC, ND, NE, OK, OR, SC, SD, TN, TX, UT, VA, WA, WI, WVA

Theme: 1.11 Biotechnology

Title: APOPTOSIS AS A TARGET FOR ENGINEERING DISEASE RESISTANCE IN PLANTS

Description: The interaction of pathogens with plants leads to a disruption in cellular homeostasis, often leading to cell death in both compatible and incompatible relationships. Programmed cell death (PCD) is now recognized to play important roles in plant disease and shares many of the morphological characteristics of apoptosis as defined in animal systems. Their current data suggest that activation or suppression of programmed cell death underlies diseases in plants as it does in animals. The goal of this project is to identify novel genes from cDNA libraries of either grape or heterologous plants that, when expressed in grape, will disrupt infection, spread or symptom development of the xylem-limited bacteria, Xylella fastidiosa (Xf), the cause of Pierce's Disease of grape. Specific objectives are to: a) develop a Agrobacterium rhizogenes-based grape transformation system that would allow screening or testing transgenes in a manner that preserved the clonal integrity of a given grape cultivar; b) create cDNA libraries from several different grape backgrounds, including two with PD resistance; c) develop a functional A. rhizogenes-based cDNA screen in grape; d) examine the morphological and cytological features of cell death in symptomatic tissues; and e) investigate the potential of blocking PD symptom expression with anti-apoptotic transgenes. UC researchers have developed a Agrobacterium rhizogenes-based transformation procedure that results in the induction of transformed roots from infected or healthy vegetative tissue sections. They used this technique to develop a functional cDNA library screen (each root contains a different cDNA library member) for genes that block either bacterial multiplication, movement, or symptom expression. They have made excellent progress in creating an extensive library of full-length cDNAs from several resistant sources as well as susceptible Chardonnay and conducting initial screens of the libraries. The first grape library has been pre-tested by screening the grape cDNAs in tomato to determine if the library contains anti-programmed cell death (PCD) genes. They screened 30,000 members of a grape cDNA library by A. rhizogenes transformation of tomato cotyledons. Toxin-induced PCD resistant tomato roots were isolated; the protecting grape cDNA insert was recovered by PCR, and sequenced. These genes have now been re-cloned and are being tested in grape against PD-infected stem sections. Based on the pre-test in tomato, a limited number of grape genes appear to effectively protect against PCD as was observed earlier with the screen of tomato libraries in tomato for anti-PCD (disease protecting) genes. Two strongly protecting open reading frames (ORFs) share sequence homology to respectively, glutathione-S-transferase (a protein that has been reported to be involved in disease resistance) and an unidentified expressed plant protein. The fact that a small percentage of the cDNAs appear to protect is encouraging in that they expect that the genome of grape will contain only a few genes that can effectively protect plant cells against pathogen-secreted signaling molecules that lead to disease development.

Impact: A critical role for programmed cell death in plant disease has been discovered. Data confirms that much of the functional machinery and regulatory mechanisms of apoptosis as

characterized in animals is conserved in plants. Genetic and chemical methods to block the induction of death in plant disease are being studied as novel plant protection

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.11 Biotechnology

Title: ENGINEERING CROPS RESISTANT TO ABIOTIC AND BIOTIC STRESS WITH IMPROVED GROWTH AND ENHANCED QUALITY

Description: The aim of this research is the molecular characterization the network required for the adaptation of crops to environmental stress. The objectives are: (1) to engineer salt tolerant crop plants; (2) to characterize the cellular network required for the activation of the many adaptive responses of plants, in particular protein modules; and (3) to characterize and identify the gene network that determines fruit quality traits. 1) Development of salt tolerant transgenic crops. Previous results have shown the importance of vacuolar sodium compartmentation on the ability of plants to tolerate high salt concentrations. The UC researchers developed transgenic plants, overexpressing, a vacuolar Na+/H+ antiporter that are able to grow, set fruit and seed at a concentration of 200 mM NaCl (equivalent to 40 percent of the salt concentration in sea water). The results also showed that transgenic plants accumulated sodium in their leaves but not in the fruits and that the agronomical attributes of the transgenic fruits and seeds were comparable to those of the wild type plants. They are initiating field trials in order to test the ability of the salt-tolerant transgenic plants to grow under field conditions, these field trials will be carry out during 2004 in several locations in the Imperial Valley. 2) Global gene expression analyses under salt stress. They have identified and characterized a T-DNA insertion knockout mutant of the vacuolar sodium/proton antiporter in Arabidopsis thaliana and used these mutant lines and also lines overexpressing the antiporter to analyze global gene expression under salt stress using DNA arrays. 3) Characterization of the gene network that determines fruit quality traits. They used proteomic approaches to analyze the citrus fruits proteome. The aim is to identify gene networks associated that could serve to developed cDNA markers (derived from EST) to assist the selection of quality traits. In addition key genes associated with the establishment of the sugar to acid ratio in the fruit have been identified and the gene products are being presently characterized. 4) Structure Function analysis of vacuolar cation/H+ antiporters. They have made significant progress in the characterization of the NHX like Arabidopsis vacuolar antiporters and are presently investigating their topology and structure.

Impact: The development of salt tolerant crops will have a significant impact in California's economy. These crops will allow the development of sustainable agriculture using marginal lands and lower quality waters. Their efforts aimed at the characterization of gene networks associated with fruit quality traits will serve to improve fruit quality.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.11 Biotechnology

Title: ENGINEERING TRANSGENE INTEGRATION IN ARABIDOPSIS

Description: Great strides have been made in plant transformation; transgenic DNAs can be introduced into almost all crop species. These transformed tissues can be regenerated and the transgene stably inherited. However, the transformation process is far from precise. The transforming DNA is usually modified at its 5' and 3' ends, the transgene is often present in multiple copies, and the target site (the site on the host chromosome at which the transgene integrates) is randomly selected. Because of this, the products of plant transformation vary widely. This means that many transformed plants must be generated in order to identify a single plant with a useful insertion, the transformed lines must be carefully characterized at the molecular level to make sure that the transgene is in a stable conformation, and that there is no possibility that a chimeric protein has been generated through fusion with an endogenous gene. Another difficulty presented by this random insertion process is that fact that genes can only be added to the plant genome; they cannot be replaced. It is often desirable, particularly in basic research, to alter the expression of an endogenous gene, (to replace one allele with another) rather than to simply add a novel gene. This isn't feasible in plants; transgenes with homology to endogenous genes replace the endogenous locus in only 1 out of 10,000 transformed lines. This is because transgenes are integrated via a process termed nonhomologous end joining (NHEJ, which produces random integration products) rather than homologous recombination (HR), a distinct recombinational pathway that inserts transgenes only by simultaneously deleting a nearly identical sequence. In many organisms (such as bacteria, yeast, certain mosses, and some mouse cell types) transgene integration via HR is the norm. Plants possess the HR pathway as well as the NHEJ pathway, but the NHEJ pathway out competes HR, effectively 'grabbing' the ends of the transgene and sequestering them away from the proteins involved in HR. For this reason, they plan to inactive the NHEJ pathway in Arabidopsis, in the hope of increasing the fraction of transformation events that occur via the HR pathway. UC researchers made 2 significant advances in their studies of mechanisms of double strand break repair. First, they developed an assay for induction of double strand breaks. In mammals, one of the earliest cellular responses to double strand breaks is phosphorylation and localization to the break of histone H2A variant H2AX. gamma-H2AX (as the phosphorylated form is termed)forms large complexes that include hundreds to thousands of gamma-H2AX molecules; this response can be detected within a minute of gamma irradiation and is followed by formation of foci of other repair proteins at the site. gamma-phosphorylation of a histone H2A variant also occurs in Drosophila and yeast. Induction of gamma-H2AX foci occurs during VDJ rejoining, meiotic recombination, and at stalled replication forks. Exact significance of this spectacular event remains to be determined, and may vary from one organism to the next. Regardless of its possible roles in DSB signaling and repair, gamma-H2AX makes an excellent marker for double strand breaks. The presence of the protein is indicative of the persistence of breaks (so DSB persistence can be assayed by Western blot) and the number of breaks can be counted by counting the number of gamma-H2AX foci. Foci can be detected using antigamma-H2AX antibodies in conjunction with laser scanning confocal microscopy. The Arabidopsis genome encodes five histone H2A-like proteins. Two of these homologs are quite similar to one another, and have the characteristic H2AX C-terminal extension, including the highly conserved extreme C terminal recognition motif for serine phosphorylation ASQE. Because they found that commercially available gamma-H2AX antibodies recognize the unphosphorylated,as well as the phosphorylated form of the plant

H2AX, they synthesized a serine-phosphorylated polypeptide that included the plant C-terminus, and had phosphospecific polyclonal antibodies generated and column-purified. These antibodies recognize a peptide of the expected size that appears only after, and within 5' of, gamma irradiation. The signal is consistently stronger in the irradiated DSB reapir-defective lig4/ku mutants than in irradiated wild-type. This suggests that plants, like fungi and animals, rapidly phosphorylate H2AX in response to the induction of DSBs. They are currently performing in situ hybridizations to determine whether this protein forms foci on chromosomes after gamma irradiation. This antibody will enable us and other plant researchers for the first time to directly assay the induction and repair of double strand breaks. Progress was also made in characterizing plant cellular responses to double strand breaks. They found that meristematic cells of DSB repair defective lig4 and ku80 mutants undergo a permanent G1 arrest after gamma irradiation at 10Krad. Interestingly, the induction of DSBs does not induce arrest in nonmeristematic cells. Meristematic cells defective in crosslink repair, in contrast, experience a transient G2 arrest. These two types of arrest produce very different types of 'gamma plantlets', enabling us to easily distinguish between classes of repair-defective mutants.

Impact: Great strides have been made in plant transformation; transgenic DNAs can be introduced into almost all crop species. But the transformation process is far from precise. The transforming DNA is usually modified, the transgene is present in multiple copies, and the target is randomly selected. Because of the effects of local chromatin domains on gene expression, the products of plant transformation vary widely. Many transformed plants must be generated in order to identify a single plant with a useful insertion. Another serious obstacle is the fact that genes can only be added to the plant genome; they cannot be replaced. It is often desirable to alter the expression of an endogenous gene, but this isn't feasible in plants; transgenes with homology to endogenous genes replace the endogenous locus in less than 1/3000 transformation events. This is because the homology-independent pathway for transgene integration (termed nonhomologous end joining, or NHEJ) is far more efficient in plants than the homologous recombinational (HR) pathway. They plan to inactivate the NHEJ pathway in Arabidopsis in the hope of increasing the fraction of transformation events that occur via the HR pathway. If successful, this approach should be directly applicable to other plant and animal species.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.11 Biotechnology

Title: GENETICS AND BREEDING OF COOL SEASON CROPS

Description: Objectives: Celery: Development of Fusarium resistant celery lines and F1 hybrid varieties and tagging of male sterility gene ms1 with molecular markers for marker assisted selection. Cole crops: Development of genomic tools in Brassica crops and development of high sulfurophane broccoli and cauliflower lines and high sinigrin lines. Two main groups of cool season crops are involved in this project. The first one consists of Brassica crops, where the main objectives are comparative genomics and development of lines possessing specific glucosinolates. The second one is celery, where the goals are to develop and release improved disease and insect resistant lines. Brassica: The UC researchers continued with comparative genomics of Arabidopsis and Brassica for specific genes and ESTs. They cloned two key genes in the aliphatic glucosinolate pathway in B. oleracea, BoGSL-ELONG and BoGSL-ALK. They

are now characterizing a third gene, BoGSL-PRO, as a candidate gene for synthesis of glucosinolates containing 3-carbon side-chains. They analyzed the sequence of the whole BAC clone containing BoGSL-ALK, finding that it is duplicated or triplicated in different Brassica accessions. They set up an experiment for maker assisted selection of plants containing different glucosinolates based on markers for the three major glucosinolate genes mentioned above. This activity will allow development of lines containing specific glucosinolates in segregating Brassica populations. Depending on content of glucosinolates and derived cognate isothiocynanates, these lines could be used for different purposes such as biofumigation or as a source of cancer protecting compounds. Celery: They continued with the development of Fusarium, late blight and virus resistant lines applying marker-assisted selection. These lines were advanced for further selection and improvement for horticultural traits. They are using markers associated to male sterility and virus resistance to develop disease resistant male sterile lines for hybrid seed production.

Impact: Cloning of major glucosinolate genes in Brassica will allow the genetic manipulation of these secondary metabolites. Discovery of markers for important traits will allow the pyramiding disease resistance genes for the development of multiple disease resistant celery hybrids.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.11 Biotechnology

Title: GENETICS AND VARIETAL IMPROVEMENT OF STRAWBERRIES

Description: Objectives: Develop and utilize strawberry germplasm in an applied program aimed at breeding, testing and selection of new cultivars adapted to arid-subtropical and Mediterranean climates, with improvement targets that include production characters, harvest efficiency, fruit quality, and environmental tolerance.

Nursery inoculation trials detected genotypes expressing variation for two potential sources of resistance to Verticillium dahliae (initial resistance to infection and tolerance to disease pressure despite substantial disease load) in a range of resistant types; crosses among these genotypes will permit genetic resolution of these mechanisms. Nursery treatments and genetic resistance for Colletotrichum acutatum, were extended to broader samples of genotypes. A long-term genetic study of the northern California UC breeding population demonstrated genetic gains of 20-78% over a 10 year period for traits of commercial importance, with no discernible concomitant decrease in genetic variation. Evaluation of genetic variation for early-season fruit production in the southern California UC breeding population demonstrated continued opportunity for developing early-fruiting cultivars, but suggest that parent selection will be substantially more effective in this effort than individual seedling evaluations. A series of studies conducted over 7 years was completed that conclusively demonstrate the polygenic inheritance of long-day flowering in strawberry. One day-neutral selection with superior performance for productivity, fruit quality, harvest efficiency, and environmental tolerance was evaluated in final grower trials and scheduled for release.

Impact: The long-term genetic study demonstrates ongoing opportunity for genetic improvement of strawberry in California, despite substantial past genetic change and the absence of germplasm infusions; these results suggest alternative mechanisms for generation of the variation responsible for continued selection response. Demonstration of polygenic inheritance of day-neutrality resolves a perennial genetic question and dictates appropriate future breeding strategy for utilization of this characteristic. Based on UC and grower trials, the day-neutral selection scheduled for release will likely replace a cultivar that produces about 40% of the fruit annually shipped from California and should become the most widely planted day-neutral cultivar in the world.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.11 Biotechnology

Title: IMPROVED VEGETATIVE PROPAGATION OF TREE FRUITS, OTHER WOODY PERENNIALS, AND SMALL FRUITS

Description: Objectives: 1. Develop a method for the regeneration of several genotypes of peach and peach x almond rootstocks as a first step towards producing transformed plants. 2. Transform peach and peach x almond rootstocks with a gene that confers resistance to crown gall. 3. Determine propagation methods for difficult-to-propagate horticultural crops. Many trials were conducted to determine a method for regenerating peach shoots from non-meristematic material. A series of experiments looked at four different genotypes, dihaploid 'Lovell', Nemaguard, Nemared, and Lovell. Explants tested included leaves of plants from the field, from shoot grown in vitro, epicotyls, hypocotyls, and stem tissue. These treatments were combined with different media formulations, Woody Plant Medium, Murashige-Skoog medium, and Quorin and Lepoivre medium. Plant growth regulators tested included IBA, NAA, 2,4 D, BA, and thidiazuron, in a large factorial experiment. Hypocotyls and epicotyls of seedlings were induced to regenerate shoots, but at a low level. Callus tissue was successfully transformed with an Agrobacterium construct carrying a GUS marker gene. Strawberry plants were regenerated from leaf discs treated with Agrobacterium tumefaciens carrying a gene for salt-resistant on medium containing kanamycin. The putative transformants were rooted, acclimated to greenhouse conditions and will be tested for the presence of the gene. There are currently over 10 different lines that have been regenerated from independent transformation events.

Impact: The development of half-resistant genotypes of strawberry could be an important breakthrough for growing the crop on marginal, alkaline land. The initial regeneration of peach shoots from non-meristematic tissue is encouraging. With additional trials and the increased percentages of regeneration, transformation of peach rootstocks, which are used for peach and almond trees, with a gene conferring resistance to crown gall will have a major impact on the industry.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.11 Biotechnology

Title: INTRODUCTION AND EXPRESSION OF TRANSGENES TO IMPROVE QUALITY AND PRODUCTIVITY OF TREE CROPS

Description: The principle objective of this research is to introduce and study 'transgenes' that can provide genetic alternatives to current practices in growing and storage of tree fruit and nut crops. This project is a continuation of research already underway on gene transfer in walnut, apple and other horticultural tree crops. The objectives are: 1. To develop and enhance gene transfer technologies in tree crops. 2. Engineer pest and disease resistance. 3. Evaluate genes impacting quality and productivity. The research will include field testing of genetically engineered tree crops to demonstrate these novel strategies. The UC research focuses on understanding the relationship between genes and horticulturally significant traits responsible for productivity and fruit quality. UC researchers are investigating these traits using functional genomic approaches that involve plant transformation and post transcriptional gene silencing (PTGS) to better define allelic diversity and gene function. 1) The focus in the productivity area is disease and pest resistance. Transgenic walnuts are being field tested to evaluate resistance to codling moth with the aim of reducing the usage of chemical pesticides and also to reduce the level of aflatoxin contamination. Resistance to crown gall in being investigated via PTGS of Agrobacterium oncogenes. They have successfully demonstrated that this approach blocks gall formation in walnut. 2) Fruit quality is being investigated in transgenic plants silenced for ethylene or sorbitol biosynthesis. Fruit quality traits are being analyzed to examine the role played by ethylene or sorbitol biosynthesis. Almond productivity is being studied through the identification of the stylar component of S-alleles responsible for self-incompatibility. Focus here is on the identification of new S-alleles and to define the almond genomic region that contains the pollen component.

Impact: The discovery and analysis of genes in fruit and nut crops that determine quality and productivity identifies genetic resources useful for the study of biological mechanisms as well as for genetic improvement these important tree crop species. Enhancing fruit quality is an important trait recognized by consumers and key to marketing of fresh fruit and nuts and thus preserves the livelihood of fruit and nut growers all over the United States.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.11 Biotechnology

Title: MECHANISM OF PLANT PERCEPTION OF OLIGOSACCHARIDE SIGNALS

Description: Objectives are: 1. To determine the relationship of the structure of LNP to its function; 2. To continue studies on mutant and transformed legumes designed to obtain information on the role(s) of LNPs in the rhizobium-legume symbiosis; and 3. To utilize LNP as a probe for identifying other proteins that are involved in the establishment of the rhizobium-legume symbiosis. UC research is continuing on a new class of lectins (LNPs) that have both carbohydrate-binding and nucleotide phosphohydrolase activities. The researchers have found that the roots of the legume, Dolichos biflorus, contain three LNPs with different cellular

distributions. One of these LNPs (called LNP1) is a peripheral membrane protein located on the cell surface of the nodulation zone of the root and previous evidence from their laboratory has shown that it functions in the perception of the Nod factor signal produced by rhizobial symbionts to this plant. They are continuing a series of transgenic studies that show that this protein is involved in the perception of Nod factors. In this past year the researchers have found that the transfer of this gene from one legume species (Dolichos biflorus) to another legume species (Lotus japonicus) broadens the specificity of the recipient species so that it can recognize symbionts that normally only infect the donor species. They have found that this peripheral membrane protein associates with at least one other surface protein upon binding to the carbohydrate ligand to this LNP and are presently characterizing the structure and function of this receptor complex. Using site-specific mutagenesis they are continuing to produce a variety of mutants of LNP1 as well as chimeric proteins that combine LNP1 or portions of it with other proteins as they continue studies on the structure function relationships of this protein.

Impact: This research should contribute to the eventual transfer of the ability to form nitrogen-fixing symbioses to nonleguminous plants. Such an accomplishment should relieve the requirement, cost and adverse environmental impact of using chemical fertilizers to replenish soil nitrate utilized by nonleguminous plants and would thus have a significant impact on United States agriculture and the environment.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.11 Biotechnology

Title: METABOLIC PROFILING AND ENGINEERING OF OXYLIPINS IN RICE

Description: The aim of this project is to develop and subsequently utilize the enabling technologies for improvement of agronomic qualities of crops such as rice, through identification, and dissection of the specific role of the enzymes responsible for the production of compounds known as "master switches" of biological processes, such as responses to environmental cues, and production of aroma in fruits and vegetables. UC researchers completed the first objective and cloned the one hydroperoxide lyase (HPL) and the four allene oxide synthase (AOS) genes and their respective promoters from rice. The identity of each clone was subsequently confirmed by sequence analysis. Based on the findings none of these genes contains introns. Rice plants were grown in dry or submerged conditions and subsequent to their wound treatments, tissues at different developmental stages, from wound-treated and not treated plants were collected. These tissues were stored in -80degC freezer. They are currently in the process of isolating RNA, which will subsequently be analyzed by Northern blot analysis. To determine subcellular localization of the above mentioned gene products, two approaches were used. One is based on import studies using isolated chloroplast and the second approach is based on the fusion of the coding region of each of the enzymes with GUS or DsRed as the markers, with the ultimate goal of locating the fluorescent signal of these markers in a plant cells expressing the introduced construct transiently. Chloroplast import experiments were performed using the transcription/ translation product of the above mentioned genes and isolated pea chloroplasts. The initial data obtained from these studies, clearly indicates that two of the AOSs

and the HPL polypeptide are targeted into the chloroplast whereas, the other two AOSs aren't. Further chloroplast fractionation will determine the sub-organeller localization of the imported polypeptide. The outcome of these findings will potentially aid them in determining the structural mechanism (s) by which plant allocates the substrates shared by the branched AOS and HPL pathways. To perform the transient transformation based sub-cellular localization assays, the researchers have cloned all the four AOS and the one HPL coding region as fusion with either a green fluorescent protein (GFP) or a red fluorescent protein (DsRed). These constructs will be introduced into barely callus via gold bombardment. To determine the subcellular localization of these polypeptides, they will employ fluorescent microscopy. To determine the substrate specificity of any chloroplast-targeted enzyme, the mature polypeptide requires to be cloned in an expression cassette. The initial import studies enabled us to determine the length of the transit peptide which in turn has permitted us to design the appropriate oligonucleotide sequences for cloning of the mature polypeptide into the expression cassettes. Cloning of these constructs is underway. For the non-chloroplast enzymes, they have cloned the entire coding region in an expression cassette. They have also successfully performed the initial analytical experiments necessary for determination of enzyme activity and substrate specificity/preference of the recombinant enzymes as well metabolic profiling of mutant rice plants to be obtained in later times. The Anawah collaborators have generated a mutant population of rice plants and are currently in the process of analysis of these mutant lines in general and oxylipin pathway in specific. The UC researchers have provided them with the AOS and HPL sequences for design of tilling appropriate oligonucleotides.

Impact: During evolution, plants have developed a multitude of defense mechanisms against adverse biotic and abiotic impacts. Plants are sessile organisms and this property, in particular, may have forced evolution of the plethora of adaptive mechanisms to environmental stresses that they see today. One of the major signaling pathways induced by stress and developmental processes is the lipoxygenase pathway (LOX), a common pathway to all biological organisms that converts linoleic and alpha-linolenic acids into a wide range of oxylipins. Oxylipins, the metabolites derived from LOX pathway, play a pivotal role in an array of biological functions, ranging from responses to pathogens and wounding, to production of compounds for the flavor industry. Hence, dissection of the LOX pathway and analysis of the resulting metabolites will provide the essential and enabling tools for manipulation of the pathway for crop improvement. Among the branches of the LOX pathway, they have chosen to focus on two, the allene oxide synthase (AOS) and hydroperoxide lyase (HPL) pathways, as they produce the most common groups of oxylipins, including signaling, antimicrobial, antifungal, and aromatic compounds. To study these pathways they are focusing on rice as the crop of choice both for expanding their basic understanding of these pathways, as well as for future biotechnological applications.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.11 Biotechnology

Title: METABOLIC REGULATION OF GENE EXPRESSION DURING PLANT SEED DEVELOPMENT

Description: Early seed development in angiosperms is characterized by rapid cell division and differentiation. As cell division ceases, cell expansion begins. Two major processes characterize the cell expansion phase: 1) the massive synthesis of storage carbohydrates proteins and lipids, and 2) an increase in the genomic DNA content as a result of DNA endoreduplication (D' Amato, 1984). DNA endoreduplication is a unique form of cell cycling in which the cell alternates between G1 and S phases without cell division. This phenomenon occurs only on terminally differentiated storage parenchyma cells (Schweizer, et al., 1995). Seed germination on the other hand is characterized by the rapid and highly organized mobilization of carbohydrates proteins and lipids into chemical signals and high-energy compounds; processes essential for the seed germination and seedling growth and development. Understanding the molecular mechanisms controlling these processes is one of the many important challenges facing plant biologists today. The research objectives of this project are to study the role of seed macromolecules such as the small subunit of a methionine rich 2S albumin seed storage protein from soybean (lunasin) in seed development. The UC researchers' hypothesis is small bioactive peptides like lunasin controls seed development by inducing DNA endoreduplication and cell expansion. The main objectives of this study are: (1) to study the effect of lunasin in cell cycle in fission yeast;(2) to study the effect of lunasin in cell cycle of tobacco BY-2 suspension cells;(3) to show whether heterologous expression of lunasin affects endoreduplication levels in hypocotyls of the Arabidopsis seedlings (4); and to show that expression of the anti-sense RNA of lunasin results in the lower levels of endoreduplication in soybean seeds. The long-term goal of this research is to develop a detailed understanding of seed biology and to apply this knowledge to the creation of superior crop varieties that are more resistant to biotic and abiotic stresses, more nutritious and more sustainable in large scale managed ecosystems. This research should contribute significantly to improving human and animal health by promoting global food security. Early seedling development is associated with DNA endoreduplication and the massive breakdown of stored starch by enzymes such as alpha amylase and beta-glucanase. A model for how sugars control early seed gene expression has been previously described by the Metabolite Signal Hypothesis. In recent years, the researchers have exploited the concept of metabolic regulation of alpha-amylase gene expression to develop a plant cell gene expression system that permits the over-production of foreign proteins in rice cell culture. Cultured rice cells (including micro-calli) have been used to produce a variety of medically important human proteins such as human alpha-1-antitrypsin, human lysozyme and human lactoferrin. Expression and secretion was achieved by placing the genes for these human proteins under the control of a seed specific rice promoter and signal peptide. These gene/promoter constructs were introduced into rice calli via particle bombardment. Upon selection and characterization, all proteins were found to be processed and post-translationally modified and fully functional. These accomplishments now make it possible to use whole plants and rice seeds as a production system for scarce and expensive pharmaceutical proteins. They have now extended their studies to include the molecular events surrounding early seed development. They are particularly interested in molecular mechanisms controlling the switch between cell division and cell expansion. In most seeds, cell expansion is accompanied by extensive DNA endoreduplication of the cellular genome. They are investigating a small, 43 amino acid peptide, expressed early in soybean embryogenesis, to see if it is responsible for the switch from cell division to cell enlargement.

Impact: A better understanding of the molecular events controlling plant growth will provide the information needed to develop superior crop varieties. These crops will provide healthier and more nutritious foods to the consumer and can also be used to manufacture human therapeutic

proteins and metabolites. This research will have a significant societal impact by promoter global food security and improving the quality of life.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.11 Biotechnology

Title: MOLECULAR GENETIC ANALYSES OF NECTARY DEVELOPMENT AND ESTABLISHMENT OF CARPEL POLARITY IN ARABIDOPSIS

Description: Objectives: 1) Continue developmental genetic analyses of the establishment and maintenance of lateral organ polarity in Arabidopsis. 2) Continue genetic analyses of carpel and nectary development in Arabidopsis, screening for carpel and nectary mutants representing new genes and new alleles of already identified genes. UC researchers have isolated several mutations representing genes that act redundantly in controlling abaxial-adaxial polarity in the carpel. In these mutants, cells in the abaxial regions appear to incorrectly assess their position and differentiate inappropriately into structures that are normally only found adaxially, or vice versa. In the past few years they have cloned many of the respective genes. Members of both the YABBY genes and the KANADI genes act together to specify cells as abaxial, and to promote lamina outgrowth. In contrast, Class III HD-ZIP genes such as PHABULOSA and REVOLUTA act to promote adaxial fates. They hypothesize that complex interactions between these three families of transcription factors might account for a substantial part of the morphological variation in lateral organs of seed plants. Their recent findings indicate that a similar genetic program involving the KANADI and class III HD-ZIP genes regulates polarity in vascular bundles, suggesting a co-option of this genetic program during the evolution of leaves in seed plants. Present work focuses on identifying the signaling pathways by which cells in the adaxial and abaxial domains communicate, and thus establishing leaf lamina. They have shown that extended expression of YABBY genes in developing leaves results in continued leaf growth and hence larger leaves. CRC, a YABBY gene family member, is also required for nectary development in Arabidopsis, and likely many other core eudicot species. They have identified sequences in the CRC promoter that are required for its specific activation in cells that will give rise to the nectary.

Impact: Cereals, legumes, nuts, and fruits of angiosperms provide a large portion of the food that is consumed by both humans and livestock. Each of these products is ultimately derived from fertilized carpels. Manipulations, such as improving fertilization by altering nectary structure or secretion, in crop species could lead to improvements in the amount and diversity of their food supply.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.11 Biotechnology

Title: MOLECULAR GENETIC ANALYSIS OF PLANT DEVELOPMENT

Description: The ATML1 homeobox gene expression has a number of unique features that make it important among plant homeobox genes thus far identified in Arabidopsis thaliana. The project will continue studies of the ATML1 gene by determining the function of ATML1 in embryogenesis, and in shoot meristem and lateral root development. The specific objectives are as follows: 1) to analyze the genetic linkage between the T-DNA insertion in the ATML1 gene in the atml1 mutant line and the phenotype of aborted seeds. 2) to analyze the genetic interaction of ATML1 with other developmentally important genes using single and double mutant epistasis analyses. 3) to study the ectopic expression of the ATML1 cDNA. 4) to formulate a model for the functioning of ATML1 in embryogenesis and SAM. 5) to characterize ATML1 gene expression in developing lateral roots. One of the goals of this project is to identify and characterize members of the HD-GL2 family of homeobox genes that are closely related to Arabidopsis thaliana MERISTEM LAYER 1 (ATML1), a homeobox gene important in plant growth and development. Research has continued to elucidate the function of A22, one of the closest relatives of ATML1. The A22 gene is located on chromosome 1, and sequence analysis predicts an ORF of 3.6 Kb, with 9 exons and 8 introns, and a predicted protein of 749 amino acids. To determine the function of the A22 gene, A22 gene expression was analyzed in RNA isolated from Arabidopsis roots, stems, leaves, meristems and siliques by RT-PCR. The highest expression level of A22 expression analyzed by this method was observed in meristems and siliques. In situ hybridization analysis of Arabidopsis seedlings confirmed the RT-PCR data for A22 expression in the meristem and showed root expression limited to the primordia of lateral roots. A22 expression was also visualized in the RAM of secondary roots but was never observed in the primary root tip. Sectioned siliques were used to analyze A22 expression during early embryogenesis. Experiments indicated that A22 mRNA accumulates uniformly in the cells of the apical portion of the embryo, from the globular through the torpedo stage. However, in the mature embryo, A22 gene expression is restricted to the outer cell layer. The researchers used an RNA interference (RNAi) approach to analyze the A22 mutant phenotype. The most recurrent features of RNAi mutant plants in comparison to control and WT plants were the following: (1) delay of 2 to 3 weeks on average in the transition from the vegetative to the floral stage, (2) huge rosettes with a greater number of larger and darker leaves, (3) fewer lateral stems and sometimes none at all, (4) shorter stems, and (5) the presence of aborted seeds in the siliques. Siliques from mutant lines contained a high and variable number of dead seeds. This phenotype was observed through several generations and was scored in four mutant lines over the T1 and T2 generations. In order to visualize the embryos, immature seeds from WT, control, and mutant plants were cleared and observed under Nomarski optics. Mutant embryos, present in aborting seeds, were affected in their cotyledon development, with defects ranging from asymmetric cotyledon development to completely unilateral cotyledon development. These results strongly suggest that A22 plays a role in early plant development and may indeed interact with ATML1 and other homeobox genes, such as STM and WUS, to control plant growth and development.

Impact: This research should contribute to a basic understanding of the establishment and maintenance of meristem cells, as well as the control of differentiation of protodermal cells into specialized epidermal cells. It will also provide fundamental insight into the regulation of cell division and early meristem formation during embryogenesis, and shoot and lateral root development, and in this regard, is of considerable importance to agricultural biotechnology.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.11 Biotechnology

Title: TRANSGENES IN CONTEXT: USING MICROBIAL ECOLOGY TO UNDERSTAND THE DYNAMICS OF ARTIFICIAL DNA CONSTRUCTS AT THE AGRICULTURAL INTERFACE

Description: Over 100 million acres of transgenic crops have been planted every year worldwide for the last 5 years. One of the consequences of transgenic crop release into the environment is the spread of the transgenic constructs into non-target organisms, including non-transgenic crops, crop relatives, other plants and potentially a wide-variety of other prokaryotic and eukaryotic organisms. The unintended presence of transgenic seed recently evidenced in corn in the American Mid-West can be attributed to such biopollution. So far, however, transgene monitoring has been focused on the commodity crops themselves and on the expression of the transgene through the expected DNA-encoded protein and their corresponding traits. Little research has been focused on non-target, non-crop biological species and populations, or on the intrinsic ecological properties of the transgenic DNA itself, independently of the traits it might encode at a specific time. This problem is particularly critical, given that most presumed environmental effects of introduced transgenic DNA should be expected to occur through non-target organisms and through unintended effects of the transgenic DNA, either due to epistatic genomic effects or because of the secondary expression of novel traits. This is an area where neither traditional molecular biology nor traditional ecology have proven suited to effectively apply concepts or methods to detect and follow the movement of transgenic DNA constructs. This proposal aims at using concepts of microbial ecology to provide a novel database and conceptual framework to study and understand the movement of transgenic DNA in the environment. Accordingly, the objectives of this proposal are: 1. To establish DNA-based methods to detect the presence of transgenic constructs in non-target organisms. 2. To establish methods to determine the genomic context in which these constructs are contained. 3. To establish the extent and dynamics of introgression of transgenic constructs into local fields and varieties of agricultural crops. 4. To establish the extent and dynamics of introgression of transgenic constructs in non-crop organisms, including plants and microbes. 5. To establish a conceptual framework to understand the dynamic change in abundance, distribution and effects of transgenic DNA in the wider context of the agricultural interface and the environment beyond. New primers were designed to allow for the fluorescence-detection of transgenic DNA in various microscopic particulates. A method was established to collect, fix and process particulates for visualization of fluroescent probe for detection. A first run was tested using the new COPAS particle fluorescence analyser. Conditions were established for the amplification of DNA within particles using polymerase chain reaction (PCR). A collection of particles from environmental samples was initiated to test age effect on the detection method. Relatively high background fluorescence was identified as a potential problem, although new tests using fluorochromes in a different spectral range promise to ameliorate this problem. In optimizing the direct amplification from particles, an in-vitro set of experiments identified a heat-stable, protease-sensitive, factor in pollen extracts that inhibits DNA polymerase activity in a dose-dependent fashion. The researchers postulate that this factor represents a protein in these particles that could potentially preclude the possibility of amplification using PCR. New fixation and pre-incubation methods are being tested to eliminate this inhibition for the field-based assays

Impact: This research is leading to a fast, comprehensive method for the direct detection of transgenic DNA in the environment. The level of detection, and the equipment being used should make it possible to process 2-4 orders of magnitude more individual genomes than it is possible to date. In addition, this method should allow for the detection of transgenic DNA by local individuals or communities, allowing for generalized, low cost, extensive monitoring urgently needed but not available today.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.17 Home Lawn and Gardening

Title: HOME HORTICULTURE ARTICLES APPEAR IN LOCAL PAPERS

Description: In bringing information from UC to the home and garden audience, the most efficient method is to make use of local mass media because they reach the largest numbers of clientele. Newspapers are widely read and as such are an excellent extension method. The objective of the weekly column is to provide to home and garden clientele researched-based information that is up to date and timely. Weekly home horticulture gardening columns have been written for the Fresno Bee by UCCE's environmental horticulture advisor for almost 15 years. In 2001-02, 81 articles were published by the Bee and in 2002, distribution was expanded to include two other local papers. The articles are researched, written and distributed via email. The columns are also occasionally printed in agricultural magazines such as Nut Grower as space is available. The articles are currently being archived to facilitate a searchable database on the Fresno County UCCE Web Page.

Impact: Because this home horticulture column consistently appears in the newspaper, ANR has developed a dedicated local readership that has improved its home gardening skills, become more environmentally conscious of choices in landscape practices and also, incidentally, created a significant support base for UCCE. Surveys have shown that readers of locally-produced garden columns are the primary attenders at home gardening workshops and classes. At least 60% of participants list the local paper as the source of information about the event. Readership is also gauged by informing readers that if they send in a Self Addressed Stamped Envelope (SASE) they will receive helpful and free follow-up information. Twenty-five to 40 requests for free information weekly are not uncommon.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 1.19 Invasive Species

Title: EFFECTS OF HERBIVORES ON CROP YIELDS AND AS BIOCONTROL AGENTS OF INVASIVE WEEDS

Description: Objectives are: 1) To examine how herbivory to early leaves affects chemical composition of floral reward characters (nectar and pollen production) and floral attraction; 2)

To compare the numbers and kinds of pollinators that visit damaged versus undamaged plants and their foraging patterns; 3) To determine the extent to which plant fruit production after damage is influenced indirectly by pollinator limitation versus directly by leaf area removal and resource loss; 4) To use plant demographic approaches and manipulative experiments to estimate the effects of biocontrol agents in the suppression of an invasive weed, yellow star thistle (YST). A UC researcher has continued to study several aspects of plants and their interactions with damaging insect herbivores. In one set of studies, he was interested in how herbivore damage can affect plant reproduction both directly, by removing leaf tissue, and indirectly, by changing the ways in which pollinators respond to damaged plants. His previous work has shown that 1) damage to leaves reduces flower size and floral rewards and pollinator visitation (Lehtila and Strauss 1999), and that 2) B. RAPA plants bred for greater resistance to flea beetle attack received poorer quality pollination than plants with lower resistance (Strauss et al. 1999). Recently, he has found that floral parts of wild radish, including pollen, contain glucosinolates, compounds that have been shown to play a role in resistance to herbivores, and that may affect palatability of rewards for pollinators. These floral and leaf glucosinolates are inducible after damage (Strauss et al. 2004). Most recently, he has shown that cantaloupe plants that received experimental, supplemental pollination, either by hand-pollination, or with honeybees, were able to completely compensate for experimentally imposed leaf damage. In contrast, damaged cantaloupe plants that did not receive extra pollination produced significantly lower yields than undamaged plants. Thus, indirect effects of damage, mediated through interactions with pollinators, may serve as significant sources of yield loss (Strauss and Murch, in press, ECOLOGICAL ENTOMOLOGY). A USDA grant from the NRI CREES program has been received to continue this project . The experiments have the following objectives: 1) To examine how herbivory to leaves affects chemical composition of floral rewards (nectar and pollen) and visitation by pollinators and 2) to determine whether bee additions can improve yields of damaged plants. Bee additions represent an alternative to spraying to ameliorate the negative effects of herbivore damage. All these objectives are important for the Agricultural Experiment Station mission. In addition, he is continuing to pursue mechanisms underlying the ability of plants to tolerate insect damage with minimal loss to yield or fitness (Strauss et al. 2003).

Impact: The importance of indirect effects through pollination suggest there may be alternative strategies to dealing with leaf damage that are independent of manipulating the densities of damaging herbivores. Strategies that promote pollination, as opposed to spraying with pesticide, have the added advantage of not harming other beneficial insects and thus may be especially useful for organic farmers.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.19 Invasive Species

Title: GENETIC AND REPRODUCTIVE FACTORS CONTRIBUTING TO THE INVASIVENESS OF CORTADERIA JUBATA AND C. SELLOANA IN CALIFORNIA

Description: The research focuses on identifying genetic and reproductive factors that contribute to the invasiveness of jubatagrass (Cortaderia jubata) and pampasgrass (C. selloana) in

California. The latter species are among the most invasive wildland exotic pests in the state. Specific objectives of the research are to: 1. Quantify the genetic structure of wild populations of Cortaderia jubata and C. selloana and use this information to trace the species' spread in California. 2. Identify ornamental plantings, cultivars sold by nurseries, and/or wild coastal populations of Cortaderia that are sources of recent invasions into inland habitats.3.Quantify sex ratios of C. selloana in ornamental plantings and wild populations, and evaluate the effect of population sex ratio on the fitness of female and hermaphroditic plants. The field component of this study was initiated in September 2003. To date, plants of both species, Cortaderia jubata (jubatagrass) and C. selloana (pampasgrass), have been surveyed and leaf tissue sampled, for genetic analyses, from plants in established and newly-founded wild populations as well as ornamental plantings throughout the state of California. In addition, they have obtained plants of all horticultural cultivars sold in California. The researchers are currently developing protocols for nuclear and chloroplast (cp) DNA marker analyses, and cpDNA sequencing. They expect to have the protocols completed by the end of January 2004 at which time they will begin to collect genetic data on the samples collected in the field.

Impact: This study will identify genetic and reproductive mechanisms that have contributed to the success of Cortaderia jubata and C. selloana in invading coastal and inland habitats of California, and thus provide information on means by which new invasions may be prevented and/or managed. Results of this study will also have a direct impact on the horticultural industry and California Department of Agriculture. Whereas C. jubata is on California's Noxious Weed list, C. selloana continues to be sold as an ornamental. This study will indicate what needs to be done to ensure that continued sale of C. selloana does not result in invasions. Results will show whether there is a need to restrict the sale of specific cultivars, modify horticultural practices to ensure ornamental plantings do not produce seed or pollen, or ban the sale of C. selloana outright and place it on California's Noxious Weed list.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.19 Invasive Species

Title: INVASIONS OF EXOTIC WEEDY SPECIES AND THEIR INTERACTIONS WITH NATIVE VEGETATION AND CULTIVATED PLANTS

Description: (1) To test the hypothesis that invasiveness of plant species in disturbed environments is positively related to relative growth rate, leaf area ratio, and relative leaf production rate, and negatively related to genome size, length of minimum generation time and seed size. Additionally, to understand the relationship between genome size and relative leaf production rate by examining the relationships between genome size, cell size, shoot meristem size, cell cycle times, and the proportion of actively cycling cells in the meristem. (2) To develop a protocol for impact assessment of alien plants and prioritization of their control, containment, and eradication. (3) To assess global patterns in naturalized and invasive plant species diversity (Eurasia vs. other continents, continents vs. islands, tropical vs. extratropical areas). (4) To quantify the relationship between eradication effort, eradication success, and the initial size of exotic weed infestations. (1) The size and duration of non-native human populations are the

major contributors to a strong correlation between native and non-native (invasive) plant species richness in the United States. (2) Greater vertical complexity of plant communities invaded by FOENICULUM VULGARE increases visitation of frugivorous birds and promotes seed dispersal of native woody species on Santa Cruz Island, California. (3) Seeds/plant, flowers/inflorescence, and numbers of herbarium records are reliable predictors of actual field distribution of invasive Crotalaria species in Taiwan. (4) Terminology in plant invasion biology acceptable for both taxonomists and ecologists was proposed (Pysek et al. 2003). (5) A general theory of seed plant invasiveness was further elaborated.

Impact: Evaluations of biological attributes of invasive plants and invasible plant communities helps to develop management protocols for screening of introduced plants and prioritization of their control. Understanding the above is leading to better management systems.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.19 Invasive Species

Title: INVASIVE INSECT PESTS AND BIOLOGICAL CONTROL AGENTS IN CALIFORNIA: IMPACT ON AGRICULTURE AND CONSERVATION

Description: Objectives: UC researchers will begin the coming five years of this project by studying the population genetics of several populations of both endangered species and biocontrol agents and do work on the population genetics and molecular identification of invasive species. Examples of the objectives are given below and similar approaches will be followed for other invasive species, biocontrol agents, and endangered species. 1. Determine the geographical origin and/ or biotype identity of invasive species and species/biotype identity of natural enemies. 2. Determine the factors important in improving biological control using natural enemies 3. Determine the potential for application of sex ratio distorters for the improved control of pest species. 4. Determine the genetic variation present in populations of recent invasive species / endangered species and its importance in the establishment / prolonged persistence of these populations. Several projects were initiated to study the genetics of invasive species including the Avocado Thrips and the Citrus Peelminer. Markers to study the population genetics of these species were developed to help in determining the area of origin of the Avocado Thrips and to determine if the current pest form of the Citrus Peelminer originates from California or is the offspring of an imported population. The large scale analysis of these populations will be done next. In addition they are making a key based on DNA sequences to easily identify different thrip species that are pests in California. The researchers have finished a study to help in the identification of the egg parasitoid species Trichogramma minutum and T. platneri. These species are commonly used in biological control of moth pests in orchards in California. They cannot be distinguished using morphological characters. Their correct identification is important because the release of the wrong species (T. minutum) in California could result in a reduction of the biological control exerted by the naturally occurring T. platneri. The method developed is based on the difference in the DNA sequences between these species. In the studies on heritable factors that influence the offspring sex ratio of parasitoid wasps the researchers are continuing their studies on the bacteria of the genus Wolbachia that are commonly found. they are

particularly studying those Wolbachia that are causing their hosts to produce exclusively daughters. They produce only daughters without the need of egg fertilization. These bacteria may be applied to wasps used in biological control programs because infection with these bacteria can lead to a higher population growth rate of the wasps. The researchers have developed methods for egg parasitoids of the genus Trichogramma to transfer the infection, however the results so far show that these infections are difficult to transmit. In addition they have initiated studies of the species Aphytis melinus, an important parasitoid of the citrus red scale in California. This species is infected with another Wolbachia bacterium that can cause sterility in crosses between infected and uninfected forms of this species. They are determining the rate at which this phenomenon occurs in this important biological control species. Recently, a second group of bacteria has been discovered that causes effects similar to those caused by Wolbachia, in order to determine how prevalent these new bacteria are they have done a survey of approximately 200 insect species. Approximately 8% of all these species was infected with these Cytophaga-like bacteria.

Impact: The studies on the invasive species will help to determine their origin and with that can help in the prevention of future invasions from these sources. The key of thrips species for California will allow fast and unambiguous identification of these difficult to identify insects. The identification method for the Trichogramma will help mass producers sell the correct species for use in California, and will improve the biological control of moth pests in California. Our studies on the Wolbachia may help in creating more efficient biological control agents once they can infect uninfected species. The study of the Wolbachia in Aphytis will also result in a more efficient use of these parasitoids, and will make the biocontrol of Citrus Red Scale more efficient. Finally our knowledge of the common occurrence of the different bacterial symbionts of insects may open new methods for the control of insect pests.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.19 Invasive Species

Title: SUDDEN OAK DEATH

Description: Sudden Oak Death is a never-before-observed malady of oak trees that follows infection by a fungus-like organism, Phytophthora ramorum. This destructive pathogen is now killing oaks by the thousands in 12 coastal counties, affecting watersheds and altering forest ecosystems and species diversity. In 1995, Mill Valley homeowners noticed a high number of tanbark oaks dying in the Mount Tamalpais watershed. A CE Horticulture Advisor sampled and diagnosed, and in collaboration with other UC researchers, initiated community-wide education and research activities. These included more than 20 one-on-one interventions per month with arborists and homeowners; five ground and helicopter surveys to assess the extent of damage; and six field experiments demonstrating prevention and management of the disease in oaks. He also made 156 conference presentations to urban foresters, arborists and homeowners, and launched an aggressive media campaign involving 58 interviews in local, regional and national newspapers and 16 televised stories on local and national TV. For homeowners, professionals and the media, our office produced and distributed 50,000 copies of six Pest Alert issues. The

first, titled "Sudden Death of Tanbark Oak, Lithocarpus densiflorus," originated the name of this disease as 'Sudden Oak Death'. The website, which has become a major resource of information on this disease, has had 4,000 worldwide hits per month since March 2000. To help homeowners, they also published and distributed 10,000 copies of "Homeowner's Guide to Sudden Oak Death in Marin County". UC's DANR allocated $50,000 emergency funds to begin educational and research projects. At the local level, they gave a presentation to the Marin County Board of Supervisors showing the gravity of the Sudden Oak Death problem. The Board, in developing the Marin County Sudden Oak Death Task Force, on which they served, complemented the efforts with financial help and began a campaign that involved state and federal elected officials.

Impact: In less than one year, the CE office initiated a program that, in cooperation with UC colleagues, brought together 23 researchers and over $3 million in state and federal funds for research and education to prevent the spread of the disease. The county departmental team received a California State Association of Counties 2001 Merit Award for Marin County's Fight Against Sudden Oak Death.

Funding Source: Hatch, Smith-Lever, and State

Scope of Impact: State Specific

Theme: 1.20 Managing Change in Agriculture

Title: CHERIMOYA RESEARCH BENEFITS RARE FRUIT INDUSTRY

Description: In the early 1980s, almost no one in North America had heard of the lumpy fruit with white flesh known as the cherimoya. But Americans were yearning for new and exotic flavors. For many of California's rare fruit growers, the cherimoya, which had been introduced almost 100 years earlier, seemed like a natural solution. The fledgling California cherimoya industry faced a number of challenges. Not the least of these was the puzzle of the different cherimoya varieties. Growers recognized that the different cherimoya varieties, propagated by bud grafts, had different properties. Some varieties bore mature fruit as early as December; others, as late as March. One variety bore well only north of Los Angeles. The flavor of another was spectacular in Orange County and south, but insipid further north. The puzzle came from the fact that the different varieties are difficult to tell apart--impossible when not bearing fruit. Collections of marked trees had all but disappeared from Southern California. A University of California, Riverside Botany and a Staff Research Associate decided to use cherimoyas for their research, which used molecular genetic markers known as allozymes. Cherimoyas were amenable for allozyme analysis for almost two dozen genes, with every different variety having its own allozyme "fingerprint." They found that almost any plant tissue could be genotyped, including leaves. Thus, a fruit-free method for identifying the genotypes had been established. Fortunately, the University of California had saved its cherimoya variety collection at the South Coast Research Station (now South Coast Research and Extension Center). Originally planted in the early 1960s by UCLA researchers, the collection of marked trees served as a control for research so that the researchers could assign names to allozyme genotypes. Once they began to genotype trees, they realized the confusion that had accumulated over the years. In some cases, multiple varieties were masquerading under the same name; in other cases, multiple names had

been given to the very same genotype. They even discovered a variety thought to be extinct. By the late 1980s, they had identified 25 varieties. (In 1997, they discovered another genotype.) Nurseries and growers were now able to identify their trees and compare varietal performance in different locations and under different growing conditions.

Impact: California, the U.S. state producing the vast majority of domestic cherimoyas, now sells an estimated 4 million pounds of the crop each year, according to Dario Grossberger of the California Cherimoya Association. “The work of UC researchers to identify varieties was critical in converting cherimoya growing from a hobby to a viable commercial enterprise because it provided the means to develop reliable data about which varieties would perform well for particular areas and conditions,” said Rob Brokaw of Brokaw Nursery Inc.

Funding Source: Smith-Lever, Hatch, and State

Scope of Impact: State Specific

Theme: 1.20 Managing Change in Agriculture

Title: ENVIRONMENTAL REGULATORY CHANGE IN ADVANCED INDUSTRIALIZED DEMOCRACIES

Description: Objectives are to: 1. Undertake a full review and critical analysis of the relevant theoretical literature on this subject, building on previous work and generating publications on topics such as the question of agency in driving large-scale policy change and on the relative effectiveness of federal and unitary polity structures in implementing international regulatory agreements. This, along with the empirical work the researcher will undertake will help generate research questions and hypotheses to form the basis of a book-length manuscript. 2. Gain familiarity with the important environmental policy issues and processes in the state of California, as well as recent evolutions in federal-state relations in the US. 3. Update knowledge of recent policy changes along the lines outlined above in the countries studied so far. 4. Apply the initial findings to a sector-specific study of the politics of hazardous and radioactive waste disposal facilities in California and elsewhere. This is important both in itself, and as a way of investigating how the politics of access and government-public negotiation processes are evolving over time. The work currently focuses on how global governance affects environmental politics and policy in advanced industrialized democracies. The researcher has also been examining international trade in hazardous and nuclear wastes. Recent research under the rubric of this project has focused on mechanisms of policy diffusion, new theories of international cooperation, the impact of the World Trade Organization on environmental policies and multilateral environmental agreements, and the role and impact of transnational environmental social movements. He is also beginning to look at the outbreak of 'mad cow disease' in the UK and its impact on agricultural and health policies in the USA, and at biodiversity politics.

Impact: This work explores very important themes in regulation and environmental management. It is of relevance to local policymakers and activist communities, as well as to people who seek to understand what 'globalization' means for environmental politics and policy.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.21 New Uses for Agricultural Products

Title: PURIFICATION OF AGRICULTURAL DRAINAGE SALT AND ITS VALUE-ADDED APPLICATIONS IN TEXTILE PROCESSING

Description: In the study of utilization of agricultural wastes in textile processing, a drainage by-product, drainage salt, has been found usable for textile dyeing. Agricultural drainage salt generated during irrigation of crops in San Joaquin Valley, California, exceeds 600,000 tons annually and cumulates in the field in a rapid rate. As a result, the waste is taking out more farmlands for salt storage and disposal, imposing serious concerns to environment and local agricultural industry. In searching for a potential solution to reduce or eliminate the waste, this research explored feasibility of producing a value-added product, sodium sulfate, from the waste and utilizing the product in textile dyeing. The results indicated that sodium sulfate could be produced from the salt and could be purified by a recrystalization method in a temperature range within the highest and lowest daily temperatures in summer in the valley. In the past year, the researchers focused on purification of sodium sulfate from a mixture of sodium and magnesium sulfates. Magnesium sulfate that was found as a major impurity in recovered salt in several locations in the valley affect dyeing of cotton fabrics since it can form precipitates with reactive dyes. By analyzing phase diagrams of both sodium and magnesium sulfate they are able to find an easy method to remove magnesium ion and increase the purity of sodium sulfate to over 99%.

Impact: The researches studied the feasibility of utilizing an agriculture waste, drainage salt, in textile dyeing in laboratory and in a textile dyeing company. With the new progresses in purification of the sodium sulfate they are able to produce 99% pure sodium sulfate from solar evaporation, which can be employed in textile dyeing in southern California.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.22 Niche Market

Title: GRASS FED BEEF, A WAY TO PRESERVE OPEN SPACE IN CALIFORNIA

Description: A large part of California's open space and wildlife habitat is provided by ranchers, whose yearly return on their investment ranges from 3% down to minus 4%. In addition to this economic squeeze, increasing urban encroachment is limiting the sustainability of these open spaces. Marketing grass-fattened beef directly to the consumer could provide both a higher return to ranchers and a product that has many health advantages for consumers. In 1996, a UC Farm Advisor in Sutter-Yuba-Butte counties, and a UC Specialist from UC Davis, teamed up with researchers from California State University, Chico, under a UC Sustainable Agriculture grant to research the feasibility and logistics of grass-fed beef operations in California. The culmination of this work was a 77-page publication including four cost studies, a sample business plan, consumer surveys and legal requirements. After the first 200 copies were quickly taken, the decision was made to publish the information on the UC Sustainable Ag website. A UC Farm

Advisor then organized producers in Marin County to focus on working together to produce grass-fed beef. The Placer-Nevada Farm Advisor and a USDA Resource Conservation and Development Area Specialist started a study of niche marketing of beef for six counties in Northern California. They joined with the UC Center For Cooperatives to organize a highly successful two-day course, "Niche Marketing of Meat", attended by 105 people. The information has also been distributed in other educational meetings and on the Web.

Impact: UCCE has led the development of California's grass-fed beef industry by organizing key information and presenting it to audiences that can use it. The project has assisted more than 40 California ranchers in starting a new business to increase their incomes, thus bettering their chances of staying in business and not having to sell their land to developers.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 1.23 Organic Agriculture

Title: DEVELOPMENT OF PLANT PATHOGENS AS BIOHERBICIDES FOR WEED CONTROL

Description: Objectives: To evaluate and develop bioherbicide agents to control nutsedges, pigweeds, grasses, purslanes, spurges, kudzu, weeds in asteraceae, and others. To evaluate bioherbicides in multistate field trials in different crops and as alternatives to methyl bromide. In 2000, the researchers observed decreased emergence of common lambsquarter and other annual weed species when desert soils were amended with composted yard waste. Since then, the population dynamics of the weeds was directly correlated with the amount of organic matter added to the soil, and did not appear to be affected by tillage (reduced or conventional) or whether the plots were farmed organically or conventionally. In the summer of 2003, experiments were conducted to determine if the suppression of weed emergence was directly related to weed seed pathogens. Known quantities of common weed (common lambsquarter, pigweed, common purslane) seed were established in a factorial design that included various levels of tillage and organic soil amendment. There were no observed differences in weed seed emergence, and no seed pathogens were recovered. A search for an improved experimental design has begun to allow for better recovery of weed seed.

Impact: Research shows that organic amendments have benefits beyond soil fertility. They may also reduce reliance on pesticides.

Funding Source: Hatch Multistate Research and State

Scope of Impact: CA, FL, IN, MA, MT, NC, NYC, PR

Theme: 1.23 Organic Agriculture

Title: ENGINEERING FOR PEST CONTROL IN REDUCED CHEMICAL AND ORGANIC CROPS

Description: Objectives are: 1. To determine efficacious means that are based on thermal, mechanical and organically-produced herbicides for controlling weeds. 2. To develop mechanical systems incorporating sensors, controls and actuators to deliver the weed control agents exclusively to target weeds. 3. To develop efficacious and reliable means for delivering biocontrol agents such as predacious insects and arthropods and pheromones for control of insects. 4. To field test the weed and insect control systems. Work has focused on detection and precision treatment of weeds within seedlines of high value, specialty crops, especially organic production. Machine vision techniques using image processing for shape analysis have been implemented in field situations to discriminate young weeds from crop plants. Success is dependent on physical separation between the weeds and crop plants. When separation is not possible, or the weeds and crops have similar shapes, spectral analysis has been investigated. Hyperspectral analysis, using 16-bit resolution, appears very promising with success rates over 95% under laboratory conditions. Similar analysis in the visual wavebands was not successful. Once weeds and crops have been distinguished, the challenge is to selectively treat the weeds while leaving the crop plants undamaged. Precision dosing systems are being designed and tested. Additionally, the use of fluid additives to enhance spread of liquid deposit while inhibiting splash of the liquid has been investigated. Use of non-ionic surfactants and long-chain polymers, in optimal proportions, has proven to achieve the desired performance by virtually eliminating splash. A unique measurement system to quantify splash was developed; image processing was used to calculate the relative displacement and coverage area of misplaced liquid. A significant benefit of highly accurate spatial treatment of weeds within crop seedlines is that growers options for herbicide can be greatly expanded. Availability of chemically selective herbicides is decreasing and there are virtually no selective herbicides that are organically derived. If spatial selectivity can be achieved in herbicide application, non-selective herbicides can be used. Many non-selective herbicides offer significantly fewer environmental hazards than selective chemicals. Field experiments using microdosing equipment have determined that crop vigor and productivity, as measured by plant biomass, can be greatly increased by using low doses of herbicides applied by the spatially-selective spot sprayer. These yields are higher than when conventional selective herbicides are used. The yield data suggested that low doses provided the optimal balance between weed control and phytotoxicity of crop plants. Additional work is underway to investigate the use of spatially-selective thermal treatment using heated oils and other liquids. Engineering design of the precision dosing systems and the bioassays of weed and crop response to heated oils are underway. Additional work will investigate the use of organically approved herbicides and spray adjuvants. Acetic acid is showing promise as a bio-derived herbicide; this conforms work at other institutions. Essential oils, such as cinnamon and clove oils have shown promise in greenhouse experiments but have been less efficacious in field trials.

Impact: Producers of specialty crops need weed control systems that are less dependent on manual labor and conventional herbicides. This project is developing weed detection methods based on visual inspection. Once weeds are identified and located, organic and reduced-risk chemicals can be used to control the weeds. These methods will reduce growers dependence on conventional herbicides.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.23 Organic Agriculture

Title: FARMING WITH NATURE: ORGANIC WINEGROWING IN MENDOCINO COUNTY

Description: Since the early 1990s, Mendocino winegrowers have been converting large acreages to organic farming. Impressed by early experiments in other crops such as vegetables, they worked to improve their land, their fruit quality and their image in the market. However, concerns about soil fertility, disease and pest control and costs made growers cautious in their initial efforts. Collaborative research by UCCE, UC scientists and local growers has provided essential information on virtually all aspects of organic winegrowing:

--Covercrop studies have resulted in many vineyard floor management options that help growers protect their soils from erosion, improve fertility, create beneficial insect habitat and compete against troublesome weeds.

--Benefits of creating beneficial insect habitat with "insectary plantings" of prune trees, as well as ornamental plants that attract natural pests of grape leafhoppers and mites, have been demonstrated.

--Modern canopy management techniques developed by UC have been demonstrated and widely adopted by growers.

--The use of electronic weather monitoring equipment for predicting powdery mildew was perfected in Mendocino County, helping growers to pinpoint when to apply precise applications of sulfur dust and other environmentally friendly fungicides.

--Farming costs have been documented by UC agricultural economists and published as cost sheets, allowing growers to plan budgets for organic winegrowing based on accurate information.

Impact: Mendocino County is now the world leader in organic winegrowing, with over 3,500 certified acres of organically-farmed wine grapes. Winegrowers have greatly reduced their pesticide usage, with most applying only sulfur dust or spray to control powdery mildew. Cover crops are planted in over 70% of the county's vineyards and cover cropping techniques developed in Mendocino County are now widely used in California. Wine grape quality has actually improved as growers have taken better care of their vineyard soils. Mendocino County has one of the largest electronic weather networks in the state, with over 80 stations. Growers now routinely use electronic weather monitoring as part of their pest management decision-making. Many growers no longer spray insecticides, relying instead on beneficial insects that live in cover crops and insectary plantings. Nearly all growers use improved canopy management techniques that improve the overall health of the vines, making them less susceptible to insect and disease attack. This environmentally friendly farming system is also very cost-effective. Wine quality has improved in many instances, and organically farmed vineyards are safer places for workers, beneficial insects, birds and wildlife.

Funding Source: Smith-Lever

Scope of Impact: State Specific

Theme: 1.23 Organic Agriculture

Title: MOLECULAR GENETICS OF PLANT-BACTERIAL INTERACTIONS

Description: The major research objective of this UC laboratory continues to emphasize the molecular basis by which plants recognize invading phytopathogenic bacteria and the subsequent expression of plant disease resistance pathways in the host plant. The long term goal is to employ the basic information from these studies to genetically engineer long-term durable resistance in several crop plants. The researchers envision that ultimately they will be able to define the molecular basis of specificity within the plant host and the molecular recognition events that lead to the expression of plant disease resistance. With this information in hand, they hypothesize that they will be able to 'construct synthetic disease resistance genes' that can recognize conserved components in the pathogen that will lead to more durable resistance. During the past year they have made significant progress towards the goal of demonstrating the direct delivery of bacterial effector proteins via the Type III Secretion System (TTSS) of both Xanthomonas campestris pv. vesicatoria and Pseudomonas syringae pv. tomato to plant cells. They have employed the eukaryotic specific reporter protein, adenylate cyclase. Chimeric fusions between the N-terminal domains of AvrBs2 and AvrRpm1 with adenylate cyclase are sufficient to deliver chimeric fusion proteins to the plant cell and measure an increase in cAMP. This is a significant discovery as this is the first report of a direct biochemical measurement of the delivery of a phytopathogenic bacterial effector protein to the plant cell. In addition, they have transformed the Bs2 resistance gene from Capsicum annuum into Nicotiana benthamiana and have demonstrated that it is functional. They have developed this pathosystem by engineering the delivery of avrBs2 to plant cells via Pseudomonas syringae pv. tabaci (Pst). Strains of Pst expressing avrBs2 elicit a Bs-specific defense response on these lines and bacterial growth is inhibited. They have used this system to begin to dissect genes in the host that are required for Bs2 resistance. Candidate genes are knocked out by virus induced gene silencing (VIGS). To date, they have demonstrated that SGT and NPK1 genes are important for the expression of Bs2 resistance.

Impact: The development of these systems will allow the researchers to genetically dissect disease resistance and identify the molecular basis of disease resistance.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.24 Ornamental/Green Agriculture

Title: ABOVE- AND BELOW-GROUND DEVELOPMENTAL PHYSIOLOGY OF WOODY ORNAMENTAL PLANTS

Description: Objectives are to: 1. Develop calorimetric techniques for the rapid and accurate measurement of metabolic heat production and respiration rates in response to environmental variables. 2. Develop techniques and methodologies for the study of tree root architecture below-ground. Field studies have been completed to observe the root development characteristics and root architecture of FRAXINUS UHDEI, PISTACIA CHINENSIS and ZELKOVA SERRATA.

Using state-of-the-art photography and modeling software 3-D models have been constructed of the tree root systems. Those individual trees having the largest and smallest mean vertical angle from the soil surface have been selected, vegetatively propagated and planted in the field for root architecture evaluation (Spring 2004). Studies using microcalorimetry to predict the response of bedding plants (marigold, pansy and vinca) and buffalograss cultivars to varying environmental conditions (temperature, salinity) have been conducted. Other calorespirometric studies have been conducted to: 1) predict the response of bedding plant seeds to growth retardant treatments, 2) determine the respiratory and metabolic heat rate responses of rose leaflets to various soil moisture tensions and 3) determine the metabolic heat and respiration rate of nematodes in response to varying temperatures.

Impact: A method for the selection and propagation of deep-rooted trees will help minimize the damage tree root systems cause to city sidewalks and curbs. Accurate predictions of plant growth response using calorespirometric data will drastically shorten the time necessary to genetically improve plants and enhance our ability to tailor plants for specific climate zones.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.25 Plant Genomics

Title: GENE NETWORK DISCOVERY IN MAIZE AND OTHER GRASSES

Description: The UC researchers aim to understand the molecular mechanisms that underlie the specification of regional identity within plant morphogenetic fields, and how particular genes have been the focus of change during the evolution of plant form. Because they use a particular transposon, the Mu transposon in grasses, as a major analytical tool, a secondary aim involves finding out how the Mu transposons are regulated by plants. Deduction of a molecular mechanism is not possible without proving exactly which genes comprise the network of function; no gene acts by itself. Thus, a third aim of this project is to identify and describe the knockout phenotype of every gene of the approximately 30,000 genes in a corn plant. They are committed to finding important regulatory regions by finding conserved sequences when comparing orthologous DNA from maize, rice and other grasses diverged from a common ancestor about 50 million years ago (MYA). This year they published results that showed that conserved noncoding sequences (CNSs) that exist around orthologous exons in maize and rice are conserved because they encode some important binding function. These results on six genes were expanded by adding CNS analyses for an additional 52 maize-rice genes. They confirmed that most plant genes have CNSs, and that CNSs make excellent and useful pan-grass PCR primer sites. Additionally, they showed that grasses have about 10X fewer and much smaller CNSs than do mammalian genes. Because plant genes are simpler than mammalian genes, they were able to see a trend that was not seen by mammalian genomic biologists: upstream developmental regulatory genes, like transcription factors, have many more and bigger CNSs than do genes encoding enzymes or structural proteins. They also show that the upstream transcription factor, knotted1, shows a concordance of CNS-richness and mutational lesions that interrupt the binding of negative regulatory factors. They also found a general nonconcordance between sites of known transcription factors and CNSs, and also found that 27% of plant genes

have no CNSs at all even though they are regulated in complex patterns. They now think it likely that CNSs are beacons to important regulatory binding sites, but not to simple transcription factors, a hypothesis being tested. - In a similar maize-rice sequence comparison, they located an 11-gene cluster on rice chromosome one and on two maize BACs, BACS they sequenced ourselves, representing the location of the two ancestral homeologs from the tetraploidy event happening 11 MYA. They found all but one of the 11 rice genes on one or the other maize BAC, but not on both. They propose that maize is largely diploid, but fractionated into bits that need to be assembled virtually using a rice scaffold. They also showed that this concept of fractionation following duplication works well at the cis-acting site level, and evidence the birth of a new transcription factor function within the last 11 million years - They developed the tools to clone maize developmental genes eta, lco1 and tls1, but have not yet proven that the sequences are actually these genes. Meanwhile, they amass functional information about the maize development perturbed by mutants in these genes. - With a professional researcher in the lab, they have implicated small RNAs in the action of a transposon-silencing mechanism called Mu-killer. They have also shown without doubt that a Mu-family transposon "jumped" horizontally (probably using some sort of living vector) over a 50 million year span separating the panicoid grass Setaria italica (foxtail millet) with the oryzoid rice. While a first in plants, this sort of result is not new to higher organisms. It is not unexpected that mobile DNA will sometimes travel horizontally in the natural course of evolutionary events, as they have now shown for the grasses.

Impact: There is a lag between publication and impact. The publication of Kaplinsky and coworkers (PNAS, 2002) announced to the plant community that one toolbox of PCR primers could be constructed to extract gene fragments and map characters in any of the 10,000 grass species. This is slowly spawning a new generation of phylogenetic and agronomic tools for our cereals, tools protected by a University patent. The horizontal transfer result will be politically hot, but the value of this apparent impact is hard to judge, as was the value of the lab's contributions to the Quist/Chapella vs. Nature magazine debate (Kaplinsky et al., Nature, 2002.) The actual value of the lab's impact lies in the chance to gain insight into the nature of the language of gene regulation and silencing in plants, a language that they can just now see, in part as CNS sequence and pattern. To help decipher these sequences and patterns is the major aim.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.25 Plant Genomics

Title: GENETIC AND MOLECULAR ANALYSIS OF OVULE DEVELOPMENT

Description: Objectives are to: 1. Perform molecular characterization of ovule development genes. 2. Use molecular methods to determine interactions between different ovule development proteins and between proteins and gene regulatory sequences. 3. Utilize novel molecular and genomic methods to identify additional regulatory loci. 4. Use information gathered to construct progressively more accurate model of molecular regulation of ovule development. The Arabidopsis INNER NO OUTER (INO) gene is a critical regulator of ovule development. Mutations in this gene lead to the absence of the outer integument, a critical layer that gives rise to the most critical layers of the seed coat. INO is tightly regulated and is expressed on only one

side of ovules, and they have shown that this asymmetric distribution of expression is essential to normal ovule morphogenesis. They have used systematic deletion of the INO promoter region to define a critical positive regulatory element of approximately 290 bases that includes information sufficient to duplicate the INO expression pattern. They show that this region is not bound by known regulators of INO expression, indicating that such regulation is indirect or requires additional factors. They have identified a new family of transcription factors, the BASIC PENTACYSTEINE (BPC) proteins, that can bind to (GA)6-9 repeat structures in the INO promoter. The pattern of expression of BPC proteins and preliminary analysis of mutants in this gene family indicate that BPC proteins may participate in regulation of expression of a wide variety of genes. They have cloned the SHORT INTEGUMENTS 2 (SIN2) gene and shown it to encode a novel mitochondrial-localized GTPase. Together with prior results on HUELLENLOS this shows a close tie between mitochondrial function and integument growth.

Impact: An understanding of the interactions between transcription factors and the genes they regulate reveals the basic mechanisms responsible for many developmental processes in higher organisms. This understanding can translate into novel methods for engineered regulation of gene expression for crop improvement or biomedical applications.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.25 Plant Genomics

Title: IMPACT ANALYSIS AND DECISION STRATEGIES FOR AGRICULTURAL RESEARCH

Description: Objectives are to: To estimate the expected and actual flow of benefits and costs of research for agriculture, and related areas, including the incidence of their distribution and to analyze opportunities, risks, and net benefits from existing and potential public-private sector linkages, including new institutions such as joint ventures, partnering, consortia, specialty research centers, start up companies, intellectual property, technology transfer mechanisms such as licensing, exchange arrangements, direct purchase, borrowing, and freedom to operate. The conservation of genetic resources is vital to the maintenance of biodiversity and to the world's ability to feed its growing population. In recent decades a number of gene banks have been set up for the ex situ (meaning away from the source) storage of particular classes of crops. Since the 1970s, the eleven gene banks maintained by the centers of the Consultative Group on International Agricultural Research (CGIAR) have become pivotal to the global conservation effort. However, key management issues, usually with economic dimensions, have largely been overlooked. In response to this situation, IFPRI (International Food Policy Research Institute), in collaboration with five CGIAR centers: CIAT(based in Colombia), CIMMYT(Mexico), ICARDA(Syria), ICRISAT(India) and IRRI(Philippines) developed a series of detailed economic studies on the cost and management of conservation of genetic resources. A book by Koo, Pardey and Wright (in press) reports these studies and discusses their wider implications. It represents important research of interest to those working in plant breeding and genetics, as well as agricultural economics and policy. A paper in Agricultural Economics (in press) also deals with these issues. Other work at Berkeley addresses access to intellectual property (IP) in

agriculture. In horticulture, lack of access to IP appear to be hindering otherwise valuable research and development (R&D) in horticultural crop varieties. While leading private-sector agricultural biotechnology firms with strong IP positions and commercial freedom to operate (FTO) see insufficient incentives in the small, fractured markets of horticultural products, researchers with public sector support for horticultural projects but weak IP positions may find that the best way of gaining FTO and moving forward is to band together and provide mutual access to each others technologies. An institutional innovation, PIPRA, the Public Intellectual Property Resource for Agriculture, had its genesis at Berkeley, the Rockefeller Foundation and the USDA, and has now materialized as a coalition of U.S. universities and foundations committed to just such a strategy. A graduate student, and a post-doc have been actively involved in PIPRA's administration and development. A paper by Graff, Wright, Bennett, and Zilberman in *California Agriculture* (forthcoming) makes the case for the PIPRA initiative for horticulture. Wright has just been named to a National Academy of Sciences Committee on intellectual property in genomics and proteomics, and is continuing to write on TRIPS (trade related aspects of intellectual property rights) and related international IP issues, and to model the interconnected world of agricultural IP related to biotechnology.

Impact: This work in analysis of the costs of conservation has formed the underpinnings of an international initiative, headed by FAO, to fund the worlds major genebanks in perpetuity [http://www.startwithaseed.org/items/latest.php?itemid=146]. The Plant Biotechnology Handbook Chapter constitutes interdisciplinary outreach to the plant biotechnology community in the area of intellectual property, continuing Wrights earlier work including a plenary address.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AL, AZ, CA, FL, GA, ID, IL, IN, IA, KS, MD, MI, MO, MT, NE, NJ, NYC, ND, TX, VA, WI

Theme: 1.25 Plant Genomics

Title: MODIFICATION OF MEIOTIC RECOMBINATION RATES IN TOMATO

Description: The applied goal of this project is to develop a general method for increasing recombination between homeologous chromosomes by altering the expression of the MSH2 gene in tomato. This project should also increase the understanding of the function of the mismatch repair system in plants in regulating recombination. The researchers have already cloned the MSH2 gene of tomato, determined the sequence of the messenger RNA, demonstrated that it is single copy and determined its map position. The specific further objectives of this project are to: 1) Produce transgenic plant with reduced MSH2 gene expression, 2) determine the effects of MSH2 suppression on fertility and genetic stability in cultivated tomato, and 3) measure the effect of MSH2 suppression on the pairing and recombination of homeologous chromosomes. This year they completed their work on the MSH2 RNAi constructs and handed them over to the Chetelat lab for transformation into tomato. They feel that the Chetelat lab is the best home for the second half of this project: the investigation of the effects of MSH2 suppression on homeologous recombination. This is our final report on this project.

Impact: The applied goal of this project is to manipulate the level of genetic recombination in interspecies crosses. Inhibition of MSH2 expression may permit recombination between more

distantly related chromosomes, providing tomato breeders with access to a wide variety of stress tolerance and insect resistance genes currently inaccessible through traditional crosses.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.25 Plant Genomics

Title: MOLECULAR GENETICS OF DEVELOPING COTTON FIBERS

Description: Cotton fiber yield and quality are quantitative traits governed by the spatial and temporal expression of genes that may require >25% of the cotton transcriptome, or somewhere in the range of ~10,000 genes. The main goal of the project is the identification of fiber genes with pivotal roles in determining agronomically important fiber traits using genomic and reverse genetic approaches and to apply this knowledge to advance cotton biotechnology and molecular breeding programs. A major effort will be devoted to comparative studies that determine gene function by correlating changes in gene expression to altered fiber phenotypes, with focus on genes that encode regulatory factors and cell wall related proteins. The nature and scope of the proposed project will entail a major effort in bioinformatics to store, archive, manipulate and convert the vast amount of data into a meaningful context. Tools and resources will be developed in the form of framework EST-derived molecular DNA markers to apply biologically-relevant information to genetic diversity and molecular breeding programs for the cotton community via a web-based interface to aid in assembly of functionally-anchored consensus genetic and physical cotton maps. Cotton provides one of man's most basic need for fiber in the form of textiles and clothing. The main focus of our work is elucidating the underlying genetic mechanisms that govern fiber growth and development using genomic approaches as a step towards long-term goals to genetically modify fibers for enhanced fiber properties. During the period under review, they have identified a significant portion of the cotton fiber transcriptome, indicating about 14,000 unique gene sequences and about 35 percent of the cotton genome are required to make a fiber. These genes were used to study the fiber transcriptome in a an evolutionary context to gain novel insight into the domestication of cotton over the course of history. As a step towards genetic modification of output traits, regenerable cotton germplasm was developed and released to enhance forward breeding and biotechnological applications in cotton.

Impact: Utilization of tools and resources developed by this project hold the key to increased production using molecular approaches towards sustainable systems that maintain U.S. competitiveness in the global marketplace.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.25 Plant Genomics

Title: WHEAT BREEDING AND MOLECULAR GENETICS

Description: The goal of the UC Wheat-breeding program is the development of new common red, common white and durum wheat varieties and germplasm adapted to California. The specific goals are to introduce new disease resistance genes, increase grain yield potential, and improve end-use characteristics. The main wheat-disease targeted in the program is leaf rust, stripe rust, septoria tritici blotch, and barley yellow dwarf virus. The gluten strength and water absorption; for the HWS, the desired traits are improved color stability, gluten strength and failing number; and for the durum wheats, targeted end-use characteristics are semolina color, protect content, and gluten strength.

Impact: The release of new varieties with better yield and improved resistance to diseases and quality is an efficient way to transfer the value of research to the growers. The incorporation of new resistance genes will reduce the requirements of pesticides resulting in a direct benefit to the environment. Incorporation of the T. dicoccoides gene for high grain protein content may improve the efficiency of nitrogen utilization.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.26 Plant Germplasm

Title: AGRICULTURAL CHANGE, CROP DIVERSITY AND CROP GENETIC RESOURCES

Description: The objective is to: Carry out a case study of the relationship between cultural (language) diversity and maize diversity in its center of origin and diversity in Mexico and Guatemala; initiate a regional study in southern Mexico on the historic and contemporary status and trends in maize diversity. Initiate a study in central Mexico on the participation of farmers in programs to promote on-farm conservation of crop genetic resources; and expand research on trends in diversity of California crops. Analysis continued on maize diversity Mexico. A major activity was to refine the analysis of data sets relating to maize populations of two closely related but separate cultural groups cultivating maize in seemingly equivalent environments. The analysis shows that the maize populations of the two groups have different qualitative and quantitative characteristics, although they cannot be distinguished by isozyme analysis. Work on the social impact of genetically modified organisms was continued in relation to data gathering activity in Mexico to estimate the diffusion of genetically modified maize there. New work was initiated on the diversity of pearl millet in its center of origin in western Africa. Pearl millet landraces from Africa that are in U.S. collections were grown and characterized in Davis.

Impact: The conservation of genetic resources for agriculture is a national and an international imperative. In addition to preserving crop genetic resources in gene banks, on-farm maintenance in strategic locations of genetic diversity is now an accepted conservation method. Social science, such as the work in Mexico and California, can facilitate identification of sites and improve programs to promote on-farm maintenance of crop genetic resources.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.26 Plant Germplasm

Title: GENETIC IMPROVEMENT OF BEANS (PHASEOLUS VULGARIS L.) FOR YIELD, DISEASE RESISTANCE,AND FOOD VALUE

Description: Bean dwarf mosaic virus (BDMV) is one of several whitefly-transmitted geminiviruses (Genus Begomovirus, Family Geminiviridae) that infect common bean. BDMV shows differential pathogenicity in common bean, infecting beans of the Andean (A) but not the Middle American (MA) gene pool. In the MA cv. Othello, resistance is associated with a hypersensitive response. To determine the extent of BDMV resistance in MA beans and the role of the HR, germplasm representing the four MA races (Durango, Guatemala, Jalisco and Mesoamerica) and the parents of cv. Othello were inoculated with BDMV. Germplasm representing all four MA races and the parents of cv. Othello were resistant to BDMV, indicating the widespread distribution of BDMV resistance in the MA gene pool. Interestingly, the HR was not correlated with resistance. A genetic analysis of BDMV resistance in cv. Othello was continued by examining BDMV resistance in F1, F2 and F3 progeny of a cross between cvs. Othello (MA) and Topcrop (A). Segregation data indicated that a single dominant allele, Bdm, conferred BDMV resistance.

Impact: Geminiviruses cause major losses to crop plants, including common bean. They have demonstrated the widespread presence of a resistance gene to the geminivirus Bean dwarf mosaic virus in the MA gene pool of common bean, which will facilitate breeding of resistance to this virus. It was also established that this is a single dominant gene, making it an excellent candidate gene for cloning and engineering plants for geminivirus resistance.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AK, AZ, CA, CO, HI, ID, KS, MN, MO, MT, ND, NE, NM, NV, OH, OR, TX, WA, WY

Theme: 1.26 Plant Germplasm

Title: GENETIC IMPROVEMENT OF PISTACHIO AND GENETIC STUDY OF THE GENUS PISTACIA

Description: Objectives: 1. Develop improved pistachio cultivars and new germplasm of P. vera for future cultivar development, 2) perform genetics and genomics research on P. vera and related species, 3) develop rootstocks with improved vigor and resistance to disease, and 4) study the genetic relationships of pistachio and associated pest and disease causing organisms. The breeding block of pistachio seedlings at Davis was removed. Budwood from selected P. vera clones from the block, identified as potentially superior items, either because of nut characters, yield compared to the population averages, or superior disease resistance was collected and budded to rootstocks. Previously budded materials were moved to the field for permanent maintenance. They will be maintained in a collection for future use in breeding or for selection trials. A second year of yield data from a set of advanced selections in the San Joaquin valley was obtained. Two items with significantly better performance than Kerman and an early male continue to be evaluated for pending cultivar release. Leaves from a closed cross progeny were

isolated and DNA re-isolated for construction of a genetic map via AFLP. AFLP was conducted on parents and determined to be feasible for map construction. DNA was set to cooperator for AFLP analysis of progeny.

Impact: Maintenance of selected pistachio clones will ensure that these superior items are retained for future use. This is important as all original populations from the breeding program have been eliminated and selection outside of the preserved materials cannot be done. The new advanced selection cultivars will provide direct economic benefit to growers. Genetic characterization of pistachio will be useful for development of future crop improvement efforts.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.26 Plant Germplasm

Title: GENETIC VARIABILITY IN THE CYST AND ROOT-KNOT NEMATODES

Description: Objectives: 1. Define nematode genetic variability for phenotypes including morphology, responses to resistance, environmental variation, and biotic interactions. 2. Determine nematode fitness and adaptability relative to environment, host plant, and host plant resistance. 3. Design and develop integrated management strategies for plant-parasitic nematodes that include consideration of environment and genetic variability. Objective 4: Implement rapid information transfer of project results to stakeholders. Root-knot nematode (Meloidogyne spp.) interactions with resistance in the host crops cowpea (Vigna unguiculata), tomato (Lycopersicon esculentum and L. peruvianum) and common bean (Phaseolus vulgaris) interactions were used to analyze genetic variability in nematodes for (a)virulence expression and stability. Resistance is being used both in commercial crop cultivars and in cover crop plantings for control of root-knot in many crops. New resistance sources have been identified in each of the aforementioned crops that confer unique specificities that match avirulence genes in the nematode. Additional analysis of the Rk gene in cowpea that confers resistance to M. incognita and M. javanica determined it to be a complex locus. Virulence in M. incognita to gene Rk was analyzed using isofemale line selection studies, in both controlled environment and field experiments. Virulent nematode lineages were selected from some but not all individual virulent nematode lines when inoculated repeatedly onto resistant plants. The fitness of some virulent lines was lower than avirulent sister lines, measured as lower fecundity rates. In common bean, differential interactions between isolates of M. hapla race A for ability to reproduce on bean plants with a dominant resistance gene were used to analyze genetics of virulence to this R gene. Segregation of avirulence in F3 to F5 nematode families derived from crosses between avirulent and virulent M. hapla parent lines indicated a single gene control of this trait, with avirulence dominant to virulence (recessive). AFLP analysis revealed high levels of DNA polymorphism between the M. hapla parent isolates. Three AFLP polymorphisms were linked to the (a)virulence locus and provided useful markers for studying the genetics of virulence.

Impact: Natural host plant resistance genes are valuable in crop plants as effective and safe approaches to managing root-knot nematodes. Studies on their specificity, efficacy and use in cropping systems advance their utilization in agriculture. Genetic variability in nematodes for ability to reproduce on resistant plants is being characterized to help guide decisions on use of

resistance crop varieties and to give direction to plant breeding programs in grain legumes, cotton, carrot and tomato.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AR, AZ, CA, HI, MI, NE, NM, OR, WA, WY

Theme: 1.26 Plant Germplasm

Title: HORTICULTURE, BIOLOGY AND ENVIRONMENTAL PHYSIOLOGY OF CALIFORNIA STRAWBERRIES

Description: Objectives: Develop and evaluate novel plant propagation and fruit production systems that enhance strawberry production efficiency and fruit quality while minimizing adverse environmental impacts; elucidate physiological and environmental factors that influence strawberry growth, development and productivity; develop novel strawberry germplasm with potential for commercial production in traditional and non-traditional strawberry production systems. Strawberry root, crown and fruit rot caused by the fungus Colletotrichum acutatum (anthracnose) is an increasing problem in California and worldwide. The development of improved strawberry cultivars with tolerance to C. acutatum is a long-term goal of the University of California strawberry cultivar improvement program. Identification of superior genotypes with tolerance to C. acutatum is the first step in the development of cultivars with tolerance to this important disease. To determine the sensitivity of a range of genotypes, and to hopefully identify genotypes with tolerance to C. acutatum, they selected ten strawberry cultivars and advanced selections from the University of California strawberry improvement program. These genotypes were grown in a runner propagation nursery and either inoculated in the nursery during summer with a sprayed-on spore suspension of C. acutatum, or maintained as non-inoculated (control) plants. Inoculated and non-inoculated plants of all genotypes were dug and planted in Irvine, California in early October in a disease-free plot treated preplant with a 2:1 mixture of methyl bromide and chloropicrin (2:1 wt:wt, 392 kg ha-1). Additional control (non-inoculated) nursery plants of each genotype were inoculated with one of two spore concentrations (5 x 105 and 1 x 106 spores per ml) at the time of transplanting in October 2003. Following transplant, all plants received frequent overhead irrigation for 10 days to assist with transplant establishment and to ensure development of the disease. Plant growth and development were assessed visually after one and two months from transplanting. For control plants of all genotypes, growth and development were normal with no visual symptoms of anthracnose infection. Inoculation with C. acutatum affected growth of all genotypes, with nursery inoculation having the least effect on plant growth, and inoculation with the 1 x 106 ml-1 spore suspension at the time of transplanting being the most damaging. Based on assessments of plant growth, all genotypes evaluated in this study were sensitive to C. acutatum, but genotypes varied considerably in the degree of stunting or mortality. The cultivars 'Irvine' and 'Chandler' were highly intolerant, and most inoculated plants were dead or badly stunted. The cultivars 'Camarosa' and 'Ventana' exhibited less stunting and plant mortality than the other genotypes tested, but these cultivars were still not highly tolerant of C. acutatum. The information developed from this project will assist growers in making decisions about strawberry cultivars and strawberry disease management.

Impact: Accurate assessments of tolerance or susceptibility to C. acutatum for strawberry cultivars and genotypes will allow growers to select suitable cultivars for their production environment, while providing plant breeders with important information on sources of tolerance or susceptibility to this important pathogen.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.26 Plant Germplasm

Title: MOLECULAR CHARACTERIZATION, BIOLOGICAL STUDY, AND DEVELOPMENT OF MOLECULAR DETECTION METHODOLOGIES FOR VIRUSES IN HORTICULTURAL CROPS

Description: The objectives are focused on viruses affecting horticultural crops, in particular grapevine. They will take a molecular approach to characterize these viruses, especially those with unknown or partially known etiology. Specific objectives will include: 1) To sequence the genome of these viruses; 2) To determine their genome organization and their relationship to other closely related viruses; 3) To study their biology and movement within the host plant and in nature; and 4) To develop molecular methodologies for their detection. Research on Grapevine leafroll associated virus 9 (GLRaV-9) was continued. Almost 80% of the viral genome (12588 bp) has been sequenced and the seven open reading frames consisting of methyltransferase (MTR)/helicase (HEL), RNA-dependent RNA polymerase (RdRp), p10, P6, heat shock protein 70 (HSP70), putative coat protein (CP) and coat protein duplicate (CPd) genes were determined. Molecular analysis clustering GLRaV-9 with species in Ampeloviruses genus in closteroviridae family, and proposing that this virus to be a candidate member of this genus. Very little was known about the genomic sequence of GLRaV-4. The researchers continued work to characterize this virus and up to date they have produced the first consistent sequence data on its genomic organization. It has been confirmed that GLRaV-4 has the quintuple gene block (QCB), consisting of p6, HSP70 homolog, HSP90 related, major and minor coat proteins characteristic for the members of the Closteroviridae family. Phyllogenetically GLRaV-4 appears to be closest to GLRaV-5 and pineapple mealybug wilt associated virus 1. During field surveys in Californian vineyards, symptomatic grapevines were collected and tested by RT-PCR for a panel of grapevine viruses. In this investigation, two different Grapevine rupestris stem pitting associated virus strains (GRSPaV) were detected using the primers RSPC-48 and RSPV-49 (universal primers). One of these viruses was isolated from a syrah selection showing graft union disorders and the second virus was isolated from a Pinot Noir vine showing stem lesions on certain rootstocks and solid reddish color in the fall on leaves. Both viruses have been partially sequenced and investigation is continued to determine the correlation, if any, between these viruses and the symptom observed in the field. Recent investigations have shown that grapevines host several viruses resembling Grapevine fleck virus (GFkV) in morphology, molecular properties, and cytopathological features, i.e. Grapevine redglobe virus (GRGV), Grapevine asteroid mosaic-associated virus (GAMaV), and Grapevine rupestris vein feathering virus (GRVFV). These viruses are phylogenetically related to one another, but taxonomically GFkV and GRGV are classified in the genus Maculavirus, GAMaV and GRVFV are in the genus Marafivirus. Virus-specific PCR detection method developed for each of these viruses. Also in

an attempt universal degenerate PCR-primers were designed which were derived from sequenced genome fragments coding for methyltransferase and polymerase and a procedure was developed for simultaneous detection of all these viruses in a single reaction.

Impact: Detecting and understanding the problems in plant propagation and production and determining the cause and finding tools to detect the cause before rendering problems will greatly help horticulturists in their management and control of the disease. In the investigation, the researchers have characterized four new viruses which causing problems in the vineyards and found methods for their early detection in the plant. In addition, by characterizing these viruses, the means used in nature for their transmission and spread could be predicted. The detection methodologies developed also could enhance the quality of certified plant materials in a certification program by testing the mother plants before collecting materials from them for propagation purposes.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.26 Plant Germplasm

Title: PLANT GENETIC RESOURCE CONSERVATION AND UTILIZATION

Description: Objectives: Acquire and conserve cool season food and forage legume, turf, and forage grass, vegetable, ornamental and medicinal plant germplasm of over 2,400 species in 268 genera. Characterize and evaluate germplasm by using morphological characteristics and molecular marker technology to enhance conservation management, increase utilization of the germplasm collections, and to incorporate the resulting genetic data into publicly accessible databases. Evaluate interactions of key associated pathogens, and/or symbionts to improve management and utilization of plant germplasm collections. Within the Western Region, throughout the U.S., and internationally, encourage the use of a broad diversity of germplasm to reduce crop genetic vulnerability. Through different avenues of technology transfer in the form of plant germplasm propagules (seed/clones), research publications and other associated information to scientists world wide, provide resources to scientists world wide for future crop development. The California Annual Report to the W-6 Technical Committee was presented at the 2003 Annual Meeting at Pullman WA. In addition to conducting committee business, the Committee toured the Western Regional PI Station at Pullman and reviewed the research and service program of the PI station as part of the Committee charge. Somatic embryogenesis protocols for generation of peach were continued. A new research effort to explore the use of yeasts as a biopesticide against A. flavus was initiated with researchers at the USDA Albany Lab.

Impact: This project supports the National Plant Germplasm System and provides a system for reporting the use and value of germplasm distributed by NPGS to California users. This information is used to justify NPGS funding. Development of non-toxic biopesticides to replace chemical fungicides will reduce human health hazards and may be less expensive to produce.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AZ, CA, CO, HI, ID, MT, NM, OR, UT, WA, WY

Theme: 1.26 Plant Germplasm

Title: POTENTIAL OF THE MODEL LEGUME MEDICAGO TRUNCATULA TO ADDRESS TARGETS OF AGRONOMIC IMPORTANCE

Description: Objectives: 1. Identify and eventually clone genetic determinants of resistance against the plant pathogen Xylella fastidiosa. 2. Implement methods for high throughput genotyping. Alfalfa weevil (Hypera postica Gyllenhal) is the most destructive insect pest of alfalfa. Damage occurs early in the growing season, when larvae feed on developing leaves, leading to reduction in both yield and forage quality. Although the damage can be controlled by cultural, biological, and chemical control practices, resistant cultivars offer the most efficient and environmentally sound strategy to control this insect pest. Characterization of genetic factors conditioning resistance is critical in implementation of this strategy. With this goal in mind, they screened a collection of 120 Medicago truncatula genotypes in a preliminary assay of host resistance/susceptibility to weevil feeding. The work was conducted in collaboration the UC Davis Departments of Entomology and Agronomy and Range Science, respectively. Briefly, 20 plants of each genotype were divided among four pots. Three pots were challenged with 10 weevil larvae each, and the fourth was left unchallenged. All plants were contained in 2-liter plastic containers equipped with a mesh top. Most larvae had established feeding sites within hours of encounter, and damage was evident by 24 hours. Pest damage was scored after one week. They observed significant variation between genotypes, with some genotypes scored as putatively resistant and some scored as putatively susceptible to weevil feeding. Quantification of weevil damage was obtained by scoring the percentage canopy that remained intact relative to untreated controls of the same genotype. Importantly, estimates of damage were typically consistent between independent trials of the same genotype, suggesting that genetic factors are responsible for the observed differences among populations. Based on these preliminary results, a research proposal was submitted to the alfalfa board through the Department of Agronomy and Range Science at UCD. The proposal had the following objectives, but was not selected for funding. 1. Phenotypic screening of Medicago truncatula genotypes for variation in their response to feeding by alfalfa weevil. 2. Genetic crosses of selected resistant and susceptible genotypes and generation of segregating populations. 3. Molecular mapping of quantitative trait loci controlling host plant resistance to alfalfa weevil.

Impact: Alfalfa Weevil is the most damaging pest of alfalfa. In addition to the large economic losses that can ensue in the absence of chemical control measures, the application of pesticides is both costly and environmentally destructive. Effective resistance to this important pest has not been identified in cultivated alfalfa. The identification of weevil resistance in the close relative, Medicago truncatula, offers the possibility of (1) identification of transgenes for weevil resistance in M. sativa, and (2) marker assisted selection in breeding programs to incorporate resistance based on wide crosses to related species of Medicago.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.26 Plant Germplasm

Title: ROOTSTOCKS, CULTIVARS, TRAINING AND CULTURE OF MULTI DENSITY DECIDUOUS FRUIT ORCHARDS

Description: Objectives: Evaluate stone fruit, pome fruit and nut crop rootstocks for size control adaptability to various conditions, resistance to disease and pests, salinity tolerance, compatibility, ease of propagation, and other horticultural characteristics. Evaluate cultivars of various species for fruit quality, insect and disease resistance, production, bloom time, harvest sequence and adaptability to denser plantings. Compare various training methods for adaptability to higher density planting, effect on productivity and fruit quality, and economic feasibility. The California Pistachio Rootstock Trials, with separate trials for yield, three locations, Verticillium tolerance, one location and salinity tolerance, one location, were all concluded in 2002. The trials all investigated the behavior of the 'Kerman' female and 'Peters' male on three different rootstocks. The three rootstocks were Pistacia atlantica, Atlantica, P. integerrima, Integerrima, and two hybrids of the two, P. atlantica X P. integerrima, PGII and UCB-1. The results demonstrate trees on Atlantica rootstocks or the two hybrids had significantly better cold tolerance than trees on Integerrima rootstocks. Trees on Integerrima and UCB-1 had equal, and superior, tolerance of Verticillium relative to trees on Atlantica or PGII. Tree on UCB-1 produced significantly better yields than trees on the other rootstocks. Trees on all three rootstocks had equal tolerance of salinity up to 8 dS/m soil salinity but at 12 dS/m trees on UCB-1 lost 35% of their yield while trees on the other rootstocks only suffered 15-28% losses in yield. Within these rootstocks individual trees with superior yields, Verticillium and salinity tolerance have been identified and the germplasm is being preserved for further trials when vegetative propagation of rootstocks can be successfully developed. Cherry: Several sweet cherry rootstock trials have been established over the years. They have evaluated about 20 Prunus mahaleb selections at 5 different sites throughout California since 1996. In 2001, they identified three new improved rootstocks from those evaluations and submitted patents on the 3. Each rootstock is propagated through vegetative means and are more uniform growth and production than those typically produced through seed. Each rootstock had been screened for resistance to Phytophthora, which is the most problematic disease for mahaleb rootstocks. Other features include low suckering, high productivity, tree size control and high yield efficiency compared with standards currently available.

Impact: Pistachios - the combined results have demonstrated UCB-1 is a superior rootstock combining cold, Verticillium and salinity tolerance with significantly better yields when budded with a 'Kerman' scion. It is becoming a leading rootstock in the industry. Cherry - they expect that these rootstocks will either replace the standard Mahaleb rootstock or be an additional option for cherry growers in California.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.26 Plant Germplasm

Title: SYSTEMATICS STUDIES OF HORTICULTURAL CROP PLANTS AND THEIR WILD RELATIVES

Description: Objectives: 1) To develop molecular markers, including nucleotide sequence data, ISSR and SSR markers, useful for genetic fingerprinting and phylogeny reconstruction in horticultural crop plants and their wild relatives, focusing on members of the family Rosaceae and the genus Juglans. 2) To seek to obtain improved phylogenetic resolution across Rosaceae with DNA sequence data by increasing sampling for genes already studied and by incorporating data from additional genes. 3) To evaluate genetic variability within and phylogenetic relationships among selected horticultural crop plants (e.g., species of Fragaria and Prunus) and their wild relatives and to test hypotheses, e.g., of hybridization and polyploidization, for the origins of particular species and groups of species. 4) To examine the evolution of particular molecular, morphological, and ecological characters in the groups of interest. 5) To use the information from the first four objectives to revise, as necessary, the taxonomies of the groups in question. A postdoctoral associate has continued to work on the UC NSF-funded project, in collaboration with a colleague at the University of Connecticut, to examine diversity and phylogenetic relationships among the actinorhizal Rosaceae and to compare those with patterns of diversity and relationship among the Frankia strains infecting the plants. The main goal of the project is to assess the degree to which coevolution and cospeciation have occurred between plant hosts and their bacterial symbionts. During the summer of 2003, an undergraduate joined the project; her summer employment was funded by an REU supplement to the NSF grant, and she has continued as a student assistant this academic year. Our analyses have revealed a surprising lack of diversity among Frankia strains on Rosaceae in California, but somewhat more diversity in other areas and they are continuing to investigate patterns of diversity in this group. Concomitantly, they have generated phylogenies for the plants based on several gene sequences. Results were presented of both aspects of this study at professional meetings in summer of 2003, and they are preparing results of both of these aspects of the project for publication. Most recently, microsatellite primers have been developed for this group, which will be useful for testing hypotheses of interspecific hybridization within two of the genera, Cercocarpus and Purshia. The UC researcher ha also collaborated with his colleagues on molecular marker development projects for stonefruit (Prunus spp.). A visiting scientist from Spain completed and published molecular phylogenetic studies of varieties of peach and almond and closely related wild species. The UC researchers assisted with phylogenetic analyses. A University of Wisconsin-Eau Claire colleague who spent a sabbatical leave in 2002 in the lab examining diversity and phylogeny of species of North American plums, has published a paper resulting from that research. The molecular marker development work in walnut, in collaborationwith the USDA's National Clonal Germplasm Repository, is largely complete and two manuscripts resulting from that work are in preparation.

Impact: The research on actinorhizal Rosaceae will help clarify the taxonomy of ecologically important shrubs in the western U. S., provide a detailed phylogeny of one major lineage within Rosaceae, and improve the understanding of the evolution of symbiotic nitrogen fixation in plants. The work on molecular marker development in several fruit and nut crops and their wild relatives has relevance to plant breeding and germplasm conservation.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.26 Plant Germplasm

Title: USE OF WILD LYCOPERSICON SPECIES IN BREEDING FOR IMPROVEMENTOF CULTIVATED TOMATO

Description: Objectives: Develop interspecific Lycopersicon populations and use DNA markers to map agriculturally important traits. Implement selection, breeding and introgression strategies to introgress genes important for germplasm improvement. Select and publicly release improved germplasm. Study interspecific recombination. Study how QTL act, alone and in combination, to produce the final phenotype. Tomato germplasm enhancement research has emphasized the identification and transfer of genes from wild to cultivated tomato (LYCOPERSICON ESCULENTUM) for chilling tolerance (CT), resistance to blackmold (RBM) and late blight (RLB). The pathogens PHYTOPHTHORA INFESTANS (late blight) and ALTERNARIA ALTERNATA (blackmold) and chilling temperatures can all cause significant yield and fruit quality losses. Previously, quantitative trait loci (QTL) for RBM, RLB, and CT were mapped in interspecific populations and QTLs identified for introgression. DNA markers linked to the QTL regions were used to select progeny lines containing the desired wild species alleles at these QTLs (i.e., marker-assisted selection, MAS). RLB QTLs on chromosomes 3, 4, 5 and 11 and RBM QTLs on chromosomes 2, 3, 9 and 12 were transferred into cultivated tomato using backcrossing and MAS. BC3S1 lines containing different combinations of one to four RLB QTLs from L. HIRSUTUM were identified using MAS, then field-tested in 2001 and assayed in replicated disease screens during 2002. Lines containing RLB QTLs on chromosomes 5 and 11 were most consistently resistant in all three types of disease assays, while RLB QTL on chromosome 4 was most associated with stem resistance. L. CHEESMANII alleles at RBM QTL on chromosomes 2, 3 and 9 in BC1S2 progeny conferred resistance in an L. ESCULENTUM background; the QTL on chromosome 2 had the largest positive effect on resistance. Sub-near-isogenic lines (sub-NILs) for RBM QTL on chromosome 2 and RLB QTL on chromosomes 3, 4, 5 and 11 (lb3, lb4, lb5b, lb11b) were developed from NILs using MAS. Sub-NILs were tested in replicated field trials in 2002, and disease data was used to fine map each of these resistance QTLs to smaller chromosomal segments, resulting in more suitable targets for MAS breeding efforts. QTLs lb4, lb5b and lb11b mapped to intervals of 6.9, 8.8 and 15.1 cM, respectively. Fine mapping of lb3 was not possible due to severe fertility problems in the sub-NILs, but a fertility locus was mapped. RBM QTL on chromosome 2 was located to a 20 cM region. Two CT QTLs from L. HIRSUTUM on chromosomes 5 and 9 were individually introgressed into L. ESCULENTUM using MAS and NILs were developed. The NILs were tested in replicated experiments and CT (measured as shoot turgor maintenance under chilling temperatures) was most strongly associated with the QTL on chromosome 9. Sub-NILs are being derived from the NILs for fine mapping. NILs and sub-NILs will also be used for further physiological studies to characterize the basis of CT. Reciprocal grafts between shoots and roots of plants containing either ESCULENUM or HIRSUTUM alleles at these CT QTLs suggest that both shoot and root signaling is involved in CT. An assessment of cultivated tomato germplasm primarily from California with AFLP markers was conducted. Of the 26 AFLP primer pairs used to genotype 74 cultivars, 102 (9.3%) of 1092 bands scored were polymorphic. A minimum of 7 primer pairs revealed unique banding patterns for all 74 cultivars even though many cultivars were genetically related, indicating the value of AFLPs for cultivar fingerprinting.

Impact: Genes controlling agriculturally important traits that are present in wild species can be used to improve cultivated tomato for agricultural sustainability. Wild species' alleles at genes

for resistance to pathogens and chilling can facilitate development of cultivars requiring fewer agricultural inputs, thus reducing environmental impacts and production costs.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.27 Plant Health

Title: CHARACTERIZING NEMATODE BIODIVERSITY THROUGH PHYLOGENETIC ANALYSIS OF GENE SEQUENCES

Description: Objectives are to: 1) Refine methodologies for obtaining molecular (DNA sequence) data and archiving morphological (light microscope image) data from individual nematodes, including small microbivores obtained directly from soil. Establish a database protocol for efficient management of these systematic and specimen data. 2)Use these refined methodologies to evaluate the biodiversity of nematodes, including various groups of vertebrate parasites, and representatives of a major suborder (Cephalobina) that includes both free-living nematodes and parasitic species. In particular, two major clades of Cephalobina (superfamilies Cephaloboidea and Panagrolaimoidea) will be the focus of investigation. Certain genera of the subfamily Cephalobinae (Cephaloboidea) will serve as a model system for assessing the biodiversity of soil nematodes. For the Panagrolaimoidea, biodiversity of insect-parasites of the family Steinernematidae (Steinernema) will be investigated. When feasible, in vitro cultures of nematode isolates representing these superfamilies will be established. 3) Perform phylogenetic analyses of nucleotide sequences to assess relationships among sampled terminal taxa and to determine which lineages are demarcated by autapomorphies, and thus can be delimited as separate species using these data. Assess if sequence data provide a basis for simple molecular methods of diagnosis (e.g., PCR/RFLP) among the sampled taxa. Accomplishments during the reporting period include using nucleotide sequence data to characterize the biodiversity of parasitic nematodes, including species with relevance to biological control and important pathogens of vertebrates. These results are important and of practical value because the inability to readily identify nematodes to species restricts many areas of investigation. For example, in one of the publications cited in this report (Nadler et al., 2003), nucleotide sequence data were obtained for isolates of Halicephalobus gingivalis, a species responsible for rare, but typically fatal infections of horses. These sequences were used to assess the number of distinct evolutionary lineages represented in clinical cases from horses, and to develop a specific polymerase chain reaction test for diagnosing nematodes from tissue and soil samples. Similar molecular approaches are necessary for many groups of nematodes because there are often few readily observable characters available via light microscopy for species diagnosis. During the reporting period the lab has continued to focus on two areas, one fundamental and the other applied. On the fundamental side, they continue to address how species should be delimited using gene trees. This theoretical framework for delimiting species is essential for additional progress in nematode systematics and biodiversity. For applied research, the lab has performed research on various groups of nematodes by using PCR to amplify specific regions of DNA for sequencing. This approach was used to assess the biodiversity of lungworms (Carreno and Nadler, 2003), which include important pathogens of domesticated animals and wildlife. The sequence data obtained in these studies are useful for diagnosing species, and in the case of

lungworms, for identifying species based on larval stages recovered from feces. Other target organisms of molecular systematic research in the laboratory include anisakid nematodes (responsible for Anisakiasis in humans), ascaridoid nematodes from skunks and raccoons (Baylisascaris) that are causative agents of visceral larval migrans in humans and other vertebrates, hookworms from pinnipeds (that appear to be responsible for significant pup mortality in certain threatened pinniped species and populations), and free-living soil nematodes (Acrobeloides and Acrobeles) that are important in soil mineralization. During the reporting period, ribosomal sequence data have also been obtained for many species in the nematode suborder Cephalobina. This database of sequences provides a useful comparative tool for analysis of taxa from soil that are sometimes difficult to identify.

Impact: This research provides practical tools for characterizing nematode biodiversity and diagnosing species using molecular methods. These methods provide a foundation for characterizing the number of nematode species in various environmental samples, and can be applied to other small organisms such as other invertebrates that are difficult to tell apart based on morphology. The most important aspect of this work is that it allows for the rapid and specific identification of certain nematodes that are otherwise difficult to diagnose, including species that are causative agents of disease in food production animals, companion animals, wildlife, and humans. The accurate and rapid identification of such disease agents benefits efforts to control these infections or minimize their impact.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.27 Plant Health

Title: MOLECULAR GENETICS OF FLORAL REPRESSION IN HIGHER PLANTS

Description: Flowering is prerequisite to reproduction in higher plants. To increase flower and progeny production, plants delay flowering until they have build up body size and nutrition through vegetative growth. The regulation of flowering could encompass both a floral induction and a floral repression mechanism. The floral induction pathway in Arabidopsis has been under intense investigation. Little is known about the floral repression mechanism. The EMBRYONIC FLOWER (EMF) genes, EMF1 and EMF2, are required for maintaining vegetative development. EMF1 encodes a putative transcriptional regulator (Aubert et al., 2001) and EMF2 a Polycomb Group (PcG) protein homolog (Yoshida et al., 2001). Molecular characterization of these two genes suggests that they are involved in a protein complex that represses flowering via chromatin remodeling. The objectives of the proposed research are to 1) Develop tools to detect EMF1 and EMF2 proteins and study their expression pattern, 2) Isolate and characterize EMF-protein complex, 3) Identify genes repressed by EMF proteins and study the mechanism of their repression by the EMF-protein complex, and 4) Isolate and characterize EMF1 homologs in crop plants. The long term goal of the proposed research is to elucidate the molecular mechanism of EMF-mediated floral repression. They have investigated the global gene expression pattern of embryonic flower (emf) mutants. Using affymetrix GeneChip technology, they identified genes belonging to several functional groups that are up- and down-regulated in three emf mutants and Arabidopsis flowers. In particular, they found that ten flower organ-specific genes were up-

regulated in emf mutants before flower development. This suggests that the flower program was de-repressed in the absence of EMF activity. The expression of the flower organ genes in the mutants was not mediated by the floral activators. Since EMF genes encode transcriptional regulator and Polycomb Group-like protein and are located in the nucleus, they could repress the expression of the flower organ-specific genes directly. Future experiments are designed to elucidate the molecular mechanism of EMF-mediated repression of the flower organ-specific and other genes.

Impact: These emf mutants flower extremely early. UC has patented the Arabidopsis EMF1 and the rice OsEMF1 genes. Transgenic rice with reduced OsEMF1 gene activity flowers early and displays short and bushy stature. These qualities are important in breeding rice that would flower early and more resistant to water lodging.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.27 Plant Health

Title: PROTECTION OF PHOTOSYNTHESIS FROM OXIDATIVE DAMAGE

Description: The objective is to dissect the processes that prevent or minimize oxidative damage to the photosynthetic apparatus of chloroplasts, with the goal of improving plant productivity and the ability of different plants to grow under adverse environmental conditions. To identify processes involved in photoprotection in photosynthetic organisms, the researchers have isolated Chlamydomonas reinhardtii and Arabidopsis thaliana mutants with altered susceptibility to photo-oxidative damage. The Chlamydomonas npq1 lor1 double mutant is deficient in zeaxanthin and lutein and is unable to grow in high light. After transfer from low light to high light, npq1 lor1 cells exhibited pronounced photo-oxidative damage within 48 hours. They have isolated extragenic suppressors of the npq1 lor1 light sensitivity. Extragenic suppressor mutations that restore the synthesis of zeaxanthin were shown to be single nuclear mutations and were mapped to the npq2 locus, which affects zeaxanthin epoxidase activity. Three npq1 lor1 npq2 strains exhibited differences in their light-harvesting complex protein composition, but this alteration did not explain the ability of the strains to grow in high light. The complete genomic DNA sequence of the zeaxanthin epoxidase gene was determined from wild type and three npq2 mutants. Arabidopsis thaliana mutants that are defective in nonphotochemical quenching (NPQ) of chlorophyll fluorescence were isolated and characterized. Map-based cloning was used to demonstrate that the npq4 mutant is defective in the gene encoding PsbS, a photosystem II subunit of previously unknown function. The PsbS protein appears to function in photoprotective thermal dissipation rather than photosynthetic light harvesting. To help define the importance of NPQ for photoprotection, they characterized the responses of npq4 mutants during short-term exposure to high light. Measurements of chlorophyll fluorescence and oxygen evolution showed that NPQ has a photoprotective role in short-term high light. To uncover photoprotective mechanisms that can compensate for the lack of NPQ, they compared high light and low light wild-type plants and npq4 mutants. HPLC analysis showed that the mutants grown in high light have higher levels of tocopherols (Vitamin E) and higher levels of ascorbate (Vitamin C). The npq5 mutations were mapped to the PAA1

gene, which encodes a member of the copper-transporting P-type ATPase family. They also examined acclimation to high light in the vtc2 mutant, which is deficient in vitamin C, and a vtc2 npq1 double mutant that is deficient in both vitamin C and zeaxanthin. These results showed that vitamin C is important for acclimation of wild-type and especially npq1 mutant plants to high light.

Impact: This project helped to identify physiological mechanisms that are important for the survival and optimal productivity of plants in adverse environments, such as high light. This will increase the geographic range that some crops can be grown.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.28 Plant Production Efficiency

Title: DEVELOPING PLANT-BASED IRRIGATION STRATEGIES TO IMPROVE IRRIGATION EFFICIENCY IN ORCHARDS

Description: Objectives are to: 1. Refine the use of plant-based water relations measurements, particularly midday stem water potential (SWP), as a practical irrigation management tool for orchards. 2. Determine the effects of water stress on tree horticultural productivity and fruit quality. 3. Recommend deficit irrigation strategies that allow significant savings of irrigation water while maintaining or improving horticultural productivity. Plant-based monitoring for moisture stress and irrigation management, using midday stem water potential (SWP), was conducted across a wide range of tree and vine crops (prune, almond, walnut, peach and grape). An irrigation study, funded by the California walnut board and initiated in 2002, was continued in two locations to test for the effects of three levels of regulated deficit irrigation (RDI) on walnut growth and yield. In 2002 there was no effect of RDI on yield, but in 2003, yields were reduced 11% - 17% in the mild RDI regime, depending on location. Further studies will be conducted to determine the source of the yield effect. In almonds, RDI was demonstrated in 7 orchards across the state for a third consecutive year, through funding by the California almond board, and thus far there have been only beneficial effects observed (improved hull split, reduced hull rot and improved harvestability), with no indication of a yield loss. This study will continue in 2004. Two studies were published concerning almond trunk shaker injury, which is often considered as a barrier to the adoption of our recommended RDI regime in almonds. These studies identified an important problem in the current shaker technology, independent of irrigation management issues.

Impact: Midday stem water potential (SWP) is being used by growers and researchers as a standard method to quantify water stress in trees and vines. Monitoring of SWP has led to a substantial reduction in water use where it has been demonstrated that irrigation can be reduced with little reductions in SWP, presumably a result of favorable soil conditions.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.28 Plant Production Efficiency

Title: INCREASING THE EFFICIENCY OF ZINC APPLICATIONS IN ORCHARDS

Description: Objectives: To quantify fruit tree capacity for zinc uptake and differences in tree capacity for zinc uptake when supplied via the soil or foliage. The relative mobility i.e., the extent of the autumnal remobilization of native zinc in leaves vs. foliar - applied zinc in leaves prior to leaf senescence and abscission will be determined. Those dynamics will also relate to the relative contributions of soil vs. foliar-applied zinc to over winter storage in the woody parts of deciduous tree fruit species as well as the potential magnitude for zinc redistribution to new growth from storage following growth resumption in spring. Those data should enable us to design more efficient zinc fertilizer application strategies than those employed currently. Attainment of that goal has ramifications both for reduced fruit production costs and, perhaps more importantly, reducing the environmental load resulting from off-target zinc accumulation. The work on Nitrogen (N) Utilization Efficiency began with quantification of soil N uptake patterns using stable isotopes coupled with periodic excavations and nutrient analyses of mature, field grown trees. The general goals--to maintain tree productivity while minimizing the economic drain and adverse environmental impacts of excessive nutrient application rates to the soil--remain in place. However, research activity has refocused on a.) Refinement of diagnostic indices of N and potassium (K) status of almond trees; b.) Reassessment of K critical value / range and better definition of yield components (e.g., flowering, fruit set, spur mortality, and spur renewal, etc.) and their sensitivity to inadequate soil K availability. Potassium deficiency, as indicated by July leaf K values <1%, increased the mortality of fruiting spurs, and reduced return bloom. Leaf K values below 0.7%K was associated with reduced leaf photosynthetic capacity. In 2003, they initiated a study to quantify zinc uptake patterns, zinc resorption from senescing leaves, and zinc redistribution from storage to the new growth in spring.

Impact: The continuing attention to a.) the characterization of seasonal nutrient uptake (N, K Zn) patterns by deciduous fruit tree species and b.) the refinement of nutrient diagnostic indices, to avoid excess nutrient applications while reducing the likelihood of yield reduction due to insufficient soil nutrient availability, has both economic and environmental consequences.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.28 Plant Production Efficiency

Title: REPRODUCTIVE BIOLOGY OF TREE FRUIT AND NUT SPECIES

Description: Objectives: 1. Develop strategies for pollination management in walnut, olive and pistachio orchards. 2. Determine developmental factors associated with blank nut production and failure of endocarp splitting in pistachio. 3. Determine phenology of flower development in almond and olive. Walnut pollination management presents unique and complex problems for production that extends beyond fruit set. Walnut pollen carries Cherry Leaf Role Virus-Walnut, viral agent that incites blackline disease. Additionally, high pollen loads lead to reduced set due to pollen-induced pistillate flower abortion. Typical planting schemes involve planting pollinizer cultivars to provide pollen throughout the dichogamous bloom cycle of the main cultivar. The

researchers are seeking research based data on pollen flow, pollen sources, the need for pollinizer cultivars and the contribution of pollen from within and beyond orchard limits. They are using SSR markers for paternity analysis to follow the movement of pollen in orchard situations. The efforts are concentrated on 'Chandler' orchards with 'Cisco' pollinizers. Results indicate that few pollinizers are required in this self-compatible species despite the dichogamous bloom habit that would appear to limit self pollination. Results are also showing a high level of pollen from outside the orchard system. Pollen contributions that affect production and fruit set from pollinizer trees within the orchard do not extend beyond 50 to 75 m. SSR markers are being shown to have great value in the analysis of gene flow in walnut orchards and they should have similar potential for use with other orchard crop species. They are also investigating pollination parameters in olive and the role of staminate flowers in the olive breeding system.

Impact: The researchers expect to elucidate the dynamics of pollen flow in walnut orchards. This information is needed to develop management strategies to optimize set, and to manage blackline disease and pistillate flower abortion both of which are related to walnut pollination.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.29 Precision Agriculture

Title: APPLICATIONS OF SYSTEMS ANALYSIS TO PROBLEMS IN AGRICULTURE AND RESOURCE MANAGEMENT

Description: The first objective of this project are to develop, test, and implement methods of site-specific management in California, focusing on cotton and rice production. The second objective is to make use of precision agriculture technology such as yield monitors and remote sensing to collect scientific data and conduct experiments involving these crops. Work carried out during this period primarily involved the development of methods for the use of precision agriculture technology for both scientific investigation and crop management. This technology includes yield monitors, remote sensing, bulk soil electrical conductivity measurement, and other measurement technologies that provide a high level of spatial precision but that do not measure basic quantities (e.g., nutrient levels) that can be directly related to crop performance. The strategy taken in approaching this problem is to focus initially on development of methods for scientific analysis of these data and then, based on the results of these analyses, to develop field-implementable practices. Work during this year focused on two projects, one involving rice production and one involving cotton production. For the rice production project analysis of yield trend data was completed and analysis of factors underlying the yield trends is ongoing. In addition, an analysis of the effects of water temperature on rice production was carried out. For the cotton production, work focused primarily on the agronomic and economic analysis of variable rate nitrogen fertilizer application.

Impact: Precision agriculture provides a win-win scenario for crop production and environmental protection. The grower saves money on inputs that are only applied where needed, and there are fewer environmental externalities. In addition, the tools of precision agriculture provide the opportunity to more effectively carry out scientific experiments at the field scale.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.29 Precision Agriculture

Title: MICROIRRIGATION TECHNOLOGIES FOR PROTECTION OF NATURAL RESOURCES AND OPTIMUM PRODUCTION

Description: Objectives are: to improve, modify, and evaluate microirrigation system design and components for natural resource protection and optimal crop production; to assess and develop decision criteria for adoption of microirrigation technologies; and to promote appropriate microirrigation technologies through formal and informal educational activities. Precision agriculture is a new farming concept that optimizes fertilizer, pesticide, and water use, while minimizing environmental impact. For orchards, this could be obtained by treating each tree differently with respect to inputs such as fertilizers, pesticides, and water management, rather than by treating the whole orchard in a uniform fashion. A critical component of this project is the determination of individual tree performance and the development of mechanisms to provide fertilizers and irrigation at a tree specific scale. This represents a new technological challenge not previously attempted. In addition to the development of this technology, this project will focus upon the determination of site-specific variables and management strategies. Recent developments in geographic information systems (GIS), global-positioning systems (GPS), variable rate technology, crop and soil sensors, and remote sensing will then be integrated with application technologies for use in horticultural crops. In 2003, created detailed maps of the yield of 12,000 trees in a commercial pistachio field. These maps illustrate a variety of field conditions that impact yield and provide an ideal test site for the application of site specific irrigation and fertilization. To facilitate the delivery of water and fertilizer at a tree specific scale the researchers have developed a prototype individually controlled micro-sprinkler system that allows for individual operation of each micro-sprinkler in a field of many thousands of such sprinklers. If this system can be scaled down in cost it will open the way for significant improvements in water management. Research and development is continuing.

Impact: Research here and in an associated project have determined that yield variability in pistachio is large and highly significant to farmer profitability. The concurrent development of new irrigation technology in this project provides, for the first time, a means to address within field variability.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AZ, CA, FL, GU, HI, ID, IA, KS, MN, NM, TX, VA, WA, WY, VI

Theme: 1.29 Precision Agriculture

Title: PRECISION TECHNOLOGIES FOR SPECIALTY CROP PRODUCTION

Description: Objectives of the project are to: 1) Develop a soil physical characteristics (compaction, moisture content, and texture) and salinity sensor that can assist in mapping soil properties relevant to soil moisture status management. 2) Conduct extensive field tests to verify

the ability of this sensor to map soil physical properties. Remote sensing has the potential for obtaining large amounts of soil and plant data inexpensively and rapidly. The researchers have successfully related vegetative indices derived from aerial images to leaf area index (LAI) and developed a model to predict crop yield using these LAI values and California Irrigation Management Information System (CIMIS) data. This approach shows promise in developing yield maps that are critical for managing nutrients in a precision farming system. Weigh buckets are simple and inexpensive alternatives for weigh wagons used for measuring crop yield during fields trials. A modified version of the 2002 electronic weigh bucket was tested during the 2003 tomato harvesting season. The modified version was lighter and worked well in the field. A new and simple weigh bucket was also developed and tested during the 2003 season. Infrared thermometry was used to control the speed of a lateral move irrigation machine, such that a desired depth of water was applied as needed within a corn field Automatic control was achieved by inputting relative humidity, canopy and air temperature data into a PLC, which calculated the crop water stress index.

Impact: Information from this project resulted in economical and environmental benefits through application of inputs such as chemicals and water on a site-specific basis to enhance crop yield, reduce inputs, and/or reduce environmental damage.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.29 Precision Agriculture

Title: PRECISION TECHNOLOGY, INSTITUTIONAL CHANGE, PRODUCTIVITY, AND ENVIRONMENTAL QUALITY IN AGRICULTURE

Description: Objectives are to: develop a modeling framework to analyze the economics of precision technologies at the farm level, analyze the diffusion of precision technologies, and design policy interventions to meet the environmental policy objective in a cost-effective manner through adoption of precision technologies. Precision technologies monitor environmental conditions and apply inputs to adjust spatial and climatic variations. They include irrigation technologies, pest control, and fertilizer technologies. They showed that adoption of these technologies is likely to increase as prices of output or input are increasing and uncertainty about climatic or pest condition is increasing. For example, adoption of drip irrigation is shown to increase during periods of drought and in locations that have either uncertainty or high prices of water. Furthermore, the gain from adoption of precision technologies increases as soil conditions become more heterogeneous. Precision technologies lead to conservation of resources such as water and chemicals, and this input saving benefits the environment. The researchers showed that the impact of this input use reduction varies across locations and that growers tend to under invest in precision technologies when relying on market forces. They suggest a wide array of policy interventions that can enhance adoption of precision farming so that it reaches a socially optimal level. These policies may include pollution fees when it is observable and subsidies for adopting monitoring or precision technologies. They developed strategies to optimally design incentives to introduce precision and conservation technologies to address drainage and soil erosion problems. They found that targeting of incentives so conservation practices may be

adopted at the locations where they are most cost efficient may double environmental benefits obtained by a given budget relative to nondiscriminatory subsidization of conservation technologies. Our analysis consistently proves that the potential of precision technologies to improve farm profitability and environmental quality is limited unless the adoption of these technologies is induced by incentives that recognize farmers' behavior, attitudes towards risk, and heterogeneity of environmental conditions.

Impact: The results of this project have been used to provide policymakers guidelines on how to efficiently manage programs such as the Conservation Reserve Program (CRP) and the Environmental Quality Incentives Program (EQIP). They have been used to design a land-use strategy to control Pierce's disease in the Napa Valley. They provide the design of efficient management of drainage in California. They were also used to provide an algorithm to determine adoption of yield monitors in cotton production in California.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 1.34 Urban Gardening

Title: SALT TOLERANCE OF LANDSCAPE PLANTS FOR RECLAIMED WATER IRRIGATION

Description: Water is a limited natural resource for most of the arid and semi-arid regions of the United States. Despite this, rapid population growth and development are occurring in these areas, especially California. Many municipal water providers are faced with the need to reduce demand for freshwater supplies while protecting against drought and cutting down on wastewater discharges into sensitive bays and estuaries. Agencies encourage the use of reclaimed or recycled water from wastewater treatment facilities for appropriate non-potable uses, including urban landscape irrigation. In 2000, 19.5 percent of recycled water in California was used for landscape irrigation, saving enough fresh water to supply 300,000 homes. An important caveat to the use of reclaimed water for landscape irrigation is that after most of the water treatment processes, sodium chloride is the most detrimental chemical compound remaining in the recycled water. Little information is available on the tolerance of common landscape plant species to the levels of salts found in reclaimed waters. This basic information is needed by landscape managers to ensure the maintenance of healthy landscapes, given the reality of increased use of reclaimed water for irrigation. A UC faculty member led a team of researchers in establishing the tolerance of nearly 40 landscape tree and shrub species to the levels of sodium chloride commonly found in reclaimed or recycled water. Common California landscape species were grown in the field and in greenhouse containers. Plants were irrigated regularly with water containing salt levels slightly above those found in most reclaimed waters, applied both by drip and sprinkler irrigation systems. Control plants were irrigated with potable water. Plant heights and canopy diameters were measured at the beginning and after six weeks of salt treatments. Visual symptoms such as chlorosis and leaf burn were recorded. Plant species were placed into three salt-tolerance categories for how well they grew compared to the control plants (low, less than 50 percent growth; moderate, 50-90 percent growth; and high, greater than 90 percent growth). Species showing high tolerance to reclaimed water included Japanese boxwood,

oleander, juniper, dwarf olive, Mexican pinon pine and California fan palm. Abelia, butterfly bush, Chinese hackberry, trumpet vine, marguerite, ginkgo and Chinese pistache exhibited low tolerance to irrigation with recycled water.

Impact: The UC research has been summarized in a widely published list of the tolerance of various landscape plant species to reclaimed water irrigation (http://ucce.ucdavis.edu/freeform/slosson/documents/1998-19992094.pdf). The green industry can use the list in designing landscapes that thrive under reclaimed water irrigation. Demonstration gardens of landscape species irrigated with reclaimed water have been planted in San Jose and by the Marin County Water District. So far, no negative impacts on either the plants or the environment have been reported. Researchers recommend infrequent, heavy irrigation with reclaimed water rather than frequent, light watering, and sprinkler irrigation at night or in the early morning, not on hot, dry, windy days.

Funding Source: Hatch and State

Scope of Impact: State Specific

NATIONAL GOAL 2

A safe and secure food and fiber system. To ensure an adequate food and fiber supply and food safety through improved science based detection, surveillance, prevention, and education.

UC-DANR's Human Resources Programs Covering:

- Human Health and Nutrition - Food Borne Diseases

According to estimates from the Centers for Disease Control, approximately 76 million Americans last year suffered from some type of food-borne illness with an estimated 300,000 serious illnesses and 5,000 deaths attributed to food borne illness each year. This compelling statistic alone suggests the need for vigorous action to reinforce the food and fiber system to ensure its safety and security. Structural changes in the food system in the past several decades have led to a vulnerability that has been indicated, on several occasions, by propagation of human disease on a wide scale. These changes are primarily the consolidation of the food industry, in particular the fast food industry, so that large volumes of food are prepared at one location and partitioned to multiple distribution points. In addition, disease organisms that are highly toxic and require relatively few spores to cause an infection (like *E. coli* O157:H7) have become more common. The combination of these organisms with the new food handling system is one cause of the unacceptably high incidence of food-borne disease in the country. Division academics are conducting research programs aimed at reducing the risk of food-borne illness entering the food chain, and extension programs directed at education of food handlers at every step of the chain, from production to consumption, in safe food handling techniques.

These projects and research indicate that technological change embodied in high-tech, human, and research capital has had substantive effects on cost savings in food processing industries; that our knowledge of both the ecology and epidemiology of Lyme disease spirochete is expanding leading to strategies for preventing and controlling Lyme Disease; that a platform for the logical development of strategies to prevent food borne infections can be developed by conducting research on food borne pathogens; that knowledge of the mechanism of osmotic tolerance and of growth in the refrigerator should lead to the design of better cleaning regimens and handling methods to reduce the possibility of contamination of food by equipment or from the processing environment; that case studies can be used to provide insights into the challenges and opportunities small to medium scale growers and processors face in the California Central Valley; that methodology can be developed that will assist industry in lowering the food allergies in common staple foods and that by developing optimal procedures for preparation, packaging, and handling conditions allows the fresh-cut produce industry to provide several new products including slices of kiwifruits and pear.

Sixteen local extension programs were delivered in this area. In addition, one statewide collaborative workgroup composed of both AES and CE academics planned and conducted research and extension projects. California academics published 46 peer-reviewed articles to address Goal 2 last year. One patent was issued to a UC researcher for this goal.

Research and Extension Performance Goals

- Develop effective research and educational programs directed toward food producers, processors, retailers, restaurants, regulators and consumers to reduce the incidence of food borne disease.
- Develop effective research and educational programs directed toward food producers, processors, regulators and consumers to minimize the risks associated with chemical contaminants in food.
- Develop effective training programs addressing food safety and sanitation issues using bi-lingual educational materials.

FY 2003-2004 Allocated Resources

Extension Federal Funds (Smith Lever 3 b&c)	Extension State Match	Research Federal Funds (Hatch)	Research State Match
$20,520	$1,235,316 [8.52 FTE]	$151,281	$4,614,322 [18.77 FTE]

Theme: 2.01 Food Accessibility and Affordability

Title: A TIME SERIES APPROACH TO ANALYZING MARKET AND FOOD DEMAND SYSTEMS

Description: Objectives are: (1) to develop fractional integrated models for singular demand systems, (2) to provide explanations for the nonstationarites that exist in food demand data, (3) to apply these techniques to measure the effects of advertising and promotion on California food commodities, and (4) to test regularity conditions and other theoretical demand restrictions accounting for the nonstationary nature of many of these price and quantity series. A higher than average percentage of residents in the agricultural heartland of California, the San Joaquin Valley, received cash assistance when welfare reforms were enacted in 1996. Average annual unemployment rates during the 1990s ranged from 12 to 20 percent, and 15 to 20 percent of residents in major farming counties received cash benefits. The paper, 'Welfare Reform in Agricultural California', developed and estimated a two-equation, cross-sectionally correlated and time wise autoregressive model to test the hypothesis that in agricultural areas, seasonal work, low earnings, and high unemployment, as well as few entry-level jobs that offer wages and benefits equivalent to welfare benefits, promote welfare use and limit the potential of local labor markets to absorb ex-welfare recipients. A paper, 'Estimation of Supply and Demand Elasticities of California Commodities' reported supply and demand elasticity estimates for almonds and walnuts. This is an on-going project that will include several California crops. The estimated demand elasticities for almonds and walnuts were inelastic.

Impact: These findings have important policy implications. More specifically, producers of California crops will face volatile prices and revenues due to changes in shifts of the supply

curve. Empirical results indicate that producers respond to price expectations over time. A system of demand and supply equations was estimated to obtain more efficient elasticity estimates. The elasticity estimates will be used to obtain measures of producer and consumer welfare effects due to changes in agricultural policies.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 2.01 Food Accessibility and Affordability

Title: ECONOMIC PERFORMANCE IN THE FOOD SYSTEM: COSTS, PRODUCTIVITY, EFFICIENCY AND COMPETITIVENESS

Description: Objectives are to: (a) develop models of production and cost structure in various sectors of the food system, recognizing the crucial roles of rigidities, spillovers, externalities and regulatory factors for both private and social optimization, and thus economic performance and productivity; (b) construct measures from these models to provide information about the level, determinants, and potential policy implications of various aspects of economic performance, productivity, and efficiency; and (c) use these measures to provide insights about the determinants of economic performance in these sectors, and how policy implementation might be designed to facilitate economic performance through pro-active investment in - or incentives to augment - productive factors, and limit inefficiencies from market or regulatory structure problems. Research has proceeded on measuring economic performance in the US food system, with a focus on linkages between primary agriculture and food processing industries, such as spatial interactions, market structure dependencies, and technological externalities, and their policy implications. Significant (largely materials) cost-savings for food processing firms due to proximity to other food manufacturing centers, areas with high purchasing power, and agricultural centers were documented. However, costs were greater for food processors located within a rural agricultural state, implying thin market dieconomies. Marginal production costs were, by contrast, found to be higher in more urban, and lower in more rural, areas, suggesting some motivation to locate in rural areas. The link between food processing sector production and the availability and prices of primary agricultural 'materials' was also shown to be weakening, due to adaptations in input costs, technology, and food consumption patterns. Demand for agricultural commodities is not as directly connected to food processors' costs and output prices as in the past, in part due to scale economies and input substitution to accommodate changing food product composition and quality.

Impact: Falling effective prices of agricultural prices do not necessarily imply lower consumer food prices or increased margins. Further, exploration of market power impacts on agricultural prices and profitability for the meat packing industry confirmed and strengthened the result (from previous work) that substantive cost economies imply economic motivations for observed concentration, consolidation and diversification patterns, but not necessarily either enhanced profits for meat packers, or lower (higher) prices for agricultural producers (consumers). It was also found for the EU that spillover effects from spatial linkages across countries were positive and substantive in the 1990s, augmenting economic performance and growth, but were not further affected by economic integration in 1993. This research contributes to an understanding

of many factors associated with food system economic performance-particularly the links between the US agricultural and food processing sectors such as spatial and technological production linkages, and market power effects on commodity and food prices. This type of information is a key to guiding national and state government policy.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 2.01 Food Accessibility and Affordability

Title: SUSTAINING LOCAL FOOD SYSTEMS IN A GLOBALIZING ENVIRONMENT: FORCES, RESPONSES, IMPACTS

Description: Objectives are to: 1. Collaborate with local food system stakeholders to identify high priority information needs and the forms in which information should be shared; 2. identify and analyze ongoing and potential forces that are maintaining or transforming the relationships between localities and their food systems; 3. examine the diverse strategies local food system stakeholders are currently using or might use to create and manage ongoing or potential change in the food system; and 4. document and assess the key economic, environmental, and social impacts of currently or potential efforts to create and manage change in the food system. Taken together, these case studies provide insights into the challenges and opportunities small to medium scale growers and processors face in California's Central Valley. In addition to work in Stanislaus County, UC researchers have completed California case studies on farmers markets and innovative marketing strategies that are connected to farmers markets. One of these markets, the Saturday Stockton Farmers Market, is in Stanislaus County. All farmers market case studies are also up on SAREPs website. Based on these case studies, they are co-authoring a chapter for *Remaking the North American Food System*, a new book edited by Clare Hinrichs and Tom Lyson.

Impact: They have had many requests for foodshed reports from California to North Carolina. These reports have provided models for other regions that are interested in conducting food system assessments in their areas. They researchers were asked to present their foodshed work in June at a statewide workshop on food system assessments sponsored by the Community Food Security Coalition. Within Stanislaus County, the acting director of Stanislaus County Cooperative Extension has appreciated our data and the contacts the Stanislaus foodshed report has generated for him. When a local senator visited the Davis Farmers Market this spring, he was also very interested in the report and the new findings in Stanislaus County and asked for a copy. Also, a resident of Stanislaus County who is involved with the Stanislaus Farmland Trust read our study and asked permission to quote portions of it in his work. He represents several farmers in the area who are in discussion with the Farmland Trust and are trying to sell the development rights to 425 acres of prime farmland. He said the study would be helpful when it came to the fund procurement portion of the project.

Funding Source: Hatch Multistate Research and State

Scope of Impact: CA, IA, MA, ME, MI, MN, MO, NH, NJ, NYC, OR, PA, PR, VT, WA, WI, WVA

Theme: 2.03 Food Quality

Title: ASSURING FRUIT AND VEGETABLE PRODUCT QUALITY AND SAFETY THROUGH THE HANDLING AND MARKETING CHAIN

Description: Objectives are to: 1) efine and measure the physical, mechanical, optical, and other properties of fruits and vegetables and their functional relationships to quality, and establish a database of these properties; 2) develop, evaluate and apply rapid non-destructive sensor technology for quantitative measurement of fruit and vegetable quality; and 3) deevelop, evaluate, and apply rapid sensing technologies to assure food safety including bio-security, purity, and integrity of produce. Research was conduced to evaluate the feasibility of sensing the level of freeze damage in Navel oranges following a freeze event for use by California Ag Commissioners. Volatile production (primarily ethanol and carbon dioxide), and electronic nose experiments, were conducted using Navel oranges obtained from Lindcove Field Station in California. Headspace sampling was conducted with one orange per sealed gallon jar for volatile circulation through hand-held electronic nose, carbon dioxide, and ethanol sensors. Analysis of electronic nose results showed that the classification accuracy for freeze detection in oranges decreased when the oranges were held in storage for more than four days between harvest and laboratory freeze experiments. The optimum model for headspace gas sampling of Washington Navel oranges using the electronic nose correctly classified 76 percent of the fruit. This overall accuracy was five percent higher than the overall accuracy obtained for Olinda Valencia oranges from the previous year. Model selection was found to vary for different orange varieties with four out of eight sensors in the model for Navel oranges being different from those selected in the 12-variable model for Olinda Valencias. Both ethanol and carbon dioxide values were significantly different between the partially frozen and unfrozen treatments. No ethanol was detected in any of the unfrozen oranges, which was similar to observations for Valencia oranges from the previous year. The overall classification accuracy was higher using ethanol (76 percent) than carbon dioxide (57 percent). Research was conducted to evaluate temperature effects on the UC Davis lectin assay for mold in processing tomato juice. Results indicate that the binding rate is fairly constant in the temperature range of 26 C to 43 C (79 F to 109 F) and that increased assay temperature cannot be used to reduce assay time. However, increased chemical concentration of key constituents did allow for shorter binding times. Heating of tomato cells for several hours at standard processing temperatures had little effect on binding performance, however heating of the fungal cells degraded assay performance. The effect of extended binding times was evaluated as a means of compensation for the reduced binding.

Impact: The development of a robust and objective freeze damage sensor suitable for field use would be a valuable management tool for citrus growers and could help keep damaged citrus from entering the retail market. Of the methods tested, ethanol sensing appears the most promising because commercial sensors that are easily calibrated are available and because no ethanol was detected in any of the non-frozen fruit.

Funding Source: Hatch Multistate Research and State

Scope of Impact: CA, GA, HI, IN, MD, ME, MN, MO, NYC, OH, PA, TN, VA, VT, WA, WI

Theme: 2.03 Food Quality

Title: GENETIC IMPROVEMENT OF BEANS (PHASEOLUS VULGARIS L.) FOR YIELD, DISEASE RESISTANCE, AND FOOD VALUE

Description: Lunasin is a novel peptide originally identified in soybean that suppresses chemical carcinogen-induced transformation in mammalian cells and skin carcinogenesis in mice. Since the lunasin gene was cloned from soybean, and the chemically synthesized form of the lunasin peptide has been used in experiments conducted so far, the isolation of lunasin from other natural sources and testing of its biological properties have not been carried out. The researchers report here the isolation, purification and biological assay of lunasin from barley, a newly found rich source of the peptide. The identity of lunasin was established by Western blot analysis and mass spectrometric peptide mapping of the in-gel tryptic digest of the putative protein band. Lunasin was partially purified with anion exchange and immunoaffinity chromatography. The crude and partially purified lunasin from barley suppressed colony formation in stably ras-transfected mouse fibroblast cells induced with IPTG. These fractions also inhibited histone acetylation in mouse fibroblast NIH 3T3 and human breast MCF-7 cells in the presence of the histone deacetylase inhibitor sodium butyrate.

Impact: This is the first report of the presence of lunasin in a seed other than soybean where it was originally discovered and the first documentation of the presence of lunasin in a cereal crop. If lunasin were found widely in other seeds, this would be a seminal observation that supports the possible role of lunasin in arresting cell division to allow endoreduplication of DNA in angiosperm seeds without cell division during the second major stage of seed development. Screening of other seeds for lunasin is being carried out in our lab.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AZ, CA, CO, FL, GA, MI, MT, ND, NE, NYC, NYG, OR, PR, WA, WI

Theme: 2.03 Food Quality

Title: IMPROVEMENT OF THERMAL PROCESSES FOR FOODS

Description: Objectives are: 1) to develop and verify methods for measurement and prediction of engineering and biochemical properties of foods as needed in process design and analysis, and product development; 3) to identify and describe transport mechanisms occurring in food processes; and 4) to develop mathematical models for analysis, design and improvement of food processes. There is a need to develop faster thawing methods, especially since current methods can be undesirably slow (still air) or are very expensive and cause uneven thawing (microwave). One possible method to speed thawing is using jets of air at high velocity impinging on the food surface. A mathematical model was developed to study the feasibility of using impingement to improve thawing rates. A finite difference code was created in Matlab, utilizing the enthalpy method. Heat transfer during thawing of a meat analog (Tylose), were compared between impingement and still air. The convective heat transfer coefficients used in the model were measured in the laboratory. The thawing times predicted by the model were verified through experiments and found to have good agreement. The heat transfer coefficient during

impingement thawing was found to range from 20 to 160 W/square m-K. The model was used to predict thawing times from -20 C to 0 C, using air at 5 C. Thawing in a refrigerator (still air) took more than 24 hours. The model demonstrated that the thawing time could be reduced to less than three hours by impinging with air at 20 C for two hours, followed by air at 5 C for the remaining time. This study demonstrated that the use of air impingement technology could significantly shorten thawing times. This mathematical model can be utilized to improve experimental design and operating conditions for impingement-assisted food processing. Strawberries are packaged and cooled in polymeric clamshell packages that are stacked in corrugated trays. Mathematical modeling of the flow and heat transfer is an ideal approach to improve the cooling efficiency for such package systems. Modeling by solving the turbulent Navier-Stokes equation is constrained by computation time. Modeling by using porous media assumptions may be restricted by the validity of the porous media assumption itself. The objective of this research was to compare the two possible modeling approaches for cooling strawberries in clamshell packages: appropriate porous media model and the k-e turbulence model. Using the k-e turbulence model, individual clamshells were modeled for various pressure gradients across the packages and the results were added in parallel and series configurations to model trays. Modeling of the entire tray was also done using Darcy-Forchheimer-Brinkman (DFB) theory of airflow through porous media. The results of the simulations were compared to experimental data for cooling of strawberries collected from lab-scale experiments and field trials. Simulations using the turbulence model showed agreement within 10 percent for experiments with individual clamshells. But when added together for the entire tray the agreement was less than 20 percent. Porosity of the stacked strawberries was determined to be 0.44. Using the porosity data and assuming strawberries as ellipsoids, the DFB model gave simulation results that agreed to the order of 15 percent for the entire tray. The DFB model was less accurate in predicting spatial variations of temperature and pressure compared to the k-e model. Computation times were significantly shorter for the DFB model.

Impact: This technology will be used to improve processed food quality and reduce losses. This information is necessary to improve process efficiency and product quality. Improved understanding of fluid flow in strawberry packages is aimed at designing clam-shell packages that minimize product spoilage.

Funding Source: Hatch Multistate Research and State

Scope of Impact: CA, DE, FL, GA, GU, IA, ID, IL, IN, MD, MI, MO, NC, ND, NE, NJ, NYC, NYG, OH, OR, PA, SD, TX, WA, WI

Theme: 2.03 Food Quality

Title: PHYSIOLOGICAL AND BIOCHEMICAL RESPONSES OF FRUITS TO CONTROLLED ATMOSPHERES

Description: The objective is to investigate the mode of action of oxygen and carbon dioxide on postharvest physiology and compositional changes of fruits in relation to their quality maintenance and postharvest life. Controlled atmospheres (CA) effectively delayed the ripening of plantains stored for 21 days at 10 or 12.5 C in 2 kPa O2 + 10 kPa CO2 or 2 kPa O2 + 5 kPa CO2 (balance N2). These treatments also were effective in maintaining higher L* and lower a*

values which resulted in a better overall appearance of the ripe fruit when compared to fruit stored in air. In general, CA did not adversely effect the acetaldehyde or ethanol concentrations in the flesh of the fruit. The benefits of using CA during 7 days of storage were minimal. CA did not alleviate chilling injury symptoms in plantains stored at 7.2 C for 7 days. Chilling injury was minimal at 10 and 12.5 C in air or in CA; however, CA did reduce subepidermal discoloration in fruit stored at 12.5 C in CA but not at 10 C when compared to air storage. Based on these findings, the researchers suggest that plantains could be stored at temperatures between 7.2 and 10 C for 7-day transit periods in air, but when shipping plantains for longer than 7 days, fruit can be stored at 10 C in 2 kPa O2 and 5-10 kPa CO2 to avoid increased respiration rates and ripening and to maintain better overall appearance of the ripened fruit.

Impact: The researchers identified the minimum safe temperature for specialty bananas and plantains to be 10 C as compared to 14 C for Cavendish bananas. Atmospheric modification (2%O2 + 5 to 10% CO2) is effective in quality maintenance of plantains and specialty banana cultivars for up to 21 days at 10 C.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 2.03 Food Quality

Title: PRODUCTION AND DELIVERY OF HIGH QUALITY STONE FRUIT

Description: Objectives 1. Describe the fruit quality and market life potential of newly released California stone fruit cultivars. 2. Develop a DNA test for internal breakdown susceptibility for use in peach/nectarine breeding programs. This will be achieved by identifying either a) gene(s) that control internal breakdown, via the candidate gene approach, or b) random DNA markers that are closely linked to gene(s) controlling internal breakdown, via the bulked segregant analysis approach. 3. Develop molecular marker tags for major loci and QTLs controlling these important fruit quality traits for use in marker-aided selection for enhanced fruit quality of peaches/nectarines. Predicting susceptibility of new stone fruit cultivars to internal breakdown. Consumer acceptance of peach fruit depends entirely on the optimum combination of fruit organoleptic traits (FOTs) associated with flavor, texture, appearance, and nutritionally important factors. Among these traits, fruit mealiness and development of off flavors are the main consumer concerns. Low temperature during storage and/or shipping extends fruit market life; however, fruit from some cultivars develop a mealy texture, off flavor, brownish flesh color, fail to ripen and lose flavor during or after cold storage. These symptoms are collectively known as internal breakdown (IB) or chilling injury (CI). They are using a genetic approach to understanding important peach FOTs. Developing molecular tags for these important genes will provide increased efficiency when breeding for greater productivity. To accomplish this, two peach populations segregating for the traits of interest were created one population self rooted and the other on a rootstock. FOT data has been collected for the populations since the 2000 season. These ongoing evaluations over several years have allowed a focused and efficient evaluation protocol to develop. Analysis of the 2002 season data led to several conclusions: significant genetic variation does exist in the populations for all FOTs measured, with particularly high heritability for mealiness, ripening date, and titratable acidity; rootstock effects

are minimal except on fruit weight, skin color, and perhaps internal browning; and mealiness is at least partially controlled by the M locus. In the last year (2002-2003), several marker systems were tested for polymorphism amongst the parent cultivars and progeny. Microsatellites were deemed to be the most useful for mapping of Pop DG and Pop G, as they are robust and transferable between laboratories, codominant, are highly polymorphic, and many have already been placed on the consensus peach genetic map. Using microsatellite markers, heterozygosity levels were estimated for the two parent cultivars. A high level of heterozygosity in at least one parent is required for effective linkage analysis when F1 populations are used. This is a particular concern for peach, where self fertility and the practice of breeding within a narrow genetic base have typically resulted in low heterozygosity. However, heterozygosity for Georgia Belle was determined to be sufficiently high (42 percent across 76 microsatellite loci), with heterozygosity for Dr. Davis only half as much (21 percent across the same loci). These results confirm the assumptions that Pop DG should function effectively as a testcross population and Pop G effectively as an F2 population. Preliminary linkage analysis with Pop DG confirmed that previously established linkage relationships for peach are applicable to our mapping populations, verifying that comparative mapping is a useful tool for this project objective. Several major QTLs for mealiness, browning, and bleeding have been located in the Georgia Belle and Dr. Davis genome. These results demonstrate the soundness of the strategies used thus far.

Impact: Internal breakdown of stone fruit is the basis of most consumer complaints. The experiments with peach and nectarine cultivars and progeny populations indicate that there is considerable genetic control of mealiness. In fact, the pattern of inheritance suggests that as few as two major genes may be responsible. The researchers are working to identify those genes and develop DNA tests for mealiness so the disorder can be eliminated from future breeding programs.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 2.03 Food Quality

Title: PROTEIN HYDROLYSIS IN SEAFOOD

Description: The immediate objectives of the project are (1) to continue to characterize proteases from marine organisms and identify applications, (2) characterize isoforms of gastric proteases from rainbow trout and sea trout and evaluate their use in in vitro protein digestibility of salmonid feed ingredients, and (3) to determine the role of enzymes in the maturation and spoilage of sturgeon caviar. An enzyme from the hepatopancreas of Jumbo squid (Dosidicus gigas) was purified to homogeneity. Based on molecular characteristics, kinetics with synthetic substrates and proteomics the enzyme was identified as cathepsin L. Techniques used for purification were ammonium sulfate fractionation, gel permeation chromatography and ion exchange chromatography. The enzyme has a molecular weight of 42.9 kDa by SDS-PAGE and this was confirmed by mass spectrometry. When treated with a thiol reagent, 27.7 kDa and 16.4 kDa subunits were observed. Amino acid sequence analysis of major peptide fragments and comparison with proteomics data bases confirmed identity of the enzyme. Kinetic analyses using

specific substrates for cathepsins B, H, L, and S supported the identity as cathepsin L. Inhibitor studies, pH optimum and temperature optimum were also used to characterize the enzyme.

Impact: Cathepsin L may contribute to texture softening and bitter peptide formation in the postmortem flesh of squid. Identification of this proteinase may aid future research in understanding and providing means of controlling quality deterioration of squid. The hepatopancreas is a rich source of this enzyme and it may also find practicable use in the food and allied industries.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 2.05 Food Resource Management

Title: LEARNING HOW TO BUY HEALTHY MEALS WITH FOOD STAMPS

Description: The USDA Food Stamp Program provides food assistance to low-income families and needy households that are making the transition from welfare to work. However, these individuals often lack knowledge and skills to select, purchase and prepare a low-cost nutritional diet for themselves and their families. For example, they tend to buy fast foods that are high in sugar and fat. UCCE's Food Stamp Nutrition Education Program (FSNEP) in Riverside County has helped food stamp recipients improve their health and become self-sufficient by learning to budget their food dollars, improve food shopping and food preparation skills and make healthy food choices. Last year, 183 food stamp recipients in Riverside County took part in the program. Riverside is one of 31 California counties participating in FSNEP, which is funded by the U.S. Department of Agriculture through the California Department of Social Services. UCCE administers FSNEP through local CE offices in participating counties. CE specialists at the university level and CE advisors and program staff at the county level work together to design and deliver FSNEP classes. In Riverside County, classes are presented at locations provided by collaborating agencies and non-profit organizations such as homeless shelters, food banks, and alcohol and drug rehabilitation centers. FSNEP classes teach participants how to budget their food money, identify high sugar, high fat foods using the Nutrition Facts labels, plan meals in advance, and prepare quick and nutritious meals and snacks.

Impact: During FY 2001-2002, 183 food stamp recipients and applicants participated in Riverside County FSNEP programs. Sixty six percent completed the required four hours of FSNEP lessons and graduated. Among graduates, 70% showed improvement in one or more food management practices (planned meals in advance more often, compared prices when shopping, used a list for grocery shopping, less often ran out of food before the end of the month.) Even more showed improved nutrition practices (more often used the "Nutrition Facts" on food labels, prepared foods without adding salt, thought about healthy food choices when deciding what to feed their families).

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 2.06 Food Safety

Title: ASSURING FRUIT AND VEGETABLE PRODUCT QUALITY AND SAFETY THROUGH THE HANDLING AND MARKETING CHAIN

Description: The objective is to develop, evaluate, and apply rapid non-destructive sensing technologies to assure food safety, including bio-security, purity, and integrity of produce. The objectives of this research were to (1) develop real-time PCR assays for the detection of Salmonella enterica and pathogenic E. coli, (2) design a flow-through PCR biosensor, and (3) design a system for collection and concentration of bacteria in water samples. Previously published Salmonella specific PCR primer sets were evaluated in a SYBR Green real-time assay. These primers were generally specific for S. enterica, but they had a tendency to form primer dimers at low serovar concentrations, thus reducing the sensitivity of the assay. Therefore, a new primer set, Sen (S. enterica), for real-time PCR was designed to target the invA gene of Salmonella. This primer set did not amplify target DNA from all 5 non-Salmonella bacteria tested, and it was able to amplify the correct fragment from all 14 S. enterica serovars tested. The Sen primer set real-time assay was able to detect as few as 6 S. enterica Newport CFU per 50 _l reaction, with an average detection limit of 35 CFU per 50 _l reaction. No fluorescence was generated from the negative control. E. coli primer sets from the literature were also tested and found to have detection limits of around 104-105 CFU/ml, so a new primer set was designed. Initial tests showed a detection limit as low as 100 CFU/ml, and a high specificity for the serotype O157:H7. The primer set amplified all 13 strains of O157:H7 tested, along with a few pathogenic E. coli strains that were not O157:H7. A flow-through sensor is being designed with a square borosilicate glass tube serving as the PCR chamber. SYBR Green dye is excited by a blue (470 nm) light emitting diode (LED) coupled to a high temperature fiber optic cable, producing green fluorescence (520 nm) in the presence of double stranded DNA. Detection of the fluorescence is accomplished by using an optical edge-pass filter in combination with a photodiode perpendicular to the excitation source. External circuitry is used to convert the photodiode current to a voltage, amplify the signal, filter power-line noise, and provide offset adjustment. A solenoid pump (8 _l/stroke) and pinch valves direct liquid transfer to and from the reaction chamber. An embedded controller drives a thermoelectric module for thermal cycling the flow cell and also controls the pump and valves. A filtration system was designed for collecting and concentrating water samples. The sample was sent through a prefiltering stage composed of three filters of decreasing pore size, stacked one on top of another. A 0.45 um pore size membrane filter was used to finally capture the bacteria, and release them by back-flushing. The process was performed using two miniature pumps and two pinch valves controlled by a microcontroller. Preliminary tests showed that alfalfa sprout irrigation water could be filtered through the prefiltering stage without significant removal of bacteria, the stage of concentration was the 0.45 um filter, and back-flushing proved successful in removing the bacteria from the membrane.

Impact: Increases in pathogen outbreaks associated with fresh produce over the last 10 years have demonstrated the need for on-site screening systems to ensure that uncooked foods are safe for consumption. A real-time automated biosensor suitable for detection of bacterial pathogens could significantly enhance food safety.

Funding Source: Hatch Multistate Research and State

Scope of Impact: CA, GA, HI, IN, MD, ME, MI, NC, NYC, NYG, PA, WA

Theme: 2.06 Food Safety

Title: CHILL AND OSMOTIC TOLERANCE OF LISTERIA MONOCYTOGENES

Description: Listeria monocytogenes is a food-borne pathogen that is second only to Salmonella as a leading cause of death due to food-borne illness. It is responsible for more than 25% of the deaths caused by food poisoning. There are three known transporters for the compatible solutes glycine betaine and carnitine. Understanding osmotic regulation in L. monocytogenes requires that they know which solute permeases are important, i.e., which ones are expressed and which ones are necessary for survival under a particular set of environmental conditions. To determine which transport systems are functional and/or required under which environmental stresses, the researchers are constructing strains containing in-frame deletions of each transporter, of pairs of transporters and of all three transporters. These will be used in growth and transport experiments. Regulation of transport is accomplished at the genetic level and at the biochemical level. They will explore the genetic level regulation of transport by using operon fusions with a promoterless lacZ gene. The mechanism of biochemical activation of transport by hyperosmotic shifts or by chill must be examined using physical and biochemical methods. They will focus on the mechanism of chill activation of transport by glycine betaine porter II (GbuABC). Our initial approach involves two aspects: purification, characterization and reconstitution of the transport system, and characterization of the state of and phase transitions in the membrane. With a better understanding of chill and osmotic tolerance in L. monocytogenes, they will design approaches to reducing its proliferation and reduce the likelihood of food-borne illness and economic loss due to food product recalls. LISTERIA MONOCYTOGENES is a foodborne pathogen that survives under hyperosmotic stress and grows at refrigeration temperatures. Solute transport systems aid in the stress-hardiness by importing the protective molecules glycine betaine and carnitine, which are found in the food. Deletion experiments showed that there are three separate transport systems that are responsible for stress-activated transport of these solutes; they are encoded by the gbu and opuC operons and the betL gene. Gbu and BetL are primarily glycine betaine transporters and OpuC is a carnitine transporter, although Gbu and OpuC show some transport of the other solute. These two transporters are activated by chill or by hyperosmotic stress, whereas BetL is activated by hyperosmotic stress. Operon fusions of a reporter gene show that expression of gbu and betL is enhanced under stress; the fusion mutant involving opuC is defective and it is being re-designed.

Impact: Knowledge of the mechanism of osmotic tolerance and of growth in the refrigerator should lead to food formulations that do not support growth of L. MONOCYTOGENES under osmotic or chill stress, and to the design of better cleaning regimens and handling methods to reduce the possibility of contamination of food by equipment or from the processing environment.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 2.06 Food Safety

Title: IDENTIFICATION OF ENVIRONMENTAL RESERVOIRS OF SALMONELLA SPECIES

Description: The researchers will test the idea that Salmonella can be a long-term resident of certain soil environments. Such environments could serve as a reservoir of Salmonella for infection of animal hosts. This idea was suggested by our work on synthesis and use of vitamin B12 in Salmonella. They have identified a large constellation of functions shared by all Salmonella species (and used as taxonomic criteria for its identification). These properties are absent from Salmonella's nearest relatives suggesting that they are central to some unknown aspect of Salmonella lifestyle. The constellation of functions (described below) are ones that seem likely to be useful during growth in certain sulfur-rich soils in which sulfur redox cycling is occurring. By learning more about circumstances under which these genes are useful and testing appropriate natural sites, they hope to identify natural soil environments in which Salmonella is found. Such sites may prove to be an unappreciated reservoir of Salmonella from which many animal infections are initiated. During the past year they have continued to pursue the details of ethanolamine metabolism in Salmonella and the mechanisms by which it is regulated. They have collected more data suggesting that Salmonella uses ethanolamine more efficiently at low temperature, supporting the idea that this pathway is generally used in soils rather than during infection of a host. They have identified a protein (EutH) that facilitates import of protonated ethanolamine and obtained evidence that no transporter is needed for entry of non-protonated ethanolame; this suggests that the carbon source is used at low concentrations, possibly at low pH. They have identified the transcription start point and isolated deletion mutations in the control region. They are currently characterizing new mutations that damage the positive regulatory protein. All of these findings should help us pursue the idea that this metabolism is part of a system useful during growth at environmental sites.

Impact: The main long-term practical importance of this is the promise that this metabolism is central to the life of an important pathogen. The system being studied is found in all Salmonella isolates, but in none of its closest non-pathogenic related bacteria. The system could be important for pathogenesis, but they think it more likely that it will reveal an environmental reservoir of Salmonella from which bacteria emerge to cause disease.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 2.06 Food Safety

Title: LOWERING FOOD ALLERGIES

Description: Common staples like cereal grains and milk provide critical sources of nutrition for many people, but can cause problems for people with food allergies. A food allergy is an abnormal response to a food triggered by the immune system and it can result in diarrhea, vomiting and in the worst cases is life-threatening. Two foods that cause allergies in children, milk and wheat, do so because certain of their proteins are held together tightly with chemical "bungee cords" and are not digested. The allergens then interact with target cells in the small

intestine, causing an allergic response. Scientists at UC Berkeley demonstrated that a specific protein present in all living cells, thioredoxin (TRX), can break the chemical "bungee cords" that are often responsible for allergenicity. Using biotechnology, they made wheat grains with higher levels of TRX, causing the chemical bonds of some of the allergenic proteins to relax. In preliminary experiments, dogs-- the closest model to humans in their allergic responses-- exhibited less sensitivity to milk treated with TRX and to the modified, high-TRX wheat grain compared to standard wheat. This demonstrates that the approach can be used to reduce food allergenicity.

Impact: Researchers have demonstrated a method that could be adopted by industry to lower food allergies in common staple foods. Such an approach could provide a specialized market for certain foods and improve food safety for the nearly 4 million people in the U.S. who suffer from food allergies.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 2.06 Food Safety

Title: NEW CONCEPTS AND PRODUCTS FROM THIOREDOXIN RESEARCH

Description: The research is designed to elucidate further the role of thioredoxin in germination and seedling development and to continue to apply these findings to the development of new products. To this end, they plan to generate additional transgenic lines of: (a) wheat for improved baking and allergenicity properties; (b) barley for improved malting properties; (c) rice for lower allergenicity and increased digestibility, and (d) sorghum and rice for increased digestibility; (e) sorghum, rice, and barley for novel dough products. Plans call for the generation of homozygous lines of each cereal overexpressing thioredoxin as well as NADP-thioredoxin reductase (NTR) and glucose 6-phosphate dehydrogenase (G6PD), the enzyme that generates NADPH to drive the biochemical processes that lead to improved traits. They shall also pursue the stabilization of the disarmed form of the major milk allergen (beta-lactoglobulin), further development of the dog as a model for human allergy, and basis for the change in germination enzymes in plants overexpressing thioredoxin. The research during the past year focused on the medical/nutritional and plant biochemical areas. With respect to the former, the researchers have demonstrated that thioredoxin (Trx) or a dithiol such as dithiothreitol inactivates the protease, elastase, by reducing a disulfide bond. Once reduced, the enzyme becomes inactive such as the residual activity digests its reduced counterpart. This finding raises the possibility that Trx or a dithiol could be used for treatment of psoriasis-a disease in which elastase provokes the main clinical symptoms. In the nutritional area, they have continued to establish the dog as a model for food allergies. They have demonstrated that sensitized dogs show symptoms very similar to humans with respect to peanut and tree nuts, in both the immediate hypersensitive reaction (skin tests) and oral challenge. Furthermore, sensitivity of the animals to the different nuts shows the same hierarchy as with humans (peanuts > tree nuts > wheat control). The results provide further support for the utility of dog as a model for human food allergy; for example, basic studies on food allergy and in the testing of genetically modified foods for potential unknown allergens. Finally, our research on barley has strengthened our earlier evidence for the regulatory role of Trx in germination and

early seedling development. Disulfide proteins of the barley starchy endosperm and embryo found to be largely oxidized in mature grain were found to be reduced during germination as they have reported for the starchy endosperm of wheat. In addition, Trx overexpressed in the grain endosperm accelerated both germination and the production of key hydrolytic enzymes, such as alpha-amylase. The results provide evidence that Trx of the endosperm acts as a member of a transmembrane communication network that enables the embryo and aleurone to communicate with the endosperm to assess its biochemical status and adjust their activities accordingly.

Impact: This knowledge will help to make foods safer for humans with allergic sensitivities.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 2.06 Food Safety

Title: POSTHARVEST QUALITY AND SAFETY IN FRESH-CUT VEGETABLES AND FRUITS

Description: Objectives are**:** 1. to assess the presence, physiological significance of nutrients and other functional components of fresh-cut vegetables and fruits as affected by storage and handling; 2. to develop and evaluate novel approaches for assuring the quality and safety of fresh-cut vegetables and fruits; and 3. to develop a better understanding of the physiology of fresh-cut vegetables and fruits in response to processing and during storage and handling. Phenolics and Vitamin C content in crops grown under conventional, organic and sustainable practices were compared. Both were significantly higher in sustainability and organically grown crops. Nutritional value was best preserved by freezing, followed by freeze and air-drying. Thermal and nonthermal processing methods (High Pressure, Pulsed Electric Fields, Ultraviolet) of preserving apple juice were compared for effect on inactivation of enzymes. Thermal treatments were the most effective, followed by pressure. Pre-drying treatments (blanching, sulfur/sulfite dips, salt) applied prior to production of sun-dried tomato products were studied. Current practices of applying sulfur with gas may be modified to use sodium metabisulfite dips; salt is also a somewhat effective alternative. A model was developed to predict tomato peelability and peeled product yield. Physical parameters are measured and used to direct tomatoes to either paste or whole peel/diced processing. Antioxidant properties of clingstone peach polyphenolics were evaluated. Cultivar, maturity and various processing methods caused significant differences. Effects of calcium addition on turgor pressure and cell wall integrity of tomatoes was studied. Calcium stabilized both plasmalemma and cell walls, resulting in increased firming. Regeneration and structural changes of heat-treated broccoli peroxidase are being evaluated, as determined using NMR, circular dichroism and activity measurements.

Impact: Use of the best agricultural production systems, fruit and vegetable cultivars and harvest maturity stages will allow food processors to start with the highest quality ingredients. Selection of the optimal preservation method for creating products from these high quality ingredients will provide the consumer with colorful, flavorful and nutritious products.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AL, AR, CA, FL, GA, IA, IL, LA, MD, MI, MS, NYG, OK, OR, PA, TN

Theme: 2.06 Food Safety

Title: POSTHARVEST QUALITY AND SAFETY IN FRESH-CUT VEGETABLES AND FRUITS

Description: Objectives are to assess the presence and physiological significance of nutrients and other functional components of fresh-cut vegetables and fruits as affected by storage and handling and to develop a better understanding of the physiology of fresh-cut vegetables and fruits in response to processing and during storage and handling. Ethylene production is enhanced by wounding during processing and the accumulation of this gas within the packages of fresh-cut fruits can be detrimental to their quality and shelf-life. The effects of 1-methylcyclopropene (1-MCP), an ethylene action blocker, on the quality of fresh-cut kiwifruits, mangoes and persimmons were determined during storage at 5 C. Fresh-cut 'Hayward' kiwifruit slices softened at a slower rate and their ethylene production rate was decreased but respiration was unaffected in response to 1-MCP application (1 ppm for 6 h at 10 C) either before or after processing. A 2-minute dip in 0.09 M (1% m/v) CaCl2 synergistically increased the effect of 1-MCP on firmness retention and 1-MCP did not affect the color (L* value) of fresh-cut kiwifruit slices. Softening and browning (decreasing L* value) were delayed when 1-MCP was applied directly on fresh-cut 'Kent' and 'Keitt' mango slices. Respiration rate of mango slices was not influenced by 1-MCP whereas the ethylene production was affected only towards the end of their shelf-life. Fresh-cut 'Fuyu' persimmons treated with 1-MCP before processing presented higher ethylene production rate, slower softening rate and slower darkening of color (decrease in L* value), whereas the respiration rate was not affected.

Impact: The information that the researchers developed on optimal procedures for preparation, packaging, and handling conditions for fresh-cut fruits has been used by the fresh-cut produce industry to provide several new products, including slices of kiwifruits and pears and arils of pomegranates.

Funding Source Hatch Multistate Research and State

Scope of Impact: AL, AR, CA, FL, GA, IA, IL, LA, MD, MI, MS, NYG, OK, OR, PA, TN

Theme: 2.06 Food Safety

Title: VIRULENCE FACTOR SECRETION BY PATHOGENIC BACTERIA

Description: The short term objectives are to: (1) define the functions of the Fops secreted by the flagellar TTSS, (2) define the essential components of the flagellar TTSS, and (3) define the critical molecular aspects of YplA that allow it to be recognized as a substrate for the flagellar TTSS. Food-borne illness due to pathogenic Gam-negative bacteria is a constant public health threat. Pathogenicity of many foodborne pathogens including YERSINIA ENTEROCOLITICA, SALMONELLA ENTERICA and enteropathogenic strains of E. COLI involves the secretion of virulence factors. Over the past 12 months a UC researcher has published one manuscript on this topic and submitted one book chapter. In addition, the research continues to focus on type III

protein secretion by foodborne pathogens. This research impacts the community of agriculture scientists by providing a platform for the logical development of strategies to prevent food borne infections.

Impact: Microbiological food safety plays an important role in maintaining the quality of the agricultural system. This research impacts society by providing a platform for the logical development of strategies to prevent food borne infections. Specifically, study of how toxins are produced provides knowledge that is necessary for the development of vaccine and treatment methods for disease prevention.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 2.07 Food Security

Title: THE RELATIONSHIP OF POVERTY, FOOD SECURITY, AND FOOD ASSISTANCE TO CHILD NUTRITION IN LATINOS

Description: The objectives of this research are to: 1) examine the validity of the 18-item Core Food Security Module (CSFM) in Latinos, particularly farm workers and immigrants; 2) examine factors related to participation in food assistance program and food insecurity in Latinos; 3) examine the relationship of seasonal fluctuation in food security to dietary variables; and 4) examine the relationship of food security to child growth.

Impact: Many low income, immigrant Latino women experienced some degree of hunger during their childhood in Mexico. Severe past food insecurity may affect current child-feeding practices. Current food insecurity appears to be related to obesity in Latino women, but choice of instruments to measure the phenomenon influences the results.

Funding Source: Hatch and State

Scope of Impact: State Specific

NATIONAL GOAL 3

A healthy, well-nourished population. Through research and education on nutrition and development of more nutritious foods, enable people to make health promoting choices.

In California, five of the top ten fatal diseases (heart disease, cancer, stroke, diabetes and liver disease) are largely affected by poor diet, inactivity, and obesity. Poor diet and physical inactivity rank second only to tobacco in the number of premature deaths they cause. Childhood habits as they relate to food choices may persist into adulthood and as a result, influence an individual's risk for disease. Approximately 35,000 Californians will die annually from illnesses related to poor diet and physical inactivity. Regular physical activity reduces people's risk for heart attack, colon cancer, diabetes, and high blood pressure, and may reduce their risk for stroke. It also helps to control weight; contributes to healthy bones, muscles, and joints; reduces falls among the elderly; helps to relieve the pain of arthritis; reduces symptoms of anxiety and depression; and is associated with fewer hospitalizations, physician visits, and medications. Minorities have much higher chronic disease than non-Hispanic whites due to health disparities. In addition to the burden of avoidable human suffering, the related health costs total approximately $15 billion annually, and even exceed those related to tobacco use.

A plethora of human epidemiological data indicates that improved nutritional and lifestyle practices will significantly reduce potential risks from chronic diseases including, but not limited to, many types of cancer, heart disease, non-insulin dependent diabetes, and osteoporosis. Better nutritional and lifestyle practices will also provide significant prenatal and postnatal benefits. Groups most at risk of nutrient deficiencies are children, women of childbearing years, substance abusers, and the elderly. Also, a disproportionate share of diet-related disease is borne by minority subgroups of the population. Forty-three percent of children in California live in low-income families (<200 Federal Poverty Level) in 2004, putting them at risk of food deprivation and making them vulnerable to under nutrition and other nutritional problems.

California research and extension professionals on the campuses and in the counties worked together to address health and nutrition issues affecting the complete spectrum of the state's citizens. Childhood obesity continues to be a major focus of research and extension programming in the state along with improving food resource management and nutrition practices. The primary focus is to impact the health and nutritional status of Californians. Specifically, our work has provided the capacity to measure cell proliferation and death rates in response to nutrients; information that proves that intermittent administration of iron supplements is safer and as effective as daily supplement administration; knowledge that fish oil improves the lipid profile by reducing hepatic conversion of carbohydrate into fat; knowledge that assessing the impact of agronomic and physical processes on phytonutrient composition of foods provides mechanisms for optimizing nutrition; evidence that a common cause of pregnancy complications is sub optimal maternal zinc and copper nutrition; knowledge that allows the production of recombinant human mild proteins in rice in large quantities allowing for the development of a novel anti-infective formula that can protect formula-fed infants against infections; knowledge about how past food insecurity in Latino women may affect current child-feeding practices; knowledge that phytochemical-rich plant-based food incorporated into usual diets have the potential to provide beneficial cardiovascular effects; information that a nutrition education program can improve food management, nutrition practices, and food safety practices;

knowledge that a video developed to inform parents and caregivers about the serious risk of iron deficiency would provide gains in knowledge about iron deficiency and may motivate families to provide diets higher in iron to prevent iron deficiency; information on how classes in bone health can be used to significantly increase knowledge about sources of calcium and the importance of regular physical activity to bone health; and information on how teen advocates can be used to change school food policy to include 1% milk, fresh salads and salad bars added, and more water and juice options.

Thirty-two local extension programs were delivered in this area. In addition, six statewide collaborative workgroups composed of both AES and CE academics planned and conducted research and extension projects. In addition, UC ANR has one Statewide Special Program that brings together AES and CE resources and personnel that addressed critical issues in the state that are included within National Goal 3. Last year, California academics published 99 peer-reviewed articles and 5 extension publications to address Goal 3 and two patents were issued that addressed Goal 3.

UC-DANR's Human Resources Programs Covering:

- Human Health and Nutrition

Research and Extension Performance Goals:

- Identify interactions between nutritional status and health.
- Identify the nutrition, health and lifestyle practices of California consumers who are at risk for nutrition-related health problems.
- Identify unique food related behavior that put specific cultural groups at risk.

FY 2003-2004 Allocated Resources

Extension Federal Funds (Smith Lever 3 b&c)	Extension State Match	Research Federal Funds (Hatch)	Research State Match
$509,592	$2,432,614 [25.72 FTE]	$325,144	$3,834,418 [15.25 FTE]

Theme: 3.02 Human Health

Title: CHROMOSOMAL MECHANISMS IN ENVIRONMENTAL CARCINOGENESIS

Description: The objective of this research project is to investigate the role of chromosomal mechanisms in the genotoxic and carcinogenic effects of environmental and agricultural chemicals. Recent key developments in UC research on chromosomal mechanisms in environmental carcinogenesis are summarized as follows: 1) The researchers conducted a series of studies on Chinese workers exposed to benzene at concentrations ranging from below 1 ppm to well above 30 ppm. Increases in chromosomal alterations were not easily detected using our

selected fluorescence in situ hybridization (FISH) techniques. In contrast, significant increases were seen even in the group with the lowest benzene exposures using conventional cytogenetic approaches. These data indicate that chromosome damage is occurring in the blood cells of workers exposed to relatively low levels of benzene. 2) They have also extended their studies using bromodeoxyuridine (BrdU) in combination with FISH to evaluate chromosomal alterations in bladder cells following treatment of rats with o-phenylphenol (OPP). Using this technique, significant increases in hyperdiploid y were not seen in bladder epithelial cells when the animals were treated with OPP alone. However, significant increases were seen when rats were treated with both OPP and the model aneugen, vinblastine sulfate. 3) The researchers showed that by using FISH in combination with cytochalasin B or BrdU , the three major types of numerical chromosome alterations (chromosomal loss, nondisjunction and polyploidy) could be easily detected in the micronucleus assay. This demonstrates that with relatively simple modifications, additional cytogenetic information can be easily obtained from the micronucleus assay.

Impact: Both benzene and o-phenylphenol are important industrial and environmental chemicals. An understanding of the mechanisms by which these agents cause their toxic and carcinogenic effects will allow more informed decisions to be made about the risks of occupational and environmental exposure. This information should permit more accurate determinations to identify safe exposure levels. Although not easily quantified, these determinations have major impacts on the economy, the environment and on human health.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 3.02 Human Health

Title: DRUG AND DISEASE INDUCED TRACE ELEMENT DEFICIENCIES

Description: This study has two basic objectives. The first objective is to identify mechanisms that contribute to the developmental toxicity of zinc deficiency. One hypothesis that will be tested is that a condition of zinc deficiency can result in tissue oxidative stress that in turn results in cellular damage, and subsequent developmental defects. If this hypothesis is correct, it would suggest that individuals already at risk for oxidative stress (for example, individuals who smoke or who consume alcohol), may have a heightened susceptibility to zinc deficiency. Importantly, knowledge of the above could guide the development of biomarkers for at risk populations. For example, a combination of markers that reflect an individual's mineral status, as well as the status of their oxidant defense system, would presumably be preferably to the simple measurement of plasma or blood zinc values. A long term objective of this work is to test the above concept using high risk populations. A second objective of this study will be to characterize specific disease states that might modulate an individual's response to zinc deficiency. The initial work in this area will be aimed at an investigation of the interaction between diabetes and zinc deficiency. The incidence of diabetes is rapidly increasing throughout the country, and it is imperative that they gain a better understanding of the influence of this disease on mineral metabolism. They and others have already shown that diabetics (humans as well as experimental animal models) are characterized by altered zinc metabolism. However the functional significance of the above is not well characterized. In the proposed work they will examine this interaction in detail, with a

focus on the combined effects of diabetes and zinc deficiency on tissue oxidative stress and tissue oxidative defense systems.

Impact: A major focus is the investigation of the effects of micronutrient deficiencies on fetal and early neonatal development. During the period under review they focused their efforts on zinc and copper. With respect to both minerals, they were able to show that early consequences of their deficiency include alterations in the ability of tissues to deal with oxidative stress. Changes in the redox status of select tissues may contribute to the developmental defects associated with zinc and copper deficiencies. This work provides evidence for the concept that a common cause of pregnancy complications is sub optimal maternal zinc and copper nutrition.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 3.02 Human Health

Title: FUNCTION OF THE AMMONIA TRANSPORTER

Description: The long-term objectives of this proposal are: 1) to isolate and characterize cytoplasmic membrane proteins AmtB/MEP, which are responsible for acquisition of ammonium; 2) to establish an in vitro assay for the function of these unusual transporters; 3) to determine genetically which residues/features of these transporters are essential for their unique substrate specificity and their function as channels; 4) to determine the structure of these proteins. The AmtB/MEP proteins are universal in distribution, being found in bacteria, including hyperthermophiles, archaea, and eukarya such as fungi, higher plants, and nematodes. Our evidence in bacteria indicates that these proteins, which have remained evolutionarily distinct from other members of the so-called major facilitator superfamily, increase the rate of equilibration of the uncharged species, NH3 across cytoplasmic membranes. Many publications report the contrary, that AmtB (ammonium methylammonium transporter B) /MEP (methylammnonium porter) proteins transport NH4+ the charged species, and concentrate it against a gradient in an energy-dependent manner. Hence, the first of the short-term goals is to generalize findings with enteric bacteria to yeast. Specifically they will show that the apparent concentration of 14Cmethylammonium, an ammonium analogue, by the yeast Saccharomyces cerevisiae is due to MEP-dependent equilibration of the uncharged species methylamine (CH3NH2) across the cytoplasmic membrane and its subsequent (ATP-dependent) accumulation in vacuoles by acidification to yield CH3NH3+. This will provide evidence that concentration of ammonium in fungi, like that in bacteria, is due to a coupled process of transport and modification (protonation), the second step of which is energy-dependent. The second short-term goal is to demonstrate that AmtB allows loss of ammonia from the cell cytoplasm when it is generated internally. If, as they have postulated, AmtB/MEP proteins act as channels rather than mediating energy-dependent concentrative uptake, they should allow leakage of ammonium from the cell interior when the internal concentration is higher than the external. The most important finding from the previous year was that expression of the only known homologue of Amt/MEP proteins, the Rhesus or Rh proteins, is controlled by availability of carbon dioxide in the green alga Chlamydomonas reinhardtii. This was shown at both mRNA and protein levels. By contrast, expression of the Amt/MEP proteins of C. reinhardtii is controlled by nitrogen availability, as it

is in other organisms. These findings indicate that the biochemical and physiological roles of Rh proteins are different from those of Amt/MEP proteins. They are in agreement with the hypothesis that Rh proteins are gas channels for carbon dioxide. Also in agreement with this hypothesis is the distribution of Rh proteins among organisms and in organs and tissues of humans and other mammals. Unlike Amt/MEP proteins, which are widespread in bacteria and archaea, Rh proteins are absent in these organisms, which may be too small to require gas channels for carbon dioxide. Rh proteins are also absent from higher plants, which obtain carbon dioxide from the air. Among eukaryotic microbes, Rh is present only in the green algae, in which it is presumably useful for photosynthetic carbon fixation, and the slime molds, in which it may be important for development. Rh proteins are widespread in invertebrates, as is true of Amt/MEP proteins, and Rh proteins are prominent in vertebrates and mammals, in which Amt/MEP proteins are absent. In humans Rh proteins are found in organs and tissues involved in waste disposal and buffering of various body fluids.

Impact: The function of Rh proteins has been unknown for over 6 decades, despite the fact that the Rh blood group substance of humans is among the most abundant proteins in the red cell membrane and can cause serious immunological incompatibility between mothers and fetuses. Studies of human respiratory physiology have assumed that all movement of gases across red cell membranes is unmediated, a view that will have to be modified if Rh proteins are gas channels for carbon dioxide.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 3.02 Human Health

Title: GENOMIC EXPANSION OF THE HUMAN ALBUMIN GENE FAMILY

Description: Objectives are: to determine the structure of the genomic region between the human alpha-fetoprotein and the GC gene; to determine the structure of genes localized in this region and to determine their phylogenetic relationship to other members of the albumin gene family; and to determine the linkage of members of the multigene family as well as the direction of transcription along the chromosome. Increased Alu density has been correlated with genetic instability, which is a recognized phenomenon in the vast majority of cancer cases. Instability arises within the genome due to various genetic alterations, duplications, deletions, chromosomal translocations, chromosomal number alterations, and gene amplifications. A high level of Alu-sequence similarity ensues a strong propensity for unequal cross over events, some of which have lead to deleterious oncogenic rearrangements. In addition, it has been demonstrated that Alu insertions can introduce consensus 3' splice sites, thus facilitating alternative splicing, constitutve splicing and misplicing. Alu-mediated defective splicing has also been associated with cancer. To investigate a possible correlation between the expansion of Alu repeats associated with primate divergence and predisposition to cancer, they selected four Alu-mediated rearrangements - known to be the basis of cancer - for phylogenetic analysis of the necessary genotype. In all four cases, they found that the different phylogenetic age of the oncogenic recombination-prone genotype could be correlated with the evolutionary history of Alus' spreading to new genomic sites.

Impact: Once identified, genetic elements involved in human cancer could be used for predictive screening to identify predisposition to cancer and targeted for gene therapy. Previously, deleterious cancer causing mutations have been identified only after the mutation occurred, thus lacking predictive value.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 3.02 Human Health

Title: HELPING CLINICAL LABORATORIES STANDARDIZE FARMWORKER TESTS

Description: Growers are required to test the blood of pesticide mixer loaders, applicators and others who contact organophosphate (OP) and organocarbamate (CB) pesticides -- such as diazinon and carbofuran -- in the workplace. A UC animal science and environmental toxicology professor, his students and colleagues showed that tests used by California clinical laboratories often were not optimal and that results were not comparable from laboratory to laboratory. This led to a change in state regulations requiring that mandatory tests be consistent and conversion factors be generated. He is working with Cal EPA Department of Pesticide Regulation to help clinical laboratories improve and standardize their blood cholinesterase measurements -- the blood enzymes used to detect exposure to the OP and CB pesticides. The researcher and his laboratory collaborated with UC-DANR IPM personnel, state workers , director of UC Davis Employee Health Services, the UCD/NIH Center for Environmental Health Sciences, and the UCD/NIOSH Agriculture Health and Safety Center. The team developed a bovine red blood cell enzyme standard using cow blood from the Department of Animal Science; they also devised an optimal assay procedure. The UC laboratory served as the benchmark in comparing blood test results with participating clinical laboratories.

Impact: The UC researcher's studies with clinical laboratories are standardizing results from many laboratories, offering growers and workers in the agricultural workplace more accurate tests to provide for their safety, and helping to keep California in the forefront of producing safe and nutritious food for the consumer.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 3.02 Human Health

Title: IMPACT OF DIETARY INTERVENTION ON CARDIOVASCULAR DISEASE RISK

Description: This project addresses the question of how dietary components may modify heart disease risk factors. Cardiovascular disease (CVD) is the leading cause of death in the U.S. The development of CVD is a complex, long-term process involving inflammatory processes, endothelial dysfunction, arterial lipid deposition and thrombus formation. Scientific evidence increasingly suggests that phytochemical-rich foods in the diet can modulate these processes in a beneficial manner and contribute to decreasing CVD risk. The overall goals of this project are to

investigate the effects of dietary-derived polyphenolic phytochemicals on cardiovascular health. The phytochemicals will include those found in soy foods and soy proteins, in cocoa products, nuts and a wide variety of fruits and vegetables. Specifically, the objectives of this project will be to examine the effects of soy isoflavones and other flavonoids on ex vivo plasma and LDL oxidation susceptibility, on platelet aggregation and cell surface activation markers, other cardiovascular risk markers, and on the expression of endothelial cell adhesion molecules. This research investigates effects of dietary phytochemicals from foods such as soy protein, nuts and cocoa on lipid and lipoprotein oxidation susceptibility, platelet aggregation, endothelial function and markers of cardiovascular risk. The major accomplishments during this period relate to the following research interests: 1) Hypothesis: Soy protein and phytoestrogens improve vascular reactivity and endothelial cell function. A randomized double-blind, crossover clinical trial was conducted in 28 healthy post-menopausal women comparing the effects of soy protein with or without phytoestrogens to a control total milk protein. Brachial artery reactivity was the primary outcome and secondary outcomes were biochemical markers of cardiovascular risk. Peak flow velocity in the brachial artery was significantly lower for women consuming soy with phytoestrogens compared to the control protein. This suggests that soy protein with isoflavone phytoestrogens can have modest beneficial effects on vascular arterial function even in healthy women. The effects were independent of any changes in lipid metabolism and oxidation status. A publication resulted from this work. 2) A review paper was published regarding cocoa flavonoids and potentially positive implications for cardiovascular health. This paper summarized the current literature and targeted practicing clinical nutritionists. 3) Hypothesis: Soy protein and associated phytoestrogens will provide antioxidant protection in the plasma during the acute phase of 0-7 hours following consumption, as measured by LDL oxidation susceptibility and measures of plasma antioxidant capacity. A randomized controlled intervention trial was conducted with 18 individuals who consumed on separate days a low flavonoid shake containing casein control protein, soy protein or soy protein with isoflavones. No differences were noted in LDL oxidation susceptibility, but plasma antioxidant capacity as measured by ORAC was significantly different depending on protein source. A manuscript is in preparation. 4) Hypothesis: Soy protein and associated phytoestrogens will delay platelet aggregation during the acute phase of 0-7 hours following consumption. A randomized controlled intervention trial was conducted with 22 individuals who consumed on separate days a low flavonoid shake containing casein control protein, soy protein or soy protein with isoflavones. Who blood platelet aggregation was measured, as well as platelet surface activation markers using monoclonal antibodies and flow cytometry. The final biochemical analyses are underway and data analysis will soon begin, with a manuscript planned for submission within the year. Ongoing activities in this research project involve further studies examining the effects of soy isoflavones and other flavonoids on ex vivo plasma and LDL oxidation oxidant defense, and in vitro studies of platelet aggregation and cell surface activation markers using purified isoflavones and structural analogs in order to elucidate possible mechanisms and structure function relationships.

Impact: Phytochemical-rich plant-based foods incorporated into usual diets have the potential to provide beneficial cardiovascular effects. The actions of the food-derived phytochemicals may be multi-factorial and related to antioxidant protection and vascular endothelial function.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 3.02 Human Health

Title: IMPROVING ACCESS TO HEALTH CARE FOR LARGE-SIZED WOMEN

Description: Objectives are to: 1. Determine the barriers faced by large sized women (defined as MBI>30) who delay obtaining health care and high quality nutritional guidance. I will include white women and women of color to determine their culturally specific obstacles. 2) Initiate culturally specific strategies to empower large women to overcome the barriers to receiving health care. 3) Collaborate with health care providers in disseminating the information concerning the care of large size women. Women are encouraged to have yearly gynecological cancer screening, however large women frequently delay seeking health care. The researchers conducted focus groups and sent a questionnaire to both large women and health care providers to determine the extent and reasons for the delay. They surveyed 498 women, including 60 'super size' women of BMI (body mass index) 55 or greater. The data show that as weight increased, the percentage of women who reported delaying seeking health care increased. About 20% of the women with BMIs in the 25-35 range reported delay of seeking care and that weight was a barrier, whereas 80% of the women with BMIs of 55 or greater reported that weight was a barrier.

Impact: The women reported barriers in three areas: 1) medical equipment, tables, gowns and chairs that are too small; 2) negative attitudes of providers, unsolicited advice to lose weight and disrespectful treatment; and 3) embarrassment at being weighed. The health care providers reported having little or no special training in examining and caring for large patients or in providing weight-related advice to this population. Most find examining large patients more difficult than other patients and that supplies are not readily available to accommodate the largest patients. This research indicates that training programs are needed for providers, and modifications in the physical environment could improve quality of care for large women.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 3.02 Human Health

Title: IMPROVING IRON/ZINC NUTRITION

Description: Objectives are to: 1. Develop new methods applicable to the study of iron and zinc nutrition focusing in underprivileged populations; 2. Apply new methods to the evaluation of possible iron and zinc fortificants of foods for human populations; 3. Encourage the development of new plant varieties with desirable properties as sources of bioavailable iron and zinc, and evaluate them in different systems including humans; 4. Evaluate the efficacy and safety of different schemes and doses of iron supplementation and foster those that appear more effective and safe; and 5. Study the mechanisms of iron absorption, regulation, utilization and safety in a rat experimental model with different iron status and receiving various iron supplementation schemes. This includes the functional characterization of early iron overload conditions. UC researchers have begun a series of studies exploring the bioavailability of different iron chelates using in-vitro dialysis techniques after simulation of gastric and intestinal

digestion phases as well as using intestinal cell cultures and intestinal loop perfusions in rats. So far their results indicate that NaFeEDTA is the preferred iron chelate regarding iron absorption. They have conducted a study on daily iron supplements administered together or separate from zinc supplements in pregnant and lactating women, measuring both iron and zinc absorptions and metabolism by means of stable iron and zinc isotopes. This work is in collaboration with the WHNRC/USDA center at UC Davis. The objective of the study is to determine the effects of iron supplements on iron and zinc metabolism. They have finished the clinical phase of this study and are proceeding to complete all biochemical analyses. The active collaboration with the UCB-Molecular and Cell Biology has continued during 2002 in the study of iron-induced oxidative stress and oxidative damage following the human and animal experimental models of daily and intermittent iron supplementation. They have finished analyzing mitochondrial DNA breakages using real-time PCR and 8-oxo DG determinations by HPLC in DNA isolated from buffy-coat from the human studies they have performed comparing daily and weekly iron administration. Results: women receiving weekly iron as well as controls not receiving iron show the same degree of DNA breakage. Women receiving daily iron show very variable levels of DNA damage probably because of possible defects in sample storage and problems with DNA isolation. They will repeat a group of women on daily iron supplementation. They have continued their collaboration with a colleague at the Instituto Nacional de Perinatologia in Mexico City on the relative effectiveness and safety of weekly and daily iron supplementation to pregnant women. The administration of 60 mg of iron daily to non-anemic women results in elevated hemoglobin levels associated with a higher prevalence low birth weights and premature deliveries. These undesirable effects are rare in women receiving weekly supplementation. They have repeated the study administering iron twice weekly. Results are similar as with weekly supplements. The infants of the mothers in this study are being followed for up to 6 months of age to determine their developmental characteristics. Lastly, they continued their collaboration with colleagues in Argentina. They conducted a study on 3.738 deliveries to determine the practice of cord ligation. The average time for cord clamping is 25 seconds, but obstetric services that have read their publication on this matter have a significantly longer time of cord clamping benefiting the infants.

Impact: The researchers have continued to prove that daily iron supplementation as currently recommended is not innocuous, and that the intermittent administration of iron supplements is safer and as effective as daily supplement administration. They have also continued to explore in depth iron-zinc supplementation in pregnancy and the choices of iron compounds for food fortification of populations. These studies may open new avenues for overcoming iron deficiency safely, including changing the practice of umbilical cord ligation for the benefit of infants' iron nutrition.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 3.02 Human Health

Title: MALE REPRODUCTIVE TOXICITY OF ENVIRONMENTAL CHEMICALS: MECHANISMS AND MARKERS

Description: Objectives are: to investigate the relationship between metabolism and the ability of environmental chemicals to cause epididymal and testicular toxicity; to investigate cellular mechanisms of testicular toxicity; and to develop improved sperm biomarkers that signal potential for reproductive harm. Recent research has been directed towards understanding metabolic mechanisms of epididymal toxicity and assessment of sperm function. To develop methods for assessing sperm mitochondrial health, the well known mitochondrial uncoupling agent pentachlorophenol(PCP), was used as a model toxicant. The JC-1 fluorophore was used to detect changes in mitochondrial membrane potential and sperm were separated by flow cytometry and level of JC-1 fluorescence. Sperm mitochondria were highly sensitive to the uncoupling effects of PCP and this assay is useful to detect sperm mitochondrial changes after chemical exposure. In studies investigating epididymal toxicity, the possibility that trichloroethylene (TCE), a widely used solvent and drinking water contaminant, could cause epididymal damage was investigated. The enzyme cytochrome P450 2E1(CYP 2E1), has been implicated in the oxidative metabolism of TCE and the formation of TCE reactive metabolites and toxicity in the kidney. The present studies found that this activating enzyme was also located in the efferent ducts that connect the testis and the epididymis. TCE protein adducts were also detected in efferent duct microsomes incubated with TCE. TCE exposure also resulted in decreased fertilizing ability and sperm membrane protein oxidation. A recently accepted paper described epididymal epoxide hydrolase activity and its possible role in xenobiotic and fatty acid metabolism in the different sections of the epididymis. These studies demonstrate that epididymal toxicity could arise via metabolic activation mechanisms.

Impact: Understanding mechanisms by which environmental chemicals adversely affect the male reproductive system will lead to better understanding of risks associated with exposure. In particular, the ability to extrapolate animal data to man is improved by mechanistic understanding. A goal is to protect reproductive health. A secondary outcome is to develop markers that signal potential for reproductive harm.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 3.02 Human Health

Title: MEASUREMENT OF CELL PROLIFERATION IN RESPONSE TO NUTRIENTS: ROLE IN CARCINOGENESIS AND ATHEROGENESIS

Description: Objectives are: 1. To optimize the stable isotope-mass spectrometric technique for measuring proliferation of epithelial cells (breast, colon, skin) in rodents and in human subjects. 2. To establish the capacity of this technique to detect alterations in cell proliferation in rodents following administration of known breast, colon and skin carcinogens in different dietary settings. 3. To develop the technique for measuring colon, breast and skin cell proliferation rates in humans. 4. To begin studies of the effects of low-fat diet on colonocyte proliferation in human subjects 5. To develop the technique for measuring vascular SMC proliferation rates in rodents and humans (i.e., to develop an "atherogenesis" assay) 6. To test diet/gene interactions on arterial SMC proliferation, in mouse models of atherosclerosis. The effect of nutrients on cell proliferation and death was determined in several systems: mammary epithelial cells (MEC),

colon epithelial cells (CEC) and vascular smooth muscle cells (VSMC). They developed a new non-radioactive (stable isotope) labeling technique for this purpose, based on incorporation of deuterium from heavy water into replicating DNA. Genistein, a soy-derived phytoestrogen proposed to have breast cancer preventative actions, was given to rats during the pre-weaning period (by intraperitoneal injections), the post-pubertal period (in the diet) or both. Only when given in both pre-weaning and post-pubertal periods was MEC proliferation significantly reduced. These findings support epidemiologic observations regarding timing of soy intake and reduced cancer risk in women. MEC proliferation in humans was slower in post-menopausal than pre-menopausal women and was higher in tumor tissue than in normal cells. The MEC proliferation measurement may therefore be useful as a biomarker for cancer risk and prevention and tumor behavior in women. Curcumin, a spice in curry that has been proposed to reduce colon cancer risk, was given to rats in the diet. CEC proliferation showed dose-dependent increases in response to dietary curcumin, not reduced proliferation. These results are inconsistent with expectations for a cancer protective (anti-promoter) agent. Long-lived, label-retaining CEC, representing epithelial stem cells, were isolated from rat colon by use of a bromodeoxyuridine tagging method. The proliferation rates of these cells was measured concurrently using the heavy water technique and revealed half-lives of several hundred days, compared to 6-8 days for differentiated CEC. The ability to measure proliferation rates of probable epithelial stem cells in colon may allow highly informative studies of carcinogenesis and diet. VSMC proliferation was measured in an atherosclerosis-prone mouse model (apolipoprotein E knockout) on both low-fat and high-fat diets. An increase in aortic VSMC proliferation occurred in the knockout mice, and was greater on high-fat diet, compared to normal controls. Increased VSMC proliferation preceded histologic changes of atherosclerosis in the aorta. Infection with murine cytomegalovirus did not increase VSMC proliferation in any group.

Impact: The capacity to measure cell proliferation and death rates in response to nutrients, in both animal systems and humans, represents a powerful new tool. Proposed cancer-protective or cancer-inducing actions of various nutrients have been tested experimentally by this approach; genistein was confirmed to have potential benefits against breast cancer promotion, but with specific limitations relating to time of intake, while curcumin did not have effects consistent with prevention of colon cancer. Improved disease prevention, early detection, treatment and pathogenic understanding may result from the safe and accurate techniques for measuring cell proliferation that they have developed.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 3.02 Human Health

Title: MECHANISMS AND MITIGATION OF AGROCHEMICAL IMPACTS ON HUMAN AND ENVIRONMENTAL HEALTH

Description: The objective is to identify, develop, and/or validate trace residue analytical methods, immunological procedures, and biomarkers. Chemicals including pharmaceuticals, drugs, food substances, pesticides and other products in commerce are never used with 100% efficiency. In pest management in agriculture, human exposures at some level are inevitable. The

1996 Food Quality Protection Act (FQPA) requires the evaluation of both aggregate and cumulative health risks from pesticides. Organophosphate (OP) pesticides produce trace residues in produce protected from insect pests. Organophosphate (OP) pesticides are the first class of chemicals that have undergone FQPA mandated aggregate and cumulative assessments based upon biomonitoring for urinary levels of six alkyl phosphate (AP) metabolites of OPs. EPA's aggregate exposure estimates (dietary, drinking water, and non-dietary residential exposures) for many individual OPs were greater than the cumulative estimate for all OPs combined based on the CDC AP biomonitoring data. The results also suggest that EPA's screening level assessments of OPs, while being qualitative indicators of the relative importance of various exposure sources, are not good quantitative indicators of actual exposures. They postulated oral absorption of nontoxic, dialkylphosphates (DAPs) from produce protected from pests by OPs. In exposure assessment OPs are estimated by urinalysis of DAPs for back calculation of absorbed daily dosage. DAPs also may be formed from OPs as a result of plant metabolism. DAPs were measured in produce for the first time as part of exposure assessment to evaluate the potential contribution of preformed DAPs from plants to OP exposure assessment. DAPs were measured in 77 produce samples known to contain OP residues from the channels of trade in California. All OP residues were below established residue tolerances. OP pesticides included acephate, azinphos-methyl, chlorpyrifos, diazinon, dimethoate, dimethoate-omethoate, malathion, methidathion, oxydemeton-methyl, and phosmet. Fifty-one of 77 samples contained more DAP residue than parent pesticide. The mole ratios of DAPs to parent organophosphate residues ranged from 0.1 to 73. Oral absorption of nontoxic DAPs contributes to overestimates of absorbed dosage from biomonitoring data reported in CDC Second National Report on Human Exposure to Environmental Chemicals. In addition to the above experimental studies, numerous pesticide registration documents have been reviewed for discussion with regulatory scientists at the state and national levels. There is greater agreement on scientific issues related to risk assessment than on the principles that guide policy development and decision-making.

Impact: The studies continue to demonstrate that little pesticide exposure of adults and children relative to toxic amounts results from normal uses of registered products. Metabolic biomarkers in food will inflate exposure assessments, particularly those for children. Measurement of organophosphate metabolites in both produce and human urine is an important finding that can make future epidemiological studies more accurate. Urine monitoring of biomarkers can now be used to more accurately establish pesticide exposures following a variety of human activities.

Funding Source: Hatch Multistate Research and State

Scope of Impact: CA, FL, HI, IN, KS, NM, NV, NYC, OR, UT, WA

Theme: 3.02 Human Health

Title: NOVEL TECHNOLOGY FOR STABILIZATION OF BIOLOGICAL CELLS IN THE DRY STATE

Description: Objectives: (1) To optimize a method for introducing trehalose into cells; (2) to obtain evidence concerning the mechanism for high temperature introduction of trehalose; (3) to scale-up the process for platelets to a full unit size; (4) to test safety and efficacy of freeze-dried platelets in animal models; (5) to establish the mechanism by which trehalose stabilizes the dry

cells; (6) to develop new means for introducing trehalose into cells, using molecular techniques. This project is aimed at achieving stabilization of living cells in the dry state. In the past year they have: (1) investigated the properties of membranes in dry cells as indicators of stability; (2) shown that microdomains in membranes of dry cells are maintained intact; (3) investigated interactions of stress proteins with membranes that might be useful in stabilization; (4) established that small stress proteins increase the stability of dry cells.

Impact: Human blood platelets have a lifetime in blood banks of five days. They have extended that lifetime to at least two years. Nucleated cells are being developed as biosensors to detect xenobiotics, particularly as terrorist threats. The dry cell technology developed here has made that application practical.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 3.02 Human Health

Title: PROTECTING THE ENVIRONMENT AND HUMAN HEALTH THROUGH WORKER TRAINING

Description: Keeping pesticides out of groundwater and surface water and preventing pesticide drift are two of the most important issues facing agriculture. At the expanding agricultural-urban interface, the spotlight on these issues intensifies. Pesticide applicators are directly responsible for ensuring that pesticides do not contaminate water or drift off the application site. Their supervisors play an important role in deciding when and how to use pesticides. The UC Pesticide Safety Education Program (PSEP) has recently collaborated with the California Minor Crops Council and local community groups to develop new train-the-trainer workshops in prevention of pesticide drift and water contamination. The workshops are designed for pesticide applicators and their supervisors. Working with applicator-supervisor pairs is a new approach that PSEP believes will increase the likelihood that new safety plans and practices will be adopted back on the farm. Workshop attendees also become "peer trainers", extending the information to other pesticide handler-supervisor pairs. In addition to prevention of drift and water contamination, these workshops cover how to reduce risks to workers and communities, and how to incorporate Integrated Pest Management (IPM) concepts into decision-making processes.

Impact: PSEP's train-the-trainer approach in these workshops leverages the efforts of a small team, extending knowledge about pesticide safety and environmental protection to many more people than would otherwise be possible. Using this approach in a number of subject areas, PSEP has trained hundreds of trainers throughout the state since 1994. These trainers have in turn trained thousands of agricultural workers. The result of this program is less environmental contamination due to improper pesticide use and an improvement in human health due to more safe and proper use of pesticides.

Funding Source: Smith-Lever, Hatch, and State

Scope of Impact: State Specific

Theme: 3.02 Human Health

Title: REGULATION OF VITAMIN A METABOLISM

Description: The objectives of this research are to understand the precise mechanisms of converting vitamin A (retinol) into its active metabolic form, all-trans-retinoic acid (RA), and to understand how diet, environmental influences, hormones and xenobiotics affect the activation of retinol into RA. The UC researchers established that RDH1 is a single copy gene on chromosome 10D3, spans ~14412 bp and has four exons and three introns. Rdh1 has three transcription start sites in kidney and one in liver. The rdh1 5'-region between -424 and +43 induces transcription in COS7, RAG, and NMu3Li cells. The promoter has no TATA box, but has a CCAAT box, required for transcription of reporter constructs, 65 bp upstream of the major start site. An AP1 site at -119 activates transcription and is stimulated by TPA. All-trans-retinoic acid antagonizes TPA; however, no RARE was found in the promoter, suggesting indirect regulation by retinoic acid. They also cloned a cDNA for mouse enzyme RALDH4. RALDH4 used 9-cis-retinal generated in cells by retinol dehydrogenases to biosynthesize 9-cis-retinoic acid. RALDH4 was expressed in liver on embryo day 14.5, in adult hepatocytes and kidney cortex. They showed that hepatocytes also express RALDH1, RALDH2 and RALDH3. Kidney expresses RALDH4 in proximal and distal convoluted tubules of the cortex, but not in glomeruli or medulla. Kidney expresses RALDH2 in proximal convoluted tubules of cortex, but not in distal convoluted tubules or glomeruli. Kidney expresses RALDH1 and RALDH2 in medulla. RALDH4 could meet specific needs for 9-cis-retinoic acid biosynthesis. They further found that mouse liver peroxisomes reduce all-trans-retinal into retinol. Mice fed a diet with clofibrate, a PPARalpha ligand and peroxisome proliferator, had 2-fold increased peroxiosmes and increased retinal reduction, but a 50% decrease in liver retinol. They expressed a cDNA that encodes the peroxisome enzyme mouse retinal reductase (RRD), which reduces all-trans-retinal. Most adult tissues expressed RRD, initiating on embryo day 7, with liver, kidney, and heart the most intense. Clofibrate increased RRD in liver. These data relate retinoid metabolism, PPARalpha, peroxisomes and RRD. They also discovered and cloned a cDNA for a novel short-chain ehydrogenase/reductase, SDR-O, conserved in mouse, human and rat. Liver expresses SDR-O (orphan) intensely. The mouse embryo expresses SDR-O as early as day seven. Mouse SDR-O localizes on chromosome 10. SDR-O shares highest similarity with RDH1, but does not have retinol dehydrogenase activity. SDR-O may catalyze metabolism of another class of compound or may not have a catalytic function, but may regulate metabolism by binding substrates/products and/or by serving as a regulatory factor.

Impact: Understanding the precise metabolic pathway(s) that convert vitamin A into its hormonal forms is important because vitamin A does not function until it is activated. By elucidating the pathways of this activation, the researchers should be able to determine whether human and animal pathologies with symptoms that overlap with the symptoms of vitamin A deficiency are caused by difficulties with activating vitamin A. Such pathologies include but are not limited to: cancer, learning impairment, immune suppression, birth defects and skin diseases.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 3.02 Human Health

Title: ROLE OF RETINOID METABOLISM IN BREAST CANCER

Description: The long-term goal of the research is to understand the role of vitamin A and its analogs (retinoids) in carcinogenesis. One aspect of this is the current focus on the role of retinoid metabolism in breast cancer. Breast cancer is the most common malignancy among women, affecting one in eight, and accounting for over 18% of all female cancer deaths. Vitamin A and some of its analogs have exhibited varying degrees of effectiveness against breast and other cancers of epitheial tissues. There is also indirect evidence suggesting that cellular retinoid metabolism may be altered in cancerous versus normal cells. The biological activity of vitamin A is mediated by its natural metabolite retinoic acid (RA), which serves as a ligand for nuclear receptors that regulate gene expression. RA is a powerful inducer of cell differentiation and is a potent anti-cancer agent. The researchers' working hypothesis is that mammary cancer cells are unable to synthesize and/or maintain sufficient levels of RA to maintain appropriate gene expression and normal cell functions, particularly growth control. To test this hypothesis, the objectives of this current research are to: (1) Determine RA synthetic activities of normal human mammary epithelial cells and mammary carcinoma cells to establish whether differences exist between the normal and cancerous cells; (2) Determine the expression pattern of enzymes and retinoid binding proteins putatively involved in RA metabolism in normal human mammary epithelial cells and mammary carcinoma cells; (3) Determine RA catabolic activities of normal human mammary epithelial cells and mammary carcinoma cells to establish whether differences exist between the normal and cancerous cells; (4) Test whether specific changes in RA metabolism results in changes in the neoplastic or tumorigenic properties of these cells. This research program is centered on elucidating mechanisms of vitamin A metabolism and homeostasis and understanding the role of these processes in diseases including cancer. During the reporting period, the researchers continued their studies comparing metabolic characteristics between normal mammary and breast cancer cells. These studies demonstrated that: a) normal mammary cells are growth inhibited to a greater extent by vitamin A (retinol) than breast cancer cells and that this growth inhibition is a function of the extent of metabolic conversion of retinol into retinoic acid; b) the relative ability to generate and respond to retinoic acid decreases in cells representative of more advanced stages of breast cancer; c) there are differences in the levels of transcripts encoding proteins involved in vitamin A transport, metabolism and signal transduction between normal and breast cancer cells. These findings indicate that alterations in vitamin A (retinoid) metabolic capacity are correlated with breast cancer progression and that this likely affects the neoplastic behavior of breast cancer cells. In complementary studies, they have identified a new enzyme involved in retinol metabolism in epithelial cells. While at present it is too early to establish a link between this new enzyme and its possible role in cancer or other conditions affecting epithelial tissues.

Impact: Vitamin A, including its naturally occurring and synthetic analogs, exhibits a variety of benefits to human health including anti-cancer effects. In aggregate, the findings provided valuable insight into the molecular mechanisms underlying vitamin A metabolism and homeostasis, which will be built upon to better understand the role of vitamin A in specific diseases. As such, the findings have ramifications for both cancer diagnosis and treatment.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 3.02 Human Health

Title: TRAINING HEALTH CARE PROVIDERS HELPS PROTECT FARMWORKERS FROM PESTICIDES

Description: One important way to improve pesticide safety for farmworkers is to provide health care workers with training and resources to help them in recognizing and treating pesticide-related illnesses and injuries. Small, rural health clinics located in farming communities generally serve California's farmworker population. These clinics often experience frequent staff turnover, so educators must use innovative methods to provide timely pesticide information and clinical training. The Pesticide Safety Education Program (PSEP) is a component of ANR's Statewide Integrated Pest Management Program. For nearly 10 years, this unit has developed materials and conducted workshops delivering information needed by health care providers to properly assess and treat cases of pesticide exposure. The workshops are held in rural farming areas. By design, they are small to make them highly interactive and to allow participants to engage in diagnostic activities based on actual case studies involving pesticide exposure. The program follows a train-the-trainer model, with the PSEP staff providing materials that key clinic personnel can take back to use as they train new staff. PSEP collaborates with the UC Davis Western Center for Agricultural Health and Safety, the UC Davis Center for Environmental Health Sciences, and the UC Berkeley Center for Occupational and Environmental Health. Workshop planners and faculty include medical staff from the California Department of Health Services, California Department of Pesticide Regulation and the Cal-EPA Office of Environmental Health Hazard Assessment, along with UC Davis pesticide researchers and educators.

Impact: Besides learning about pesticides and how to diagnose and treat pesticide-related illnesses and injuries, health care providers in rural agricultural areas also are learning how and where to report suspected cases. This gives California farmworkers additional protection from the possible hazards of pesticide exposure. Clinic staff distributed pesticide safety information, helping their patients to learn ways to avoid pesticide exposure. The workshops also attracted community leaders, farmworker advocates, workers compensation insurance representatives and growers, who attend to obtain added information about health impacts of pesticides. Because of the popularity of and demonstrated need for these workshops, three years ago PSEP staff extended them to tribal health care providers and others who work with Native American farming communities along the California-Arizona border. In collaboration with Arizona state agencies, PSEP now conducts workshops in Yuma and Phoenix.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 3.02 Human Health

Title: VALIDATION AND APPLICATION OF HOLOTRANSCOBALAMIN II AS A NEW MEASURE OF VITAMIN B-12 ABSORPTION

Description: The objectives are : 1) To optimize the test conditions for a new assay based on changes in plasma holotranscobalamin II (holoTC II) as measure of vitamin B-12 absorption; 2) to validate the new assay by comparison with the traditional Schillings test, in individuals suspected of having or know to have B-12 malabsorption; 3) to apply the new test to assess vitamin B-12 absorption in patients with clinical conditions that increase risk of vitamin B-12 malabsorption; 4) to apply the test in adults in Mexico and children in Guatemala in order to determine if those with deficient vs. normal B-12 concentrations absorb vitamin B-12 more poorly, and whether antibiotic treatment improves B-12 absorption. The UC researchers detected a high prevalence of vitamin B-12 deficiency in US elderly (22%), and in all age groups in developing countries (usually 40%). The cause of deficiency may often be malabsorption of the vitamin from food, due to impaired gastric function. To test this concept, they developed a new method of detecting vitamin B-12 malabsorption for use in field studies, based on change in plasma holotranscobalamin II after an oral dose of vitamin B-12. The Hatch funds are being used to apply the test on B-12 deficient individuals in California, Guatemala and Mexico. In Guatemala low plasma holoTC II occurred in vitamin B-12 deficiency but was not a more sensitive predictor of deficiency than plasma methylmalonic acid. In Californian elderly, those with both low plasma B-12 and low holoTC II had the highest plasma homocysteine concentrations, suggesting the combined measures predict B-12 status better than plasma B-12 alone. In 2003 they received a new grant from UC Mexus to measure holoTC II in adults. They will measure predictors of vitamin B-12 and holoTC II concentrations in plasma (including diet, holoTC genotype, and Helicobacter pylori) and response to elimination of Helicobacter.

Impact: This research will greatly improve detection of vitamin B-12 malabsorption in population groups who suffer from this condition. B-12 deficiency can have permanent adverse effects on cognitive function, and millions of people could benefit from early detection and effective interventions to prevent malabsorption of the vitamin. Plasma B-12 plus holoTC II may be a better measure of B-12 status than B-12 alone.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 3.03 Human Nutrition

Title: 35 YEARS OF NUTRITION EDUCATION HELPS LOW INCOME FAMILIES MAKE GOOD FOOD CHOICES

Description: Families with limited incomes want to feed their members well but often don't have the information to make good food choices. Their neighborhoods typically have fewer supermarkets and more than the average number of fast food outlets. Chronic disease and obesity rates tend to be higher for these people. Eating a well-balanced diet can reduce the risk of chronic disease and help maintain a healthy weight. For 35 years, the Contra Costa County Expanded Food and Nutrition Education Program (EFNEP) has been providing sound and

practical nutrition education to low income families. They reach program participants in pregnant and parenting teen programs, in parent groups, and in families making transitions such as English as Second Language, day care provider training, families in transitional housing and drug rehabilitation programs. The EFNEP instructors speak Spanish and work with interpreters to meet the other language needs of the county's diverse population. The EFNEP program is sensitive to cultural food patterns, promotes traditional healthy food ways and helps families cope with influences in their food environments. They teach nutrition for infancy through adulthood, food safety, food preparation and food shopping principles. They also refer families to other health and food resources in their neighborhood to make sure there's enough food in the house.

Impact: In fiscal year 2002 - 2003, Contra Costa's part time (70%) nutrition instructor enrolled 294 participants representing 1,699 family members. According to EFNEP evaluations before and after the teaching:

--87% of participants improved their diets.

--78% showed improvement in one or more food resource management practices (plans meals, compares food prices, doesn't run out of food by the end of the month, uses grocery lists).

--82% showed improvement in one or more nutrition practices (chooses health foods, plans meals, prepares foods without adding salt, reads nutrition labels, makes sure children eat breakfast.)

--65% showed improvement in one or more food safety practices (thawing foods and storing foods properly.)

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 3.03 Human Nutrition

Title: A NUTRITION EDUCATION PROGRAM THAT HELPS FAMILIES MAKE HEALTHFUL CHOICES

Description: People who are most "food insecure"--those unable to use traditional means for acquiring and managing their family food supply--are at greater risk for obesity and poor health. That fact, confirmed by a recent UC study, is one reason that poor health is more common among low-income and minority populations. Obesity is not just a matter of personal health. It is a costly and deadly public health concern that affects economic productivity and state budgets as well as personal and family well-being. For more than 30 years UCCE's federally-funded Expanded Food and Nutrition Education Program (EFNEP), has helped California youth and families with young children develop healthy eating and lifestyle practices. This unique program delivers research-based education in classroom and community group settings to help Californians with limited resources make better nutrition and health decisions. EFNEP currently operates its adult program in 17 California counties and its youth program in 10. Paraprofessionals and volunteers, many of whom are members of the target population, deliver

EFNEP as a series of group lessons. EFNEP youth programs are presented at schools, after-school care sites and community centers.

Impact: During 2001-2002, EFNEP reached 49,191 people through the adult program and 36,717 youths. A post-survey showed improvements in food management, diet and safety:

75% of participating adults improved in one or more methods of food management (plans meals, compares prices, does not run out of food).

82% improved in one or more nutrition practices (makes healthy food choices, reads nutrition labels, has children eat breakfast).

59% of improved in one or more food safety practices such as thawing and storing food properly.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 3.03 Human Nutrition

Title: ADULT FOOD STAMP NUTRITION EDUCATION PROGRAM (FSNEP)

Description: The Food Stamp Nutrition Education Program (FSNEP) is the largest of the federal safety net programs and first line defenses against hunger. Unfortunately, not all who are eligible and can benefit from this program are enrolled. Additionally, even with financial assistance, many families are unable to effectively use this resource to provide healthy diets for their families. In Placer County in 1997, there were 17,812 low-income residents. Of these, 7,412 received Temporary Assistance for Needy Families (TANF) assistance and 9,173 received food stamp assistance. UCCE's Adult Food Stamp Nutrition Education Program (FSNEP) educates these consumers on healthy food choices, wise food purchasing, and safe and proper food handling and preparation. Programs are delivered through educational classes, mini-workshops and correspondence courses. A monthly newsletter, Foodlines, is delivered with the food stamps to each Placer County food stamp recipient. A Foodlines for Professionals newsletter is distributed monthly to agencies and organizations that work with food stamp-eligible families and individuals. Over 1,700 individuals received the Adult Food Stamp Nutrition Education Program (FSNEP) over the past three years. A total of 82,800 Foodlines newsletters were distributed to food stamp recipients. Strong relationships were established with other agencies in support of these nutrition education efforts. One television segment was presented on 'Good Day Sacramento.'

Impact: Low income families have improved their diets, increased the variety of food choices, improved their food preparation, budgeting, and meal planning skills and improved their knowledge of safe food handling practices. Success in this program has contributed to funding for two other Placer County Nutrition Education projects that serve families with children 0-5 years of age.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 3.03 Human Nutrition

Title: BIOANALYTICAL INVESTIGATIONS RELATING DIETARY CONSTITUENTS TO THE DEVELOPMENT AND PREVENTION OF DISEASE

Description: Objectives are to: 1. Identify specific dietary constituents (e.g. flavonoids) that display the greatest ability to enhance the expression of individual GST isozymes in tissues. 2. Determine time-course, dose-response and any gender-related effects associated with the dietary intake of specific flavonoids. 3. Determine in vivo if induction of GST isozymes by specific dietary constituents can provide protection against experimentally induced lipid peroxidation. 4. Expand upon the LC/MS methodology used to characterize additional metabolic proteins that may be affected by dietary constituents. 5. Improve and expand the LC/MS methodology toward characterizing protein-electrophile adducts formed in vivo upon lipid peroxidation. 6. Continue to improve the analytical methodology used for the purification and quantification of specific dietary constituents in foods, especially in terms of those possessing pharmacological properties. 7. Determine how processing, storage and various cultivars affect flavonoid profiles in foods. The primary goals of this project are (1) to establish relationships between the consumption of specific phytochemicals and whole foods and the induction of key detoxification enzymes (glutathione S-transferases; GSTs), and (2) assessing the impact of agronomic and physical processes on the phytonutrient composition of foods in order to ensure quality and develop an analytical foundation for personalized diets and intelligent nutrition. The following is a list of key results from the UC efforts over the past year: 1. Demonstrated that farming practices impact levels of total phenolic and vitamin C in Marionberries, strawberries and corn. These studies demonstrate a trend of statistically higher levels of total phenolics in foods grown by sustainable than by organic than by conventional farming practices [Asami et al. 2002; Mitchell and Barrett, 2003, in press]. 2. Characterized procyanidin oligomers through heptamer in clingstone peaches and demonstrated that thermal processing can alter the distribution of oligomers [Hong et al. unpublished]. 3. Development of a robust and sensitive LC/MS method employing SIM for the quantification of GSTs directly in tissue homogentates [Burns et al. unpublished]. 4. Identified and nearly isolated a novel GST enzyme (mGSTO) in liver and demonstrated that mGSTO is inducible by dietary flavones.

Impact: Optimizing diet and the quality of fresh and processed foods is key for ensuring the health of Californians. Assessing the impact of agronomic and physical processes on phytonutrient composition of foods provides mechanisms for optimizing nutrition. Investigating the influence of diet on detoxification pathways provides information for assessing how diet alters mechanisms that modulate disease.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 3.03 Human Nutrition

Title: BIOAVAILABILITY OF VITAMIN A AND ZINC FROM SELECTED FOODS OF POTENTIAL USE FOR INTERVENTION PROGRAMS IN POPLUATIONS AT HIGH RISK OF DEFICIENCY

Description: Objectives are: 1. To assess the bioavailability of vitamin A from selected plant sources in Bangladeshi volunteers, using the paired deuterated retinol dilution technique; and to assess the validity of a simplified technique to estimate vitamin A bioavailability, using plasma isotopic ratios of retinol within 1-3 weeks of initiating consumption of a single major source of the vitamin. 2. To assess the efficacy of local plant or animal sources of vitamin A or vitamin A-fortified rice in the treatment of maternal night blindness during pregnancy in Nepalese women. 3. To assess in adult volunteers the absorption of zinc from wheat products fortified with either zinc sulfate or zinc oxide. 4. To assess in Peruvian children at risk of zinc deficiency the net absorption of zinc and iron from wheat products fortified with iron and different levels of zinc. During the past year, several studies were completed on: 1) the kinetics of equilibration of an oral dose of a vitamin A tracer (tetra-deuterated retinol) administered to young children, 2) assessment of zinc status, using dietary and biochemical techniques, and 3) absorption of zinc fortificants added to food. The vitamin A studies extend the earlier work in adults, in which they validated the use of the deuterated retinol dilution (DRD) test to assess total body vitamin A reserves quantitatively. The DRD test requires an assumption of equilibration of the labeled oral dose with pre-existing body reserves, so preliminary studies were completed to determine the kinetics of this equilibration process by collecting multiple blood samples from adult volunteers. Because they are not able to collect frequent blood samples from young children, they examined "population equilibration" by measuring plasma isotopic ratios in groups of children who were examined on one or two occasions at different intervals following consumption of the oral dose of labeled retinol. One of the studies of assessment of zinc status examined current zinc intakes (1994-98) by a representative sample of US children in relation to the recently revised Dietary Reference Intakes. Almost all children were consuming usual zinc intakes greater than the current RDA and high percentages (51-92% of children <4 yrs of age) were consuming levels greater than the safe upper limit. A significant increase in zinc intakes during the period of study was attributable to increased consumption of zinc-fortified foods. Another study relevant to assessment of zinc status reexamined NHANES serum zinc data to establish appropriate statistical cutoffs (based on the 2.5th percentile) for defining adequate serum zinc concentration. The results indicated that appropriate cutoffs should be specific for males and females, age group, time of day of blood sampling, and fasting status. Radio-labeled tracer studies (using whole-body counting) were completed in adult volunteers to assess zinc absorption from higher and lower phytate-containing wheat products fortified with either zinc sulfate or zinc oxide. As expected, fractional absorption was less with higher phytate diets. However, there were no significant differences in absorption in relation to the chemical form of the fortificant.

Impact: Results of the vitamin A studies can be used to develop guidelines for implementing a novel test (the deuterated retinol dilution test) to assess the amount of vitamin A stored in the body. The analyses of dietary intake indicate that US children consume adequate amounts of zinc; but considerable numbers of younger children consume more than the safe upper limit, and consumption of zinc from fortified foods is increasing. The cutoffs established by re-analysis of data on serum zinc concentrations can be applied to assess zinc status. The zinc absorption studies indicate that either of the zinc salts assessed can be used to fortify wheat products.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 3.03 Human Nutrition

Title: BIOLOGICAL ACTIVITY OF RECOMBINANT HUMAN MILK PROTEINS

Description: Recombinant human milk proteins are being expressed in plants and animals. These proteins may subsequently be added to infant diets. The objectives of this project are to study the biological activity of different recombinant human milk proteins. The iron-binding protein lactoferrin was chosen as a model protein, partly because it is a protein with several physiological functions, partly because the recombinant protein is produced in Aspergillus and rice and is available in significant quantities. Antibacterial activity of lactoferrin in different forms together with cell and receptor-binding assays will be used to evaluate stability against digestion (proteolytic enzymes), and effects of different glycosylation. Bovine lactoferrin will be used as a comparison. Other recombinant human milk proteins, such as lysozyme, haptocorrin, lactadherin and lactoperoxidase will also be evaluated. Recombinant human milk proteins are being produced in the milk of transgenic animals and in plants. These proteins may subsequently be added to infant diets. The objectives of this project are to study: 1) the effect of different heat treatments necessary for manufacturing infant diets, and 2) the effects of low pH and proteolytic enzymes on the stability and physiological activity of recombinant milk proteins. The iron-binding protein lactoferrin, the enzyme lysozyme and the protease inhibitor alpha-1-antitrypsin (AAT) were chosen as model proteins, partly because they provide physiological functions, partly because the recombinant proteins are available in significant quantities. They are now also producing haptocorrin and lactoperoxidase, two other human milk proteins, in rice. Recombinant human lactoferrin (Lf), lysozyme (Lys) and AAT were subjected to different heat treatments, pH and proteolytic enzymes in solution and as a component in infant formula. The treated proteins were evaluated with regard to receptor-binding using human cells (Lf), their ability to inhibit the growth of pathogenic bacteria (Lf, Lys), and the ability to inhibit proteases (AAT). The stability of recombinant human milk Lf, Lys, and AAT expressed in, and purified from rice was studied in vitro and shown to exhibit similar characteristics to those of the native proteins. Recombinant and native Lf, Lys and AAT were exposed to different temperatures, pH and digestive conditions mimicking those of the infant's gut and their activities were investigated after these treatments. The ability of recombinant AAT to inhibit trypsin activity was similar to that of native AAT and it is thus possible that recombinant AAT added to infant formula may have a function similar to that of human milk AAT. Lf and Lys also resisted heat treatment, low pH and proteolytic enzymes and both proteins were able to inhibit the growth of enteropathogenic E. coli (EPEC) in vitro. AAT may limit proteolytic activity in the infant gut and thereby protect other bioactive proteins from being digested prior to exerting their activity. Lf and Lys maintained their iron-binding and enzymatic properties to an extent similar to the native molecules. Thus, these recombinant human milk proteins are active and may remain so in the infant gut. Haptocorrin and lactoperoxidase, two additional anti-infective proteins in breast milk, which kill bacteria by other mechanisms, are now also expressed in rice at high levels. The biological activity and stability of these proteins will be evaluated.

Impact: Recombinant human milk proteins can now be produced in rice in large quantities. Proteins with biological function, such as Lf, Lys, alpha-1-antitrypsin, haptocorrin and lactoperoxidase may therefore be added to infant formula. The researchers have already successfully produced recombinant human lactoferrin, lysozyme, AAT, haptocorrin and lactoperoxidase, which are present in breast milk, at high levels in rice. Addition of recombinant lactoferrin, lysozyme, haptocorrin and lactoperoxidase may protect the infant against infection, and AAT may act as a "biological guard" to assure bioactivity of these proteins in the small intestine. Thus, a novel anti-infective formula may be developed that can protect formula-fed infants against infections. This may have significant health consequences in both less developed and industrialized countries.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 3.03 Human Nutrition

Title: CALIFORNIA BONE HEALTH CAMPAIGN

Description: Osteoporosis is a serious calcium-loss disease that thins the bones and makes them brittle and very vulnerable to breaking. However, it is a disease that can be slowed down, or prevented. One in two women, and one in eight men over age 50 will have an osteoporosis-related fracture in their lifetime. Simple falls for people with osteoporosis can lead to hip, spine and wrist fractures and up to 20% of those with hip fractures die within a year of their injury. One in six Latino women already has osteoporosis. Interactive, hand-on nutrition and health education are essential tools to serve our community in the battle against osteoporosis. Fresno County's Project LEAN offers a series of four classes to low-income Latino women, ages 18-55, living in six Fresno zip code areas. Huesos Fuertes, Familia Saludable asks Latinos over two years one drink an extra cup of 1% milk every day to increase their calcium consumption. The program also teaches about other sources of calcium and bone-strengthening exercises. During this year, ten food demonstrations at five neighborhood grocery stores were conducted. The very popular "strawberry smoothie" recipe using fresh fruit and 1% milk was demonstrated. Brochures with 1% milk recipes were handed out in Spanish and English. The message is: Adequate calcium consumption and exercise are the keys to preventing osteoporosis.

Impact: Between January and April 2004, the program reached over 6,000 individuals at community events such as health fairs and parent fairs at schools. An additional 200 women are scheduled to participate in the bone health classes. Pre- and post-class surveys from previous years indicate a significant change in knowledge about sources of calcium and the importance of regular physical activity to bone health. Milk sales data documented their self-reported increased consumption of 1% milk. This program will continue in 2005 and expand at additional zip codes in Fresno. Fresno County Cooperative Extension hires Community Health Program Representatives, "Promotoras," from within the communities they serve. Cooperative Extension offers employment opportunities and opportunities to grow in the respected role of teacher and advocate "Promotora" in the community.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 3.03 Human Nutrition

Title: EMPOWERING FOOD STAMP RECIPIENTS FOR A BETTER FUTURE

Description: The first goal of the Food Stamp's Nutrition Education Program (FSNEP) is to empower families and individuals to help themselves. FSNEP offers food stamp recipients and applicants the "tools" to make positive changes in their lives. These tools range from motivating recipients to eat healthier diets to teaching families how to cook in order to prepare better foods at lower costs; teaching life skills that enable recipients to get and keep a job; teaching basic survival skills such as how to get out of debt, how to shop to save money, how to use community resources; introducing food safety skills to reduce food borne illness; and helping children learn better eating habits and the importance of physical activity. FSNEP is administered by the University of California, Davis, and is funded through an interagency agreement with the California Department of Social Services (CDSS) and the U.S. Department of Agriculture (USDA). FSNEP funding began in 1994 with a $750,000 budget allocated to 17 California counties. Its budget has grown to $8.8 million dollars and operates in 42 California counties, serving approximately 79,124 Food Stamp recipients. Adult FSNEP delivers nutrition education programs directly to food stamp families and individuals through a variety of activities. FSNEP staff are hired and trained by university academics to deliver up-to-date university and USDA publications focusing on economical food shopping, low-cost and safe cooking practices, financial management, parenting and other life skills. Youth FSNEP operates out of school districts that offer free and reduced-price lunches. University staff train teachers to deliver the nutrition education to grades kindergarten through high school.

Impact: An important component of FSNEP is evaluation. Each year, program activities are evaluated and results are analyzed to determine ways to improve both program delivery and impact. Major improvements have been documented in dietary change (increasing fruit and vegetable consumption, decreasing foods high in fat and sugar, and reducing the number of times families eat at fast food restaurants); self-sufficiency changes (reducing money spent on food while, at the same time, increasing the diet's nutritional content; increasing skills in shopping and food preparation practices) and decreasing food-related illness in both adults and children. Empowering food stamp individuals and families requires the development of partnerships with other agencies. FSNEP has worked with over 179 different community groups and agencies throughout California.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 3.03 Human Nutrition

Title: FOODS FOR MAINTAINING HEALTH

Description: Objectives are: To determine the ability of food and food components or properties to stimulate the biological mediators of satiety and the correlation with subjective indicators of satiety and satiation in humans and to evaluate how food properties associated with satiety can be used in behavior modification programs. The UC researchers have demonstrated that in women increasing the fat or fiber content of a test meal results in greater feelings of satiety. Fiber also prolongs the time that it takes for subjective assessment of satiety to return to baseline, fasting conditions. Subjective measures of satiety were shown to be correlated with release of cholecystokinin (CCK). These results suggest that CCK is a useful biomarker of foods that can enhance satiety, independent of subjective measures. In men subjective satiety is correlated with CCK response; however, satiety is less sensitive to variations in the macronutrient composition of the test meal. In this study they also demonstrated that the addition of fiber to a test meal would reduce insulin response similar to the effect of lowering the carbohydrate content of the meal and that fiber delays the increase in plasma triglyceride postprandially. They are currently examining the impact that fat that is intrinsic to food structure compared to added fats will have on subjective and biochemical assessment of satiety. In another study they demonstrated that both whole almonds and almond oil lower plasma and LDL cholesterol in human subjects. These results suggest that the lipid fraction of almonds is essential for its cholesterol lowering effect. They also observed that consumption of almond products increased HDL cholesterol and lowered plasma triglycerides.

Impact: The results demonstrate that diets low to moderate in fat content will be more satiating if they are high in fiber content, which is useful information for individuals modifying dietary habits to lower risk for chronic disease. Additionally the results suggest that CCK can be developed as a biomarker for satiety for use in the study of food intake regulation and its relationship to obesity.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 3.03 Human Nutrition

Title: OBESE FEMALE RESTRAINED EATERS: TWO TREATMENT OPTIONS

Description: The specific aim is to improve the psychological health and well-being of obese female restrained eaters through a non-restrictive ("non-diet") approach. This non-diet approach will emphasize eating in response to physiological cues (i.e., using hunger and satiety as regulators of food intake) and enhancing body acceptance. The non-diet approach will be compared to a standard behavioral obesity treatment program (control group) that emphasizes reducing energy intake and weight loss. (Both treatments will additionally encourage improving dietary quality and increasing physical activity.) The UC researchers hypothesize that on a long term basis (12 months, 18 months), improvements in self-esteem, depression, body image and more general psychological characteristics will be greater in the non-diet group compared to the weight loss group. These results are anticipated because restrained eaters are unlikely to maintain the weight loss (45), and previous studies suggest that improvements in individuals participating in traditional weight loss programs are predicated upon lost weight (95). Additionally, the non-diet group will be receiving treatment directly aimed at enhancing psychological well-being,

independent of attempts at weight loss. In contrast, they anticipate that early in treatment (3 months), improvements will be greater in the weight loss group compared to the non-diet group. They anticipate these early treatment results because participants in weight loss groups typically lose weight early in treatment, which is associated with increased psychological health and well-being. They do not anticipate that non-diet participants will lose as much weight, as they will be instructed not to actively restrict intake. At the same time, they plan to monitor metabolic fitness in both treatment groups. This will help to provide information about changes in risk factors such as blood pressure, lipoproteins (total cholesterol, very low density lipoprotein-triglycerides, low density lipoprotein cholesterol, high density lipoprotein cholesterol), markers of insulin sensitivity (glucose, insulin, hemoglobin A1C), percent body fat and intraabdominal fat. Finally, they will collect information about physical activity (amount of physical activity, resting heart rate, and indirect measures of daily metabolic rate) and eating behavior (quality of diet and degree of restrictive eating, leptin levels). A two year follow-up was conducted and analyzed. Results showed that cognitive restraint increased in the Diet Group and decreased in the HAES Group, indicating that both groups implemented their programs. Attrition was high in the Diet Group (41%), compared to 8% in the Non-Diet Group. The Diet Group showed initial improvement in many variables, including weight, low-density lipoprotein, systolic blood pressure, energy expenditure, Hunger, Disinhibition, Bulimia, Body Dissatisfaction, Interoceptive Awareness (markers for eating disorders), depression and self-esteem, although only the improvement in Disinhibition was sustained at two year follow-up. The HAES group, on the other hand, improved in all of the above variables except weight, which exhibited no change, and sustained these improvements at two years.

Impact: Increasingly more of us are trying to lose weight. Indeed, many women, regardless of their size, experience a life-long battle and preoccupation with their weight. Despite the attention to weight and the increase in diet behavior, the incidence of obesity continues to rise. There is little data to show improved long term success for the majority of participants who engage in weight loss behaviors. This study documented that HAES, an alternative approach to obesity treatment, enabled participants to maintain long-term behavior and health change, while the Diet approach did not. It provides evidence that encouraging size acceptance, a reduction in dieting, and a heightened awareness of and response to body signals is effective in supporting improved health for obese women.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 3.03 Human Nutrition

Title: PARENT AND HOUSEHOLD INFLUENCES ON CALCIUM INTAKE AMONG PREADOLESCENTS

Description: Objectives are to: 1. Identify factors (knowledge, attitudes, behavior and environment) associated with total calcium intake among the parents of preadolescent children using qualitative methods. 2. Identify parental factors (knowledge, attitudes, behavior and environment) related to total calcium intake of their preadolescent children using qualitative methods. 3. Quantify the salient parental and preadolescent factors (attitudes, knowledge,

behaviors, and environment) that predict total calcium intake of the preadolescent using quantitative methods. 4. Develop and test potential messages and dietary strategies among parents and preadolescents based on the salient factors related to preadolescent calcium intake. Osteoporosis is the most readily identifiable health issue associated with inadequate calcium intake. Obtaining sufficient calcium during adolescence helps ensure adequate mineralization of the skeleton to ensure bone health later in life. Results from a previous multistate project highlighted that familial factors play an important role in the calcium intake of youth; however, little information is known about these factors. Therefore, this multistate project (13 states) is actively examining the influence of parental factors (knowledge, attitudes, behaviors) and the environment on calcium intake of children in early adolescence (11-14 years old) from cultural/ethnic groups most at risk for osteoporosis. This review period focuses on identifying factors associated with total calcium intake among the parents of preadolescent children using qualitative methods and identifying those parental factors that contribute to the child's intake. During this period the researcher served as chair of the regional research group, helping direct the project activity as a whole. Specific accomplishments include working with scientists from other states to develop a semi-qualitative questionnaire on parent's attitudes towards supplements and use of fortified foods and reviewing the development of a parent interview regarding knowledge of calcium's nutritional role, source of calcium rich foods, and family meal patterns. A UC researcher trained a graduate student to conduct parent interviews, identified methods to reach target parents in California, and supervised a graduate student's completion of 7 Hispanic and 2 Asian parent interviews. They are currently identifying parents for 7 additional interviews.

Impact: The results of this project will be used to identify factors that influence the calcium intake of young adolescents. This information can be used in designing effective, tailored nutrition interventions for young adolescents and their parents. An improvement in calcium intake among young adolescents may reduce the future burden of osteoporosis.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AL, AZ, CA, CO, HI, IN, MI, MN, NNM, OR, WA, WY

Theme: 3.03 Human Nutrition

Title: PREVENTING CHILDHOOD OBESITY, 2003-PRESENT

Description: Being overweight is the most common health problem facing US children and it is reaching epidemic proportions. Childhood obesity has more than tripled in the last 30 years for children 6-11 years of age. Today, more than 15% of 6-11 year old children are overweight. One factor is the foods that children are eating-or not eating. Approximately 70% of US children still exceed the dietary recommendations for total and saturated fats, while 91% of these children are not consuming the recommended minimum 5 servings of fruits and vegetables daily, instead averaging only 2.5 servings daily. The other major contributing factor to the rising obesity rate is the lack of physical exercise. Forty-eight percent of girls and 26% of boys do not exercise vigorously on a regular basis. Additionally, the 2002-2003 California Physical Fitness State Report reveals that less than 75% of 5th grade children meet the six fitness standards. This situation is likely to deteriorate as school districts lose resources and are forced to reduce PE, thus making family involvement in their children's fitness programs all the more vital. Fifteen

key informant and focus group interviews were conducted with local health and child development professionals, lower-income parents, and lower-income children (ages 6-8 years) to determine lower-income children's snacking and activity habits, and how to design a program to help prevent obesity for 6-8 year old children. A total of 13 professionals participated in key informant interviews, and 14 parents and 18 children participated in focus group interviews. Based on the information received from the surveys, a 6-week English/Spanish, family focused, interactive program was developed and presented at two locations in San Luis Obispo County. The program teamed a child with a significant adult in his/her life. The educational messages focused on nutrition knowledge of popular snack foods, healthy and easy-to prepare snacks, and fun physical play. The program was evaluated for knowledge gain and changes in snacking and physical activity.

Impact: Twenty two children and adults from Oceano and Paso Robles participated in the two 6-week pilot tests. Pre/post knowledge gain showed a 20 percentage point improvement (pre=55%; post=75%). Ninety-five percent of participants reported at least one positive behavior change, including reducing the consumption of sodas, sport drinks, and fruit drinks as snacks; increasing the consumption of water as snacks; and increasing physical activity. FSNEP awarded a second grant to modify the curriculum based on evaluation data and present the program again.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 3.03 Human Nutrition

Title: PROJECT LEAN (LEADERS ENCOURAGING ACTIVITY & NUTRITION)

Description: Healthy eating and regular physical activity have a positive impact on some of the most important factors of teen life: learning, feeling and looking good, energy level and motivation, and the risk of chronic diseases like obesity, heart disease and diabetes. At a time in their life when teens begin making independent choices about what they eat and how active they are, they may have limited opportunities to choose healthy food and engage in physical activity. This is particularly true in their school environment. Project LEAN trains teen advocates for healthy school policies about food and physical activity choices. With school and community partners, the teen advocates have conducted school assessments and worked toward policy changes. They work with student groups in several Central Valley communities, including Firebaugh, Fresno, and Mendota in Fresno County, and Woodlake and Farmersville in Tulare County. The districts' student enrollment range from 2,500 to 70,000. The Project LEAN staff is also working with a community coalition to support the work of a local school district to adopt a district-wide Healthy School Environment policy. The goal of this policy is to enhance a school's learning environment by providing access to good food options, physical activity, and nutrition education for lifelong health.

Impact: The significant Project LEAN successes include: school food policy change from 1% milk in three school districts, fresh salads and salad bars added to student cafeteria options in two districts; additional water and juice options available in soda machines in two districts. Successes in Woodlake Unified School District (WUSD) include: a 1% milk vending machine

placed on Woodlake High School's campus, carrying flavored and non-flavored milk. (The profits from the sale of milk belong to the Future Farmers of America chapter on campus.) During the 2003-2004 school year, Woodlake Unified School District applied for and received a universal "Breakfast in the Classroom" grant that feeds breakfast to all students from kindergarten through 5th grade. In addition, WUSD Food Service has introduced a "100% Fruit Smoothie" to the snack bar (seasonal), and no longer purchases candy for sale on campuses district wide as of February, 2004.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 3.03 Human Nutrition

Title: TEACHING CHILDREN HEALTHY FOOD HABITS THROUGH PARENTAL EDUCATION

Description: Childhood obesity is increasing and has been declared a national epidemic. Obesity in children is a critical health risk since it can lead to increased risk of diabetes and other chronic diseases later in life. In Riverside County, the percent of overweight children 0-12 years among low-income families is 14.6%, which is higher than both the national (11%) and the state (14.4%) averages. Teaching children to lead an active and healthy lifestyle could help reverse the trend in childhood obesity. Since young children learn by modeling their parents, the teaching must begin at home. Low-income families often lack access to preventive health and nutrition information. Therefore, helping low-income parents understand the relationship between diet, exercise and health, and learn how to make healthy food choices for the family is the first step in helping their children form healthy habits for life. The Expanded Food and Nutrition Education Program (EFNEP) brought comprehensive nutrition education to over 650 low-income families with young children in Riverside County last year. This was truly a cooperative effort among various ANR academics and program staff, and requires strong partnership with local agencies. In Riverside County, EFNEP classes are delivered through collaboration with over 30 agencies and organizations including Head Start, Even Start, Healthy Start and other parent participation programs sponsored by Riverside County Office of Education. Cooperative Extension (CE) specialists at UC Berkeley and UC Davis are responsible for developing and updating a core curriculum for EFNEP based on current nutrition research. The CE advisor and program staff in Riverside County teach the curriculum to low-income families with young children in the county. Local agencies and non-profit organizations that serve low-income families with young children are our partners in helping to recruit EFNEP participants and providing sites for EFNEP classes.

Impact: During FY 2001-2002, 667 low-income families completed the required six hours of nutrition lessons and graduated from EFNEP. Among graduates, 77% showed improvement in one or more food resource management practices (more often planned meals in advance, compared prices when shopping, used a list for grocery shopping, less often ran out of food before the end of the month), and 84% showed improvement in one or more nutrition practices (more often used "Nutrition Facts" on food labels, prepared foods without adding salt,

considered healthy food choices when deciding what to feed their family). About 30% of EFNEP participants reported that their children ate breakfast more often.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 3.03 Human Nutrition

Title: THE IMPACT OF ELIMINATING SODAS IN THE SCHOOL ENVIRONMENT ON THE CALORIE AND CALCIUM INTAKE OF ADOLESCENTS

Description: The objective of this study is to provide evidence-based data regarding the relationship between the sale of sodas in California high schools and the dietary intake and health of students. This study will focus on the impact of soda consumption on calories and calcium intake, with availability of sodas in the school environment as the independent variable. The sales of diet versus sweetened sodas in the school environment will be monitored, and compared to the daily consumption of all types of sweetened and/or diet beverages from all sources, including those not purchased on the school campus. Five high schools that are planning to eliminate sodas in the fall of 2005 will be assigned to the treatment group in a non-random manner. One of the practical reasons that schools willing to participate in the study cannot be randomly assigned is the dependence on soda sales as a critical source of revenue. Based on interviews with representative California high school districts, they have determined the feasibility of successfully recruiting five schools that plan to establish policies restricting beverages. Five control high schools will be randomly selected and matched based on the students demographic profile. If a positive relationship is found between soda availability in schools and calcium and/or calorie intake, this will provide evidence that limiting sodas in the school environment is a positive policy to address concerns regarding high calorie and low calcium intake in adolescents. If no effect is found, for calories or calcium intake, it will suggest that other interventions and school nutrition policies, such as nutrition education programs, may be a more effective focus. The bone density measurements will determine if a relationship can be shown between bone density and calcium intake in this time period for this age group. In addition, if soda machines negatively impact bone density and calcium intake, this will provide evidence-based information for setting public health policy. The objectives of the study were to 1) to assess iron status in a representative sample of children from low-income families, aged 12-36 months, 2) to examine the association of several risk factors with iron status in this group of children, and 3) as a long-term goal, the development of a comprehensive nutrition education program to reduce the risk of iron deficiency. Recruitment took place at the Contra Costa Public Health WIC Program in Richmond, Contra Costa County and the WIC clinic in Earlimart, Tulare County. To be included in the data analysis, the subjects mother must have completed the risk factor questionnaire and a venous blood draw obtained from the child. Blood samples used in the analysis included only those without evidence of hemolysis or elevated C-reactive protein. Data from Contra Costa County has been entered into the statistical program, SPSS and initial analysis has been conducted. Data from Tulare County is in the process of being entered into SPSS. In Contra Costa County, Hispanics comprised the highest proportion of subjects, followed by African Americans, Mixed Ethnicities, Asians, Native Americans and Non-Hispanic whites, and others. Approximately 34% of the sample had a family income less than $14,999. To be included

in the data analysis, the subject's mother must have completed the risk factor questionnaire and a venous blood draw obtained from the child. Furthermore, the subject must not have elevated C-reactive protein or have evidence of hemolysis. Of the 183 children with completed surveys and blood draws from Contra Costa County, a total of 151 subjects were analyzed. Of the 240 completed blood draws in Tulare County, 198 subjects had completed blood draws. Change-point modeling determined the cut-off values for serum ferritin 8.7 mg/L, transferrin receptor 10.0 mg/mL, and transferrin saturation 13.2%. There was an 11.1% prevalence of anemia among all children; no differences were observed between males and females. Preliminary bivariate analysis shows associations between low-and adequate-iron stores, and between iron-sufficient and iron-deficient children. The percentage of iron sufficient and iron deficient subjects who utilized several food assistance programs was similar except for the use of Food Stamps; 24.8% of the iron sufficient subjects utilized foods stamps compared to only 9.4% of the iron deficient subjects. Maternal anemia was associated with iron deficiency in the child as 38% of the mothers of children with iron deficiency were diagnosed with anemia during their pregnancy compared to 21% of the mothers of children who were iron sufficient. Current bottle feeding practices were associated with iron deficiency, with approximately 85% of the iron deficient children compared to 50% of the iron sufficient children currently using a bottle. Similar, to what they observed with maternal anemia, 38% of the children with iron deficiency compared to 18% of the children who were iron sufficient had been previously diagnosed with anemia. In summary, results to date demonstrate a prevalence of anemia of 11.1%, iron deficiency of 16.4% and iron deficiency anemia of 3.4%.

Impact: Efforts should be made to provide information to this target population regarding the potential positive health implications of participation in the food stamp program. A greater emphasis must be made to educate women about the need for optimal iron intake during their pregnancy. Appreciation of the health significance and causes of iron deficiency and iron deficiency anemia by members of the medical community is necessary. These data are being used in an education program provided by 4 California counties.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 3.03 Human Nutrition

Title: VIDEO ZOOMS IN ON IRON DEFICIENCY

Description: Because iron deficiency lowers capacity to work, interferes with cognitive ability and increases the risk of premature or low birth weight babies, it is a serious problem for people of all ages. But in young children, when the brain is still developing, iron deficiency can lead to irreversible impairment of mental capacity. UCCE research in Contra Costa county has shown that 42% of the study sample of 150 one-to-three-year-old children enrolled in the Richmond WIC (Women, Infants and Children Supplemental Food Program) were iron-deficient. (Deficiency is defined as serum ferritin level 12 g/l or less.) While the Richmond study population was 82% Hispanic, iron deficiency is recognized as a widespread problem in all ethnic groups. A Contra Costa County UCCE Nutrition Advisor took the lead in producing a short video: "For Goodness Sake: Prevent Anemia." The video, in English and Spanish, was

designed to inform parents and caregivers about the serious risk of iron deficiency, the importance of being tested, and dietary interventions to prevent iron deficiency. A total of 261 adults from WIC clinics in the county participated in a study to test the video's efficacy. The study population was 56% Hispanic, 21% Black, 18% White, and 5% Asian. In addition, 95 people were tested on the Spanish version.

Impact: The evaluation showed that 69% of the participants showed gains in knowledge about iron deficiency. The average improvement was 20%. Assessment of reactions to the video showed that:

--75% of the respondents liked the video "a lot."

--86% thought it was easy to understand.

--63% indicated that they would try recipes or ideas suggested in the video.

The results indicate that the video "For Goodness Sake: Prevent Anemia" may well motivate families to provide diets higher in iron to prevent iron deficiency. For information on ordering the video, go to http://anrcatalog.ucdavis.edu search for "anemia."

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

NATIONAL GOAL 4

Greater harmony between agriculture and the environment. Enhance the quality of the environment through better understanding of and building on agriculture's and forestry's complex links with soil, water, air, and biotic resources.

Over the past year, UC ANR identified issues that are core to its programs. This process of issue identification strengthened the commitment of UC ANR to National Goal 4 through focused efforts on these Core Issues. The Core Issues pertinent to Goal 4 include Invasive Species, Sustainable Use of Natural Resources, Water Quality, Organic Production, Soil Quality, Waste Management, and Air Quality. ANR has made to commitment to provide additional resources, when available, to target these issues.

This focusing of effort resulted in significant progress by UC ANR in addressing a wide array of key themes within National Goal 4. The vast extent of this research and extension is indicated by the large number of publications produced and local extension programs conducted in this area over the last year. California academics published 405 peer-reviewed articles and 43 extension publications in the areas covered by Goal 4. Over 436 local extension programs were delivered in this area. UC ANR funded 10 statewide collaborative workgroups and 2 continuing conferences comprised of both AES and CE academics that planned and conducted research and extension projects dealing with issues on a county, regional, and statewide basis. In addition, UC ANR has 11 Statewide Special Programs that bring together AES and CE resources and personnel that addressed critical issues in the state that are included within National Goal 4. Three patents were issued to UC researchers addressing this Goal.

FY 2003-2004 Allocated Resources

Extension Federal Funds (Smith Lever 3 b&c)	Extension State Match	Research Federal Funds (Hatch)	Research State Match
$1,799,201	$13,445,700 [106.26 FTE]	$1,524,830	$31,839,918 [110.66 FTE]

Theme: 4.01 Agricultural Waste Management

Title: ANIMAL MANURE AND WASTE UTILIZATION, TREATMENT AND NUISANCE AVOIDANCE FOR A SUSTAINABLE AGRICULTURE

Description: The objective is to develop, evaluate, and refine physical, chemical, and biological treatment processes in engineered and natural systems for management of manures and other wastes. A commercial dairy wastewater management system was evaluated for solids separation and degradation. The characteristics of flush water and collected manure were determined. In addition, the performance of a solid-liquid separator and the impact of low rate aeration in the

lagoons on solids degradation and odor reduction were evaluated. The characteristics of recycled wastewater for flushing was found to be very consistent over a five-month period with the standard deviations of total solids (TS) and volatile solids (VS) being 6.4% and 7.1% of the mean values, respectively. The characteristics of fresh manure collected in the flushing water were less consistent with the standard deviations of TS and VS being 26.2% and 23.6% of the mean values, respectively. Solid removal efficiency of the stationery screen separator was 26.9%, 33.9%, 36.8% and 41.5%, for TS, VS, SS, and VSS, respectively, with the standard deviations being 17.2-25.8% of the mean values. The low rate aeration of the lagoons did result in less solids build-up and reduced the odor threshold by 20 to 40%, but it had an insignificant impact on the existing sludge in the lagoons. More intense aeration is found to be necessary in order to cause significant degradation of solids in the lagoons. An integrated dairy wastewater treatment system was also studied in the laboratory. The system includes anaerobic digester, solid-liquid separator, aeration tank, and hydroponic greenhouse units. Various parameters of each unit operation were studied and an engineering design model for such a system was developed. Research was also conducted on development of an ammonia emission model, which is capable of predicting ammonia emission rates from lagoons in response to different manure characteristics, lagoon management practices, and climatic factors. The model was calibrated and validated using pilot-scale experiments.

Impact: The results of this research led to the development of effective dairy waste treatment and management systems, and air emission prediction tools and air emission mitigation technologies. Integrated animal waste treatment system will allow utilization of dairy manure as resources for energy and fertilizer and remediate environmental pollution problems caused by confined animal feeding operations.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AL, AR, CA, CO, FL, GA, GU, HI, IA, ID, IL, IN, KY, LA, MI, MN, NC, OH, PA, SC, TX, VA, WI

Theme: 4.01 Agricultural Waste Management

Title: CE HELPS TO SOLVE DISPOSAL PROBLEM IN ERADICATING EXOTIC NEWCASTLE DISEASE.

Description: In October 2002, a devastating foreign animal disease was discovered in several small flocks of chickens in Southern California. By December, Exotic Newcastle Disease had spread to large commercial flocks of egg-laying chickens. To eradicate the disease, over 3.5 million chickens had to be euthanized and disposed of. Sending the dead birds to landfills was the safest and most feasible option for disposal. At the time, covering the carcasses with several feet of compacted soil was the only accepted method of disposal. However, not enough soil was available at the landfills to dispose of so many carcasses in that way. Some other method of burial had to be developed. A UCCE poultry farm advisor worked with the Riverside County Waste Management Department and the private company operating the El Sobrante landfill to develop a biosecure and rapid method of covering the carcasses with 12 feet of trash that could be compacted to form a three-foot cover, thus reducing the need for additional soil. Each delivery of carcasses could be completely covered within 10 minutes with an impervious layer of

compacted trash that would prevent access by sea gulls and other scavengers that could spread Exotic Newcastle Disease. A videotape of the disposal procedure was developed and presented to the CDFA and the USDA for their approval of the disposal method. The video was then used as a guide to train other landfill operators in Southern California who received birds from infected flocks. This video has now been widely distributed throughout the United States.

Impact: The disposal method provided an environmentally safe and effective approach to the disposal of infected birds. This method, approved by USDA, enabled landfills to continue receiving carcasses throughout the effort to eradicate Exotic Newcastle Disease in California. This method assisted in reducing the spread of Exotic Newcastle Disease, thus assisting growers, while not filling up landfills unnecessarily.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 4.02 Air Quality

Title: ANR RESEARCH CLARIFIES ROLE OF TREE SPECIES IN AIR POLLUTION

Description: Trees and shrubs help clean the air. They absorb carbon dioxide, release oxygen and provide surfaces for the deposition of airborne particles and unhealthful gases such as ozone. Also, water evaporating from tree leaves cools the air and shade from trees cuts energy consumption, reducing the need for air-polluting energy generation. However, there is another side to the story. Some trees and shrubs emit high rates of certain volatile organic compounds (VOC), which react with nitrogen oxides (NOx) and sunlight to form ozone, a ground-level pollutant. Other plants emit very little VOC. A team of researchers representing UC Cooperative Extension, UCLA and UC Riverside measured isoprene emission rates for more than 60 California trees and shrubs. Although isoprene is not the only compound released by trees, it is often dominant and therefore was selected for the project. Of the species studied, the researchers found that the highest isoprene emitters were certain oak, poplar and eucalyptus species. Plants that emitted very low levels of isoprene included those in the rose family such as almonds and apricots, ash trees, cotton, lilac and euryops daisy. Emissions from trees might be compared to vapors from gasoline spilled at the pump. For example, a medium-sized liquidambar tree on a warm summer day emits about one gram of isoprene per hour. For a very large planting of 10,000 trees, the isoprene emission would be about 10 kilograms per hour, an amount comparable to the evaporative emissions caused by spilling about 12 gallons of gasoline per hour.

Impact: The California Air Resources Board is using the UC study results to develop state implementation plans that strike the proper balance between NOx versus VOC reduction. The research is also a valuable tool for landscape planners, who when selecting trees and shrubs consider a wide variety of characteristics such as size, shape, color, growth rate, etc. Now, the VOC emission rates also can be considered.

Funding Source: Hatch, Smith-Lever, and State

Scope of Impact: State Specific

Theme: 4.02 Air Quality

Title: COST-BENEFIT ANALYSIS OF GASOLINE ADDITIVES & ENVIRONMENTAL EFFECTS

Description: Methyl tertiary butly ether (MTBE) was added to gasoline as an oxygenate to reduce air emissions in the state of California as well as other regions. However, lacking a comprehensive assessment of all impacts to the environment prior to adding MTBE, California is experiencing widespread contamination of groundwater and surface waters as well as formaldehyde air emissions, posing a carcinogenic threat to humans. A cost-benefit analysis was needed to evaluate the gasoline blend with MTBE versus alternatives. Responding to the California State Legislature's request, through Senate Bill 521,a UC Environmental Economist conducted a cost-benefit analysis, along with physical scientists who conducted environmental impact assessments, of fuel blended with MTBE. The analysis was used by the Governor to decide to ban the MTBE additive, phasing it out by 2004.

Impact: The cost-benefit analysis included scientific data generated from physical scientists to which valuation methods could be applied to derive monetary values of costs and benefits of environmental and economic impacts of using different fuel additives. The analysis concluded that there were no significant reductions in air emissions due to MTBE-blended fuel as compared to non-oxygenated alternatives, but that MTBE presented significant public health risks and costs associated with water contamination. The analysis, presented at two public hearings as well as in various written forms, has led to a ban of the MTBE additive.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.02 Air Quality

Title: FORMS OF CARBONIC ANHYDRASE LINKED TO PHOTOSYNTHETIC OXYGEN EVOLUTION

Description: The chemical mechanisms that allow chloroplasts to evolve molecular oxygen, and thus begin the complex process of photosynthesis, remain a mystery. They know that oxygen is evolved from the splitting of water molecules and that the apparatus for carrying out this feat is located in a chlorophyll-protein complex, photosystem II, within chloroplast thylakoid membranes. Certain cofactors are required, among them manganese and calcium cations and chloride and bicarbonate anions. The project is to focus on one of these ions, bicarbonate, as a possible chemical intermediate in oxygen evolution. It has been proposed by several UC investigators that bicarbonate, HCO3-, formed by the hydration of CO2 in solution (CO2 + H2O 'HCO3- + H+) could serve as the form by which water enters the oxygen-evolving reaction. As bicarbonate is decomposed to yield molecular oxygen, another product of the reaction, CO2 is also liberated. The CO2 must then be rehydrated to again form bicarbonate in a cyclic process. One prediction of this theory is that photosystem II and the oxygen-evolving apparatus itself must be able to catalytically hydrate CO2. Otherwise, this reaction would be extremely rate-limiting. The catalytic hydration of CO2 in solution is normally the function of the enzyme

carbonic anhydrase (CA). They have discovered, in support of the idea that bicarbonate may be a chemical intermediate in oxygen evolution, that thylakoid membranes actually contain two sources of CA activity. One source appears to be a 33 kDa protein located in the lumenal space between thylakoid membranes. A second source is closely associated with the oxygen-evolving mechanism within the membrane. The lumenal protein can be removed by washing the membranes with concentrated CaCl2 solution. It has been proposed, based on a similar enzyme found in Chlamydomonas reinhardtii that it functions to supply CO2 to the carbon-fixing enzyme, rubisco. The physiological function of the second source of thylakoid CA activity that remains tightly bound to the photosynthetic membranes is also in question. They believe, however, that this source is most likely the one that supplies bicarbonate to the oxygen-evolving mechanism. The specific objectives of the planned work are several: 1. To characterize separately and in detail the two sources of thylakoid membrane carbonic anhydrase activity. For the lumenal source, they intend to obtain the base sequence for the gene as a first step in genetic manipulation. For the intrinsic carbonic anhydrase activity, they will attempt to localize the activity to some substructure of photosystem II. For each, they will determine pH optimum, ionic strength optimum, response to specific inhibitors and other biochemical parameters. Once they can control the activity of each CA source separately, they will begin to ask what physiologic role each plays in the chloroplast. 2. To test the hypothesis that bicarbonate is a chemical intermediate in oxygen evolution. In plants, photosynthesis begins with the light-driven decomposition of water and the release of molecular oxygen in a protein-pigment complex located in chloroplast thylakoid membranes. This complex, known as photosystem II (PSII) is the initial site where light energy from the sun is converted to stable chemical forms that can then be used to maintain not only plant life, but nearly all biological systems on earth. They continue to study the workings of PSII with the expectation of eventually uncovering the chemical mechanism of oxygen evolution. This past year they have concentrated on characterizing the enzymatic activity that they discovered was associated a particular extrinsic protein (OEC33) attached to PSII on the inside surface of thylakoids. This protein has carbonic anhydrase (CA) activity, and can catalyze the reversible hydration of CO2 to form bicarbonate, HCO3-. This anion is known to have some, so far unspecified, role in oxygen evolution. The researcers propose that the OEC33 can supply PSII with bicarbonate to fulfill this requirement. They have found that the OEC33 has unique properties compared to all other CAs described. The primary structure bears no primary structure homology to any other CA. The metal cofactor required for activity is manganese, not zinc as is used in every other CA. It is thermally stable, and retains enzymatic activity after treatment at 90 C for 15 minutes. Most unusual, the activity is controlled by ultra-violet (UV) light. In the dark, the enzyme is only capable of catalyzing the equilibrium, carbonic acid (H2CO3) =C HCO3- and H+. After treatment with low levels of UV light, the enzyme then catalyzes exclusively the equilibrium, CO2 + H2O C= H2CO3. They have demonstrated these unique characteristics in vitro with enzyme that was expressed in E. coli. The actual in vivo function of the OEC33 remains uncertain, but they found evidence that its carbonic anhydrase activity is important for oxygen evolution. When the CA activity is inhibited by the specific inhibitors acetazolamide and ethoxzolamide, oxygen evolution is likewise inhibited. This evidence supports our hypothesis that the function of the OEC33 is to supply HCO3- to the PSII complex. They are now characterizing the 'dark' and 'UV-light' forms of the OEC33 described above. It is probable that the high-energy light causes an oxidation of the enzyme. If so, the light effect should be induced chemically at the appropriate oxidation-reduction range. They have also completed reconstitution experiments in which the OEC33 was first removed

from PSII by washing membranes with 1 M CaCl2. This removed both membrane bound CA activity and most of the oxygen-evolution. Both activities were restored by adding back E. coli-expressed OEC33. This confirmed that the OEC33 is the site of CA activity and demonstrates once again the correlation between the CA activity and oxygen evolution. Once the carbonic anhydrase activity of PSII is fully characterized, they will begin testing the published chemical models that are based on the idea that bicarbonate ions are the immediate source of photosynthetically-evolved oxygen.

Impact: For over half a century several thousand researchers around the world have sought to describe the chemical mechanism by which plants make oxygen to replenish the atmosphere. Detailed knowledge of how nature accomplishes this amazing feat is needed before they can hope to reproduce this form of solar energy capture. The work described represents the most promising approach to achieve this goal.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.02 Air Quality

Title: PEDOLOGICAL STUDIES OF CALIFORNIA SOILS: LINKS TO SOIL SURVEY, SOIL QUALITY, AND AIR QUALITY

Description: Objectives are to: 1) Study processes of soil formation and landscape evolution in California and implications for soil quality. 2.) Investigate soil impacts on air quality (PM10, PM2.5) in relation to agricultural management and health effects. 3.) Participate in the National Cooperative Soil Survey, on the Western Region Committee on Soil Survey and Inventory, and on the California Soil Survey Committee, and to improve the diagnostic criteria and function of the US soil classification system, and the application of soil survey information to issues of environmental quality. UC researchers are wrapping up their initial work on lab-generated dust and have expanded their data set on threshold water content values and dust production rates from soils as a function of texture and water content. Work is underway to establish relationships between water content and water potential. They plan to begin fingerprinting lab dust samples using ICP-MS analyses and trace element composition to improve identification of PM-10 sources. They expanded our work on conservation tillage and dust to the large-field scale in collaboration with growers in the San Joaquin Valley, and are attempting to relate on-implement dust measurements to measurements of dust leaving the field at a few locations. The work on K-fixing soils in the San Joaquin Valley shows that more K is fixed in soils from Sierran alluvium than from Coast Range alluvium and that fixation is greatest in coarse-loamy and fine-loamy soil families. They are working to establish quantitative relationships among K-fixation, vermiculite content, and landscape age to increase the predictive power of K-fixation from soil surveys. Work continues on the relationships among soil C, mineralogy, and microaggregates in forested Sierran and Cascade soils. Most recent results show that oldest soil C occurs in microaggregates, especially in mid-elevation soils formed from andesite, suggesting that effects of climate change on soil C in CA forest biomes will depend on soil mineralogy. New projects are investigating 1) the effects of the degree of serpentinization of ultramafic rocks on soil properties and plant community composition in the Coast Range and Sierran foothills and 2) Si chemistry and

duripan formation processes to understand how soil processes converge to produce duripans in four widely differing environments in CA.

Impact: The dust research showed that conservation tillage may offer opportunities to reduce soil-derived PM-10 to help the San Joaquin Valley meet air quality standards. The K work used soil survey information to predict which soils will most likely respond to K- fertilization for cotton production. The soil C work should help predict how much soil C might be released as carbon dioxide if climate change (warming) causes forest vegetation types (biomes) to migrate uphill and will be used to develop forest management plans to maintain soil C stocks. The new projects have intrinsic value in proving new information about how soil-forming environments affect soil development and how plants respond to variation in soil properties.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.02 Air Quality

Title: REVEGETATION CONTROLS DUST IN ANTELOPE VALLEY

Description: A long drought in the 1980s had reduced vegetation cover in Antelope Valley in the western Mojave Desert. Dust storms had wiped out crops and forced farmers to reseed fields repeatedly. Suspended soil had blown into Lancaster, Palmdale and surrounding rural areas, causing unhealthy levels of airborne particulate matter. Reduced visibility had caused traffic accidents and disrupted operations at military facilities. Exacerbating matters, wind erosion had increased the barren areas. Beginning in early 1992, a collaborative effort of UC Cooperative Extension (UCCE), USDA Soil Conservation Service (now Natural Resources Conservation Service), the Los Angeles County Fire Department, the Antelope Valley Resource Conservation District and local air pollution districts instituted a massive revegetation campaign. Seeds were flown in by fire department helicopters and planted on 2,500 acres by local contractors. Throughout the 1990s, UCCE conducted plant density measurements to identify the most successful native shrub species. UCCE planted replicated trials of alternative revegetation practices to determine optimal seeding and transplanting techniques and to identify ways to reduce revegetation costs. Combination strategies of revegetation and wind-fencing were developed, and UCCE measurements validated their ability to suppress dust emissions.

Impact: The 300,000 or so residents of the area obtained more healthful air to breathe, farmers experienced fewer problems, and dust-related traffic accidents declined. Maximum daily particulate matter concentrations in Lancaster declined from 780 micrograms per cubic meter of air in 1991 to an average of 75.6 during the next 10 years, with many fewer instances in which state and federal air quality standards were exceeded. Drought conditions returned in the mid-1990s, but the revegetation held the soil in place.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 4.02 Air Quality

Title: STUDIES OF AIR QUALITY DEGRADATION IN NON-URBAN ENVIRONMENTS

Description: Objectives are to: 1. Develop scientific knowledge of processes by which ambient concentrations of ozone, acidic gases and particles, and other air pollutants reach undesirable levels in suburban and rural environments. 2. Develop statistical and mathematical models of transport, diffusion, chemical transformation and deposition of air pollutants. 3. Develop instrumentation and procedures to better measure pollutants and the processes affecting dispersion and deposition them on soil, plant and water surfaces. 4. Develop environmental, physical and biological parameterizations useful to decision-making and planning processes in society. The major focus has been aircraft sampling of meteorological conditions and air quality in several areas of central California: the San Francisco bay area, the northern San Joaquin Valley, the southern Sacramento valley, the Sierra Nevada east of Sacramento and the Lake Tahoe Basin. UC researchers have participated in large, multi-investigator regional studies (such as Central California Ozone Study - 2000, Lake Tahoe Atmospheric Deposition Project) as well as individual projects with funding from the US EPA, California Air Resources Board, The San Joaquin Valley Research Consortium, and the UC division of Agricultural and Natural Resources. Analysis and interpretation of these measurements have provided significant insight into the chemical composition of air pollutants in these areas and their transport and dispersion to rural areas. In addition to flying instruments which measure standard meteorological variables, they flew several real time pollutant monitors (ozone, oxides of nitrogen, particle concentrations) and a filter-denuder system to collect "grab" samples of gases and particles for laboratory analysis. From our studies and those conducted by others it appears that in summer, the Bay area has only a minor impact on the air quality in the Sacramento valley and northern Sierra. Conversely, a significant fraction of air pollutants are transported to the San Joaquin Valley in summer and impact the southern Sierra appear to originate in the Bay area. High concentrations of photochemical smog constituents frequently reach elevations of 5000 to 6000 feet in the Sierra, but either stop their eastward travel about these altitudes or become vertically mixed such that high concentrations of these pollutants infrequently reach the high Sierra. In the High Sierra, a general decline in the regional air quality is seen but rarely the highly polluted air attributable to a plume from a specific urban source. Results from the filter-denuder sampling include documenting concentrations of ammonia, nitric acid, phosphorous, total gaseous and water soluble particulate inorganic and organic nitrogen in the Sierras east of the Central Valley and in the Tahoe basin. They find high concentrations of these in both areas but concentrations in the Tahoe basin are about one-forth those over the foothills. They have sampled forest fire smoke and find much higher proportions of ammonia, phosphorus and organic nitrogen than in non-smoky conditions. Nitrogen and phosphorus containing pollutants are depositing into Lake Tahoe, fertilizing algae growth and reducing lake clarity. Sources of nitrogen appear to be combustion and agricultural emissions from the Central Valley plus emissions from biomass burning.

Impact: These studies document the degree to which non-urban areas downwind of pollution sources are affected by the ensemble of emissions from urban, transportation and agricultural sources. In particular how these areas often experience concentrations greater than those found in the urban areas themselves as they are exposed to the accumulation of all emissions along the traveled trajectory. The knowledge of the sources of these pollutants, their transformations and

dispersion as they travel and their deposition into sensitive ecosystems is being utilized in the development of viable plans to reduce these impacts.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.03 Biodiversity

Title: BIODIVERSITY AND ECOSYSTEM FUNCTION: AN INVESTIGATION OF RESILIENCE AND CHANGE UNDER MANIPULATED AND NATURALLY-VARYING CLIMATE

Description: Anthropogenic climate warming and loss of biodiversity are two major concerns. At their interface lie three critical questions: How will climate warming alter the diversity of life on earth? What is the relationship between ambient species diversity and ambient ecosystem processes? What is the relationship between ambient species diversity and the magnitude and direction of ecosystem responses to climate warming? These questions are important because of our intrinsic and economic concern for the preservation of diverse forms of life on earth, because biological effects of climate warming have the potential to generate feedbacks to the climate system, and because of inherent interest in understanding the role of ecological diversity and the relation between diversity and stability. The goal of the UC research is to provide insight into each of these three questions for subalpine meadow ecosystems. This five-year project will test 7 hypotheses about biodiversity over a range of spatial and temporal scales in montane meadows. Alternative to these hypotheses (H) are a variety of conceptual models that they will also evaluate. The null hypotheses and examples of alternative models are: H1: There is no spatial correlation between species richness (SR) of plants and arthropods, nor among the major represented arthropod orders. An alternative to this null hypothesis is the "diversity-promotes-diversity" model, which predicts a positive spatial correlation in SR across taxonomic groups. H2: Location along the climate gradient bears no relation to plant and arthropod SR. An alternative is the "climate-influences-diversity" model, which predicts that SR is correlated with climate. H3: Manipulated climate change has no effect on plant and arthropod SR. An alternative is the "perturbation-reduces-diversity" model, which predicts that SR will decline in perturbed plots. H4: The response of SR to manipulated climate bears no relation to pattern of variation in SR along the climate gradient. An alternative is the "space-for-time" model, which asserts that the pattern of variation in SR along a climate gradient predicts the response to a climate manipulation at specific locations along the gradient. H5: Spatial variation in ambient plant SR bear no relation to time-averaged magnitudes of ecosystem characteristics such as soil organic matter (SOM), aboveground biomass (AGB), and net nitrogen mineralization (NNM) that are indicative of ecosystem functions. An alternative is the "diversity-enhances-ecosystem-function" model, which predicts that SR is positively correlated with the magnitudes of ecosystem functions. H6: Ambient SR bears no relation to the coefficients of variation over time of ecosystem parameters. An alternative is the "diversity-enhances-constancy" model, which predicts negative spatial correlations between SR and the coefficients of variation over time. H7: Ambient SR bears no relation to the magnitudes of ecosystem responses to manipulated climate change. An alternative is the "diversity-enhances-stability" model, which predicts that SR is negatively correlated with the changes, under climate change, in the magnitudes of ecosystem

responses. During the past year of this project, the UC researchers carried out an analysis of how climate warming affects the susceptibility of a variety of plant species to plant pathogens and herbivores. Data from the warming manipulation experiment indicate that the effects of climate warming on both disease and herbivory vary greatly across plant species, environmental conditions, and type of pathogen or herbivore. Plants in the earlier melting plots generally exhibited the most damage and were attacked by a larger number of species, consistent with theoretical predictions. However, although the overall trend was an increase in damage with warmer temperatures and earlier snowmelt, some pathogens and herbivores performed better in cooler or later melting plots. In other work they unexpectedly found that the effect of experimental climate warming on plant species richness is mediated by grazing, with species losses in warmed plots exceeding losses in grazed and warmed plots.

Impact: To predict vegetation dynamics under climate change, it is necessary to understand how plant pathogens and herbivores will respond, yet very few empirical studies of pathogens and herbivores under climate change exist. The findings suggest that as the planet warms, the resultant changes in plant-parasite interactions may disrupt current community structure. But land use practices, including grazing, are likely to interact with the effects of warming in unexpected ways. This information will contribute to the basis for decisions made by numerous governmental entities.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.04 Biological Control

Title: ALTERNATIVE APPROACHES TO CONTROL VARROA DESTRUCTOR (FORMERLY, VARROA JACOBSONI), AN ECTOPARASITIC MITE OF THE HONEY BEE

Description: The objectives of the revised project include: 1) To test whether the entomopathogenic fungus, Hirsutella thompsoni, can infect Varroa mite, the parasitic mite of honey bee; 2) To understand the infectious mechanisms of the fungus; 3) To test the effects of H. thompsoni on non-target honey bees, 4) To compare the virulence of various isolates of H. thompsoni on Varroa mites; 4) To select the most infectious isolate to Varroa, yet it cause no negative effects on honey bees; 5) To develop culture media appropriate for mass production of the fungus; and 6) To develop proper formulations of the fungus for applications in field bee hives. Varroa destructor is recognized as the most serious pest of both managed and feral Western honey bee, Apis mellifera in the world. Because Varroa has developed resistance to many acaricides and residues of these acaricides have been found in the hive products, it is important to explore the feasibility of using biological control agents including fungi that may infect and kill the mite. Accordingly the UC researchers have investigated the infectivity of entomopathogenic fungus Hirsutella thompsonii on Varroa mite as well as host honey bee under laboratory conditions. Their scanning electronmicroscopy study revealed that the fungus infect the mite mainly through membranous leg suckers and the mite died from mycosis with LT50s ranging from 51.1 to 94.9 h depending of the fungal strains and isolates. Since H. thompsonii did not infect honey bee from larval to adult stage in our laboratory tests, this fungus may have the potential to be developed as a biocontrol agent for Varroa mite. During the spring and summer of

2003, they collaborated with USDA laboratory to investigate various formulations of H. thompsonii in laboratory cage experiments. The experimental results indeed showed that the fungus can kill mites in caged bees; however, the experiments also indicated that improvement on formulations would be needed to increase the application efficacy. More cage tests of improved formulations will be conducted this coming spring and summer. If the results of cage tests show significant improvement of new formulations, these formulations will be further tested in small hives for further selection of the best formulation for future tests in large bee colonies.

Impact: The results of the experiments reported for the first time the possibility of using H. thompsonii as a biological control agent for honey bee parasitic mite, Varroa destructor, and showed the evidence of the infection mechanism. The research has a great potential to benefit the beekeeping industry.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.04 Biological Control

Title: BIODIVERSITY STUDIES OF SPIDERS

Description: Molecular genetic tools, coupled with ecological and morphological data, will be used to examine patterns of biodiversity and endemism in a group of spiders known to be important in ecologically important landscapes, in particular oceanic islands and agroecosystems (including rice, taro, grapes). A UC researcher has already conducted extensive work in agroecosystems and natural areas in California, and in the islands of French Polynesia and Hawaii. He plans to expand on this work to include more of the islands of French Polynesia and Micronesia, to collect and identify tetragnathine spiders in natural and agricultural areas in throughout these areas and hence determine patterns of endemism in the context of the natural and modified landscape in each area. Molecular information from the specimens will be used to determine patterns of diversification and identify biodiversity hotspots. The accumulated specimens and molecular vouchers will be housed in the Essig Museum of Entomology. The results of this work will allow assessment of the use of these spiders as biological indicators of sites of high conservation value in Hawaii and California, and their role as natural predators in rice and grape agroecosystems. A final objective will be to examine the role of particular invasive species of spiders on the native spider communities, focusing on agroecosystems and natural areas in both California and Hawaii. He will compare and contrast the role of yellow sac spiders (Cheiracanthium spp.) and widow spiders (Latrodectus spp.) as natural predators in agricultural systems, and as agents potentially involved in native species decline in natural areas. The UC researcher is accumulating spiders from a diversity of habitats both in California and in the Pacific, the goal being to understand patterns of biodiversity and identify sites of rarity and conservation concern. This year he focused on: 1. Long-jawed spiders in California. Long-jawed spiders (Tetragnathidae) are characteristic of sensitive habitats, in particular riparian areas. There are 6 species that commonly occur in the state: The most common are T. laboriosa and T. versicolor. Slightly less common are T. elongata, T. nitens, T. pallescens, and T. shoshone. Together with undergraduate student Hillary Thomas, they have collected all of these spiders and

have examined morphological and molecular characters for all of them. They have found that the California species are not closely related to each other, and there may be additional cryptic species. Moreover, while for some species there is considerable structure between populations from different areas, for others, there is little structure, and they therefore infer extensive gene flow. They are gathering ecological information to understand the basis of the structure or lack thereof - whether ecological or geographical. This will allow us to determine the way that the biodiversity is structured, how it has been moved around naturally (e.g. by rivers), and how human impact has affected this structure. 2. Spider diversity patterns in California. Together with a Museum Scientist, they are developing a database of spiders. Once complete, they will be able to search the database and provide a picture of distributions of species over space and time. In this way they will be able to determine easily, (i) hotspots of diversity; (ii) expansion in distribution over time (invasive species); and (iii) diminution of distribution over time (rare/endangered species). By linking to similar databases across the other museums of the Berkeley natural history Museum consortium, they can also determine associations with agricultural and urban areas. 3. The spider genus Argyrodes is represented in Hawaii by two major lineages, one kleptoparasitic, the other araneophagic (spider-eating). Unlike the kleptoparasitic lineage, the araneophagic lineage has undergone adaptive radiation, with multiple described species. He has recently completed the descriptions of these species and, together with graduate student Malia Rivera, they are determining relationships between species based on molecular information. In this way they will be able to determine species diversity patterns across the islands and identify sites of conservation concern. 4. The islands of the South Pacific. He has worked out of the UC Berkeley Gump field station in Moorea, to collect spiders from the Society and Austral islands. He has collected several undescribed species (presumably endemic), and many presumed introduced species and is generating molecular characters for these taxa to show how they are related, and to determine whether they are recent introductions. In this way they will be able to assess biodiversity hotspots and impacts of non-native species.

Impact: Among the arthropod predators occurring in wetlands, both fragile riparian and island systems, and agro-ecosystems, spiders are often the most important insect pest predators. This project provides information on the specific identity, abundance, diversity patterns and movement of these spiders, information that is essential for successful biological control in such agro-ecosystems.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.04 Biological Control

Title: BIOLOGICAL CONTROL IN PEST MANAGEMENT SYSTEMS OF PLANTS

Description: Goal A: 1, 3, 6 Goal B: 7 Goal C: 10 1. Survey indigenous natural enemies. 3. Determine systematics and biogeography of pests and natural enemies. 6. Evaluate natural enemy efficacy and study ecological/physiological basis for interactions. 7. Identify potential predator-prey and parasite-host associations 10. Assess biological characteristics of natural enemies. APHELINUS are parasites of aphids, and in particular UC researchers are studying a complex of cryptic species attacking the Russian wheat aphid. A USDA grant has allowed for a

project focused on the molecular, morphometric and behavioral differences of closely related populations in Europe. They have demonstrated substantial differences in reproductive behavior and host preferences even at the same geographic locality in several European and Asian localities. Differences in their host choice have identified potentially new species for use in biological control. The citrus peelminer, MARMARA GULOSA (Lepidoptera: Gracillariidae), is a Californian species that attacks willow, citrus, oleander and cotton, with willow determined as the original native host. It is increasing in pest status in northern California (Kern, Kings, Tulare and Fresno Counties). They have a project funded through a CDFA Buy California Grant and the Citrus Research Board to rear the peelminer and its parasite, CIRROSPILUS COACHELLAE Gates (Eulophidae). This wasp is the dominant parasitoid in citrus, and has also been found to attack the invasive citrus leafminer. The peelminer parasites are being reared for ongoing innundative releases in the Imperial and San Joaquin valleys. Over the past fall they have shipped more than 3,000 parasitoids to the researchers for release against the peelminer in the San Joaquin valley. No establishment has been recorded to date. They are currently exploring zucchini as a new rearing medium. The citrus leafminer, PHYLLOCNISTIS CITRELLA (Lepidoptera: Gracillariidae), was found in Imperial County in February, 2000 and has spread north to Coachella and Mecca on the northern edge of the Salton sea. In cooperation with CDFA and ICAC, the miner was surveyed for damage and spread and parasitoids. Through funds provided by the Citrus Research Board and grants from the CCNAB and UC-IPM, the eulophid parasitoid (CIRROSPILUS COACHELLAE) of the citrus peelminer (MARMARA GULOSA), is being reared in the lab and is being tested against the citrus leafminer. They have discovered CIRROSPILUS attacking leafminer in the field, as well as an extensive array of native parasites.

Impact: The work on leafmining moths has been invaluable for designing new cultural and biological control strategies that will reduce pesticide applications in citrus. Citrus peelminer and Citrus leafminer are two new pests that threaten citrus in California. The studies on bionomics of the citrus peelminer and an assessment of native parasitoids of leafminers contribute tremendously to development of control measures for the newly introduced citrus leafminer.

The work on APHELINUS will have an immediate impact on surveys and biological control efforts aimed at pest moths, whiteflies and aphids across the southern U.S.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AZ, CA, CO, GU, HI, ID, KS, MT, ND, NJ, NM, NYC, OH, PA, SC, SD, UT

Theme: 4.04 Biological Control

Title: BIOLOGICAL CONTROL IN PEST MANAGEMENT SYSTEMS OF PLANTS

Description: This project will address the following goals: 7. characterize and identify pest and natural enemy communities and their interactions. 8. Identify and assess factors potentially disruptive to biological control. 9. Implement and evaluate habitat modification, horticultural practices and pest suppression tactics to conserve natural enemy activity. The major insect pest associated with northern red oak (Quercus rubra L.) in northern California is an aphid, Myzocallis walshii (Monell), that feeds on the undersides of the leaves. This aphid was inadvertently introduced into California over 40 years ago. Observations on the Davis Campus

during 2003 revealed that the life history of M. walshii is typical for a Myzocallis species associated with nearctic oaks. The aphid over-winters in the egg stage. Eggs hatch in the spring and give rise to the first of several asexual generations in which winged (alate) parthenogenic females give rise to wingless (apterous) nymphs that develop into alate parthenogenic females. In late fall, the sexual generation begins with the production of apterous females (oviparae) and alate males. When mature and mated, the oviparae lay from 4-6 eggs/female in cracks and crevices among the bark, shortly before the leaves begin to fall. Exploration for natural enemies of M. walshii in the eastern U. S. during spring and summer of 2003 recovered a single species of parasitic wasp. It belongs to the family Aphelinidae, and has been tentatively identified as Aphelinus perpallidus Gahan (det: L. E. Ehler). However, it has a limited fecundity and is relatively ineffective in suppressing the aphid in its native range. It also may occur in California already. Additional exploration is planned for southern Europe in 2004 in areas where M. walshii is established to determine if native European parasites have adapted to it.

Impact: This project demonstrated that conservation and augmentation of native predators associated with M. walshii is more promising than importation of exotic parasites. This will significantly guide future management strategies.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AZ, CA, CO, GU, HI, ID, KS, MT, ND, NJ, NM, NYC, OH, PA, SC, SD, UT

Theme: 4.04 Biological Control

Title: BIOLOGICAL CONTROL IN PEST MANAGEMENT SYSTEMS OF PLANTS

Description: Objectives are to: 1) Survey indigenous natural enemies; 2) Conduct foreign exploration and ecological studies in native range of pest; 3) Determine systematics and biogeography of pests and natural enemies; 4) Determine environmental safety of exotic candidates prior to release; 5) Research, establish, and redistribute natural enemies; 6) Evaluate natural enemy efficacy and study ecological/physiological basis for interactions; 7) Characterize and identify pest and natural enemy communities and their interactions; 8) Identify and assess factors potentially disruptive to biological control; 9) Implement and evaluate habitat modification, horticultural practices and pest suppression tactics to conserve natural enemy activity; 10) Assess biological characteristics of natural enemies; 11) Conduct experimental releases to assess feasibility; 12) Develop procedures for rearing, storing, quality control and release of natural enemies; 13) Implement augmentation programs and evaluate efficacy of natural enemies; 14) Evaluate the environmental impacts of biological control agents; 15) Evaluate the economic impacts of target pests and their biological control. Microdus rufipes, a larval parasitoid of the codling moth was imported from China, and reared in glasshouse cages before field release in walnut orchards in California. In addition, monitoring of codling moth cocoon parasitism by Mastrus ridibundus, a parasitoid introduced from Kazakstan, indicated late season parasitism of up to 70% in some orchards. Parasitism of leaf curl plum aphid by Aphidius colemani continued to be high, with aphid populations low again in 2002. A strain of Aphidius transcaspicus collected from mealy aphid on almond in 2001 showed good parasitism of mealy plum aphid in field sleeve cages, but it is not yet known whether they have become established in

prune orchards in the Central Valley. Weekly monitoring of the red gum lerp psyllid with sticky traps continues at 29 sites in 17 counties of California. To date 43,000 parasitoids, Psyllaephagus bliteus, have been released in 57 sites throughout the state. Parasitoids are now established in 30 counties and are continuing to increase in density and spread. Adult female counts on the traps were 37% lower in 2002 compared to the year before the parasitoids were released. Most of the areas with improvement are near the coast and parasitoids are just now becoming established at inland sites. Eugenia psyllid populations along with its parasitoid, Tamarixia nsp., continue to be monitored in Alameda County. The timing of pruning to reduce psyllids and enhance parasitism is being studied and looks promising. Spotted gum psyllid plots have been established in Southern California. The parasitoid collected in Australia in 2002, Psyllaephagus hirtus, was tested in quarantine and found to be specific but the colony was lost prior to release. Foreign exploration for the parasitoid in Australia will be done in early 2003. The sunflower moth, Homeosoma electellum, was consistently more abundant in agricultural than in native sunflower habitats. In contrast, parasitism was 6-10 times higher in native than in agricultural habitats. Also, fewer parasitoid species were found in agricultural habitats, and parasitism by individual parasitoid species was reduced by 90%. These results indicate that patterns of trophic interactions varied by habitat type and were related to plant phenotypic changes and environmental habitat factors such as crop domestication, nitrogen fertilization, and plant phenology. Two molecular markers were developed for detection of Cacopsylla pyricola in the gut of arthropod predators. Detection was possible after 32 h of digestion for both markers. One marker was present in four different psyllid species tested, while the other was specific to C. pyricola and C. pyri. Neither marker was detectable in representatives of the Coccinellidae, Chrysopidae, Hemerobiidae, Anthocoridae, Miridae, Salticidae, Aphididae, Tetranychidae and the Tortricidae, suggesting their suitability for general trophic studies.

Impact: Biological control, or the use of natural enemies to suppress the abundance of insect and mite pests, is an approach to pest management that is designed to reduce pesticide use in food and fiber crops and thus the negative impacts of pesticides in the environment. The result of this work is contributing to reduced pesticide use in California orchards.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AZ, CA, CO, GU, HI, ID, KS, MT, ND, NJ, NM, NYC, OH, PA, SC, SD, UT

Theme: 4.04 Biological Control

Title: BIORATIONAL METHODS FOR INSECT PEST MANAGEMENT (IPM): BIOORGANIC AND MOLECULAR APPROACHES

Description: The objective is to develop insect regulatory peptides and proteins, including various enzymes and insect-specific toxins, as novel agents for plant protection. UC researchers are continuing work on development of recombinant baculoviruses for insect control. In a recent PNAS paper they reported that scorpions use potassium ion as a prevenom and they have isolated several novel toxins from scorpion venom. This information helps select insect specific toxins for use in the recombinant baculoviruses. They have demonstrated that combinations of toxins can be used synergistically in baculoviruses for insect control. They have looked at

recombination frequencies as a possible environmental risk factor related to the release of the recombinant viruses. They have characterized the apoptosis suppressor protein from an insect virus. Such reagents will be very useful for collaborators who are using the protein to block programmed cell death in several plant species. These recombinant plants expressing IAP are resistant to a variety of stressors including pathogens. The researchers are investigating the molecular mechanism by which insect viruses gain control of the behaviour of their hosts. They are helping several countries to develop recombinant baculovirus technology both for protein expression and for the development of green pesticides.

Impact: Field tests of recombinant baculoviruses have shown them to be very effective insect control agents on major insect pests. They work as fast as classical pesticides, preserve yield while not disrupting natural enemies. They have found no evidence of potential harm to humans or to the environment. They offer a cost effective way to move away from dangerous pesticides in many third world areas.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AZ, AR, CA, CO, FL, MN, MT, NV, FL, PA

Theme: 4.04 Biological Control

Title: CHARACTERIZATION OF MICROBIAL MICROHABITATS ON LEAVES

Description: The objectives are to: to determine the spatial and temporal heterogeneity of sugar availability at small scales on leaf surfaces using whole-cell bacterial biological sensors; assess the differences in cell survival and other behaviors of bacteria occurring in aggregates on leaves compared to solitary cell; compare the chemical environment of solitary bacterial cells with aggregated cells on leaves; determine the contribution of cell-cell signaling molecules on the fitness of aggregated bacteria on plants; and evaluate strategies of interference with, or degradation of, cell-cell signals in epiphytic bacteria as means of inhibiting their colonization of plants. A novel strategy termed habitat-inducible rescue of survival (HIRS) was developed to identify genes of Pseudomonas syringae that are induced during growth on bean leaves. This strategy is based on the complementation of metXW, two co-transcribed genes necessary for methionine biosynthesis and required for survival of P. syringae on bean leaves exposed to conditions of low humidity. The researchers constructed a promoter-trap vector, pTrap, containing a promoterless version of the wild-type P. syringae metXW genes. Only with an active promoter fused to metXW on pTrap did this plasmid restore methionine prototrophy to the P. syringae metXW mutant B7MX89 and survival of this strain on bean leaves. Promoter activity experiments using a gfp reporter gene revealed that these plant-inducible gene promoters had very low levels of expression in minimal medium. Based on GFP fluorescence levels, it appears that many P. syringae genes have relatively low expression levels and that the metXW HIRS strategy is a sensitive method to detect weakly expressed P. syringae genes active on plants. Of the 130 plant-inducible loci isolated following metXW-HIRS selection, a subset of 46 was characterized and their transcriptional regulation examined by fusion to a promoterless inaZ reporter gene. Most loci had very low levels of transcriptional activity in culture media, whereas their expression typically increased between 10-100 fold on either wet or dry leaves. These plant-inducible loci encode proteins involved in virulence, stress response, nutrient acquisition,

membrane structure, chemotaxis, and other miscellaneous functions. Over half of the plant-inducible loci encode ORFs that are either novel or have no obvious function. Another subset contains promoters located either in internal portions of known genes or in the non-coding strand of known genes. The latter possibly encode antisense transcripts that result in down-regulation of genes that are either not required for or are detrimental to epiphytic fitness. Of those loci containing obvious promoters to genes with known function, two were shown to contain genes that, upon deletion, reduced the mutants' competitive ability to grow with wild-type P. syringae in protected sites on dry leaves. The first gene is homologous to oriB, a gene of unknown function located in the Conserved Effector Locus of the P. syringae hrp/hrc pathogenicity island, which suggests that hrp/hrc-associated genes are involved in epiphytic fitness. The other gene, ssuE, gene encoding a NADPH-dependent FMN-reductase involved in the sulfate starvation response was induced not only on leaves but also in P. syringae cells grown in culture media containing sulfur sources other than sulfate. Furthermore, a P.syringae ssuE mutant strain exhibited impaired growth in media lacking sulfate or cysteine. Our findings suggest that there is a limited supply of sulfate on leaf surfaces, and that the primary sulfur source for P. syringae located in protected sites may be plant-derived compounds other than sulfate.

Impact: The identification of genes of the plant pathogen Pseudomonas syringae that are induced while this bacterium is on leaves provides much information on the nature of the leaf surface environment. Furthermore, the researchers have identified many adaptive traits that this good epiphyte expressed only while it is on leaves. Such adaptive traits, if transferred to, and expressed in, beneficial bacteria such as biological control agents should improve their fitness on plants and lead to better biological control of plant diseases and frost injury. This method of selecting for genes expressed in plants should be a powerful means to study other plant associated bacteria.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.04 Biological Control

Title: INTEGRATED MANAGEMENT OF FOREST INSECT PESTS

Description: The objective is to evaluate key natural enemies of insect pests in urban forests; assess natural-enemy guilds associated with forest insect pests; relate guild structure of natural enemies to forest health. Post release evaluation of ENCARSIA AURANTII (Howard), an imported parasite of obscure scale, MELANASPIS OBSCURA (Comstock), continued on oaks (QUERCUS sp.) in Capitol Park of Sacramento. Each year from April through mid-September, biweekly capture of scale crawlers and adult parasites on yellow card traps revealed that both scale and parasite populations were similar to levels observed during previous years. Over ten years after the introduction of the parasite, both pest and parasite populations have stabilized at relatively low levels. As chemical insecticides are no longer needed for suppression of obscure scale in Sacramento, this exotic pest is now considered to be under complete biological control.

Impact: The obscure-scale infestation on oaks in Sacramento's Capitol Park no longer requires any chemical suppression and therefore is under complete biological control.

Funding Source: McIntire-Stennis and State

Scope of Impact: State Specific

Theme: 4.04 Biological Control

Title: PREDATOR AND PARASITOID BIOLOGY AND THE ECOLOGY OF BIOLOGICAL CONTROL

Description: Objective 1: To quantify the incidence of egg limitation versus time limitation for the parasitoid Anagrus erythroneurae, and measure how the incidence of egg limitation changes under changes in host availability. Objective 2: To quantify the relationship between female size and lifetime reproductive success for Anagrus erythroneurae, and measure how this relationship may change with changes in host availability. Objective 3: To quantify the impact of predation on adult female Anagrus erythroneurae foraging freely in the field. Objective 4: To quantify the use of sugar-rich foods by female Anagrus spp. in the field to determine if their longevity is being constrained by access to such foods. The goal of this project is to develop a fundamental understanding of the ecological and evolutionary underpinnings of plant-insect, predator-prey, and parasitoid-host interactions, and to apply this knowledge to the development of sound pest management practices. During 2003 work was conducted in two systems. First, the researcher worked on biological control of the grape leafhopper ERYTHRONEURA ELEGANTULA on winegrapes by two parasitoids in the genus ANAGRUS. Although this system has been intensively studied for fifty years, a UC researcher have just discovered that the parasitoids are adversely affected by sulfur, which is applied to virtually all vineyards for control of powdery mildew. Surveys of 20 vineyards revealed that parasitoids in sulfur-treated vineyards lay only about 50% as many eggs over their lives as parasitoids in sulfur-free vineyards, even when host availability is equivalent. This difference may explain why grape leafhoppers are pests in commercial vineyards. Manipulative experimentation is currently planned to address this possibility. Second, he worked on understanding the impact of LYGUS HESPERUS on cotton production in California's San Joaquin Valley. This pest has also been extensively studied for many years, but its interaction with the host cotton plant remains highly enigmatic and controversial. In particular, growers have long complained that they are unable to predict the impact of LYGUS on cotton: sometimes LYGUS seem to produce much more economic damage (abscission of cotton's flower buds, which are called squares) per capita than usual. Without being able to predict these events, growers are forced to adopt a hyper-conservative management approach, spraying fields when only low densities of LYGUS are present. During 2003 the researchers conducted a survey of 21 commercial cotton fields, pairing fields that were enigmatic (e.g., fields where the amount of damage was more than expected) with control fields (where damage was as expected). They obtained two key results. First, the enigma is a real phenomenon, and is not simply a reflection of the difficulties associated with obtaining a good estimate of LYGUS density. Fields that growers identified as enigmatic, more damage than expected did indeed have more square abscission than is normally observed for a field harboring the measured density of LYGUS. Second, they found that the basis for the enigma may lie more with the cotton plant than with the behavior of the LYGUS bugs. They found that LYGUS generate quite predictable levels of feeding damage (as measured by the number of developing anther sacs in the flower buds that are killed by LYGUS feeding). Instead, the enigma seems to be linked to variable plant responses to feeding damage: some plants appear to be more sensitive to feeding

damage than other fields. The ongoing work is, therefore, exploring plant reproductive biology, and examining the possibility that plants may be employing facultative strategies to abort damaged squares under certain conditions, but retaining damaged squares under other conditions.

Impact: The results show that sulfur is disrupting the efficacy of ANAGRUS is contributing to the reduction of sulfur use in California vineyards. Newer, more selective control options, including biological control agents, are available, and will be used instead. The UC research provides a better understanding of the impact of LYGUS on cotton plants, reducing the need to control this pest when at very low densities.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.04 Biological Control

Title: THEORY AND PRACTICE OF BIOLOGICAL CONTROL

Description: The objective is to introduce natural enemies of exotic pests in California; conserve natural enemies of sugarbeet pests, augment natural enemies of stink bugs. The parasite guild associated with small and medium-sized larvae of beet armyworm (Spodoptera exigua [Hubner]) on sugarbeet in northern California consisted of three species: Hyposoter exiguae (Viereck) and Pristomerus spinator (F.) (Ichneumonidae), both larval endoparasites; and Chelonus insularis Cresson (Braconidae), an egg-larval endoparasite. Total parasitization in field samples ranged from appox. 30 to appox. 65%. Cotesia marginiventris (Cresson), a major parasite of S. exigua in the southeastern U. S. that also occurs in California, was conspicuously absent from sugarbeet; this finding warrants further study. However, only P. spinator and C. insularis were associated with S. exigua on hay alfalfa in northern California. Total parasitization ranged from appox. 20 to appox. 70%. Cotesia marginiventris was present, but it was not reared from S. exigua. The absence of H. exiguae may be due to an ascovirus infection of S. exigua larvae. Very few S. exigua larvae were infected with nucleopolyhedrosis virus (NPV) Predation on sentinel egg masses of S. exigua in hay alfalfa in early October was relatively high, exceeding 90% in most cases. However, rate of predation per egg mass was independent of host density (eggs/mass). These results are similar to those obtained in sugarbeet in 2002.

Impact: This technology will speed adoption of biological control strategies in CA crops. Beet armyworm is under good natural biological control in both sugarbeet and hay alfalfa in northern California. Growers should be encouraged to conserve its predators and parasites through judicious use of chemical insecticides.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.08 Forest Crops

Title: INTERACTIONS AMONG BARK BEETLES, PATHOGENS, AND CONIFERS IN NORTH AMERICAN FORESTS

Description: Objectives: Characterize the role of biotic and abiotic factors in predisposing trees to bark beetle attack and subsequent mortality to: 1) determine the influence of fungal associations on fitness of sibling beetle species with non-overlapping host ranges in normal and novel host trees. 2) determine if mycangial fungal associates change the nutrient quality of host and non-host tissue. Dendroctonus bark beetles cause significant mortality to the nation's forests each year. Several of the most serious pests (e.g., D. ponderosae, D. brevicomis, D. jeffreyi, and D. frontalis) are associated with one or more species of fungi transferred by the beetles among host pines in mycangia, specialized fungus-bearing structures on the pronotum or on the maxillae. Recent phylogenetic analysis of Dendroctonus species and their ascomycete mycangial fungi suggests that there has not been an extremely close co-evolutionary relationships between some pairs in these mutualistic associations. While there has been a significant amount of research on the nature of the initial interactions of beetles and their associated mycangial fungi with the defenses of host trees, there has been limited work on the subsequent interactions between beetles and fungi which may prove to be critical to beetle fitness. The program was successful in generating unanticipated results during the year. It is estimated that the forests in southern California have been subject to the most severe drought conditions in the last two centuries. As a result of overstocking of the forest and historically unprecedented drought, there has been significant mortality of conifers from both bark beetle attacks and dehydration. UC researchers monitored beetle activity in two forests, one subject to very high levels of nitrate and ozone pollution and the other relatively free of pollution effects. Tree mortality and beetle activity were significantly higher at the high pollution site. Differences in beetle activity between sites were significantly associated with ozone injury to pines, while differences in tree mortality between sites were significantly associated with both ozone injury and fertilization level. Tree mortality was 9% higher and beetle activity 50% higher for unfertilized trees at the high pollution site compared to the low pollution site. Tree mortality increased 8% and beetle activity increased 20% under the highest rates of nitrogen additions at the low pollution site. The strong response in beetle activity to nitrogen additions at the low pollution site is evidence that atmospheric nitrogen deposition increased tree susceptibility to beetle attack at the high deposition site. While drought conditions throughout the region were a major factor in decreased tree resistance, both ozone exposure and atmospheric nitrogen deposition further increased pine susceptibility to beetle attack.

Impact: The overall project goal of the proposed research is distinguish between the potential nutritional benefits and ability to utilize specific host trees in the mutualistic associations of beetles and fungi. The results from this research will provide a better understanding of the relations between key forest insect pests and their host trees as mediated by a mutualistic association with vectored fungi. Understanding the interactions among these organisms can contribute to better sustainable ecosystem management of the nation's forest resources.

Funding Source: Hatch Multistate Research and State

Scope of Impact: CO, CA, FL, IA, MN, OH, OR, WI, UT, MT, MN

Theme: 4.09 Forest Resource Management

Title: FIT- BRINGING A NATURAL RESOURCES CURRICULUM TO THE K-12 CLASSROOM

Description: Living in an urbanized state, few Californians recognize how much they depend on the forest for water, wood products and wildlife habitat, as well as their responsibility for its proper management. Through environmental learning integrated into the educational system, students can discover how to make critical choices about issues such as forest health, ecosystem management, consumerism and local economies. The goal of the Forestry Institute for Teachers (FIT) is to provide California's K-12 teachers with knowledge, skills and tools to more effectively teach forest ecology and forest resource management practices. The program is co-sponsored by UCCE, the Northern California Society of American Foresters, US Forest Service and many other organizations. FIT brings natural resource specialists together with teachers from both rural and urban schools for one week, working side by side to explore the intricate interrelationship of forest ecosystems and human use of natural resources. The science-based curricula explore many subject areas, including environmental science, physical science, social science, biology, forestry and history. At each session, more than 40 local resource professionals representing many disciplines are invited to teach components of the course. UCCE advisors and specialists serve as co-directors and teachers. FIT offers annual institutes in three Northern California locations: Humboldt, Shasta and Plumas Counties. Back at their schools, FIT participants conduct in-service training for colleagues, and develop forestry education projects with their students.

Impact: Since 1993, over 1,000 K-12th grade teachers, evenly spread among grades, have participated in FIT. About one-third comes from Southern California, one-third from central and rural California and one-third from the Bay Area and Sacramento. Their responses to the course emphasize (1) new insight into the complexity of forest management and (2) activities and lessons that prove valuable in the classroom. Because teachers have utilized the activities and information gained from FIT in the classroom, students are improving their knowledge and decision-making skills. FIT has received a number of environmental education awards.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 4.10 Global Change and Climate Change

Title: CARBON, WATER VAPOR AND ENERGY EXCHANGE OVER GRASSLAND AND TREE/GRASS ECOSYSTEMS

Description: The complex mixed grass/oak system possesses multiple functional types, has rates of carbon uptake and water loss limited by soil water deficits, is normally grazed and burned, and grows on non-ideal terrain. These characteristics challenge Biometerologists. Better information on the fluxes of carbon and water is needed for management and to predict effects of climate and environmental change. This project will: 1) measure and model carbon, water and energy fluxes of grassland and mixed grass/oak ecosystems; 2) study how sloping terrain affects the interpretation and measurement of carbon and water fluxes over grass; and 3) examine theories on the coordinated use of water for the assimilation of carbon. For the past three years UC researchers have been conducting a comparative study on the carbon and water exchange over a deciduous oak/grass savanna and annual grassland. These two ecosystems coexist in the same climate and on similar soils, but possess contrasting structural and functional attributes. The eddy

covariance method is being used to measure fluxes of carbon, water and energy between the ecosystems and the atmosphere. Soil respiration is being measured on a periodic manual basis with a chamber system and continuously with a soil flux gradient system and an eddy flux system. At the grassland, most carbon exchange occurred during the wet season. Seasonal variations in photosynthesis followed changes in leaf area index, which in turn are governed by soil moisture, available sunlight and the timing of the last frost. Soil respiration was a function of soil temperature, soil moisture, growth and rain pulses. On an annual basis integrated values of canopy photosynthesis, respiration and net ecosystem exchange were 867, 735, and -132 gC m exponent -2, respectively, for the 2000-2001 season, and 729, 758, and 29 gC m exponent-2 for the 2001-2002 season. Thus, the grassland was a moderate carbon sink during the first season and a weak carbon source during the second season. A shorter growing season, due to late start of the rainy season, was responsible for the lower photosynthesis in the second season. Thus, the timing of rain events had more impact than the total amount of precipitation on ecosystem carbon exchange. With regards to ecosystem water balance, they are examining how a number of abiotic, biotic and edaphic factors modulate energy exchange over oak/grass savanna and annual grassland ecosystems. The net radiation balance was greater over the oak woodland than the grassland despite receiving similar sums of incoming short and long wave radiation. The lower albedo and lower surface temperature of the woodland were responsible for this difference. Differences in net energy exchange caused major differences in seasonal evaporation and sensible heat exchange. The woodland evaporated about 380 mm per year and the grassland evaporated about 300 mm per year. Differences in the physical water holding characteristics of the soils at the two sites account for this difference in evaporation, and provide a partial explanation why the vegetation differs at the two sites.

Impact: Field measurements of carbon and water exchange are being contributed to the AmeriFlux and FLUXNET project data archives, for access and use by the world wide research community, educators and students. Biophysical models, such as CANOAK, will implement algorithms, being produced from our field measurements. Ultimately, this will be translated into information that quantifies surface boundary fluxes of hydrological, weather, biogeochemical and climate models. Information on carbon and water exchange of an oak savanna can be also be used to manage oak savanna and predict how this ecosystem will respond to climate change, contributing to improved long term management decisions for these systems.

Funding Source: McIntire Stennis and State

Scope of Impact: State specific

Theme: 4.10 Global Change and Climate Change

Title: GLOBAL WARMING AND SURVIVAL OF DESERT BIGHORN SHEEP

Description: The objectives are to characterize and model the current status and future prospects for survival of desert bighorn sheep in southeastern California. Bighorns exhibit a metapopulation-like distributed, inhabiting about 50 isolated mountain ranges in the California deserts. Their habitat occurs on mountaintops so global warming may cause their habitat to contract upwards with eventual extinction. UC researchers assembled a GIS model including the most important environmental variables, and on the basis of 27 previous extinctions, modeled

and predicted bighorn vulnerability to climate changes projected by global climate models. Lower elevation, drier, and more isolated ranges are most vulnerable. They also used existing software (a population viability analysis model) to estimate error in our extinction in model. There may be cascading effects because the overall bighorn metapopulation is composed of smaller metapopulation clusters. Consequently, loss of certain populations effects the viability of the metapopulation cluster by loss of sources of dispersal necessary for recolonize following extinction. Although they continue to refine their data sets for the GIS model, this phase of the project is mostly complete. The next phase involves (1) using molecular genetics to establish genetic structuring of the metapopulation, (2) refine predictions of the GIS model, and (3) establishing baseline parameters on vegetation by which future changes due to climate can be monitored. Sequences of mtDNA, inherited only through the female line, will indicate the degree or mixing or isolation from dispersal of the various mountain ranges. From radio-telemetry studies, they know that males commonly move between mountain ranges in search of reproductive females. Females are much less likely to move (i. e., philopatric), but persistence of local populations in the metapopulation are dependent on dispersal of females, the reproductive unit in this species in which males do not participate in rearing of young. If females seldom reach isolated ranges, there should be a pattern in the distribution of haplotypes (mtDNA sequences) that reflects the past history of movement of females. If dispersal by females was prevalent in the past, the distribution of haplotypes should be uniform. Baseline monitoring of vegetation or other environmental variables into the future is necessary because the desert is highly stochastic. The climatic pattern is complex, being driven by two weather systems-western winter precipitation pattern and the southern summer monsoonal pattern-each largely independent in its effects. Thus, different regions of the California desert may follow different climate trends. This accounts for the very different vegetation in different parts of the desert because season, timing, and amount of precipitation have substantially different biological and ecological consequences for bighorn sheep. The researchers used an extinction model (Epps et al. 2004, Conservation Biology) to generate testable predictions on climate-related habitat quality and population stability. Lower mountain ranges in more southerly locations were most subject to extinction due to climate warming. To index diet quality they collected fecal samples from at least six individual desert bighorn sheep per population in 11 populations monthly during the critical winter/spring period of vegetative growth and bighorn sheep reproduction in the Mojave Desert. Preliminary analyses of fecal nitrogen levels showed that spring diet quality was significantly lower in low-elevation ranges, as predicted by the climate-extinction model. Spring diet quality is positively correlated with lamb recruitment (and thus population growth) in desert bighorn sheep. In April 2003, they collected samples from another 12 populations across a gradient of elevation and latitude to gain further statistical power for these analyses. Fecal nitrogen levels in this final set of samples are currently being analyzed. They have completed laboratory analysis of 14 microsatellite loci from fecal nuclear DNA collected in about 30 contiguous populations of desert bighorn sheep. The data contained 542 complete genotypes, from which they were able to identify 420 individual sheep using genotype-matching software. They determined the sex of all these individuals using DNA methods, and have sequenced a 680 base pair fragment of mitochondrial DNA from 340 of the 420 individuals. Results from both nuclear and mitochrondrial DNA show a large degree of spatial structuring of bighorn populations. They will use a GIS model to test how natural landscape features affect genetic similarity of adjacent populations. The very large sample of adjacent populations will give them great statistical power for determining what features of the desert landscape serve as barriers to bighorn sheep dispersal. This in turn will allow them to

model how climate-related extinction of given populations may be off-set by natural recolonization. They will also be able to test whether genetic variability has been reduced in areas under increased climate-related stress, as predicted by our extinction model.

Impact: The predictions from the desert bighorn sheep model allows anticipation, and mitigation, of the impact of global climate warming. The data establish a baseline condition against which the consequences of actual future climate changes can be compared in a biological system where the location of effects is specified.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.10 Global Change and Climate Change

Title: MEASUREMENT OF MODELING OF WATER AND CARBON DYNAMICS FOR WATERSHED MANGEMENT IN SIERA NEVADA MOUNTAINS

Description: Objectives are: 1. To characterize the daily, seasonal, and interannual dynamics of carbon and water of three types of forest ecosystems in the Sierra Nevada Mountain, based on field measurements of photosynthesis, plant and soil respiration, carbon dioxide and water vapor fluxes between the atmosphere and ecosystem. 2. To develop mechanistic models of water and water dynamics for major plant species in the forest at ecosystem level using instrumental measurement data; 3. To derive canopy morphology models based on digital photography and computer automated photogrammetric measurement; 4. To quantify the spatial and temporal patterns of the carbon and water dynamics of forested landscapes and water basins by scaling up measurements of the lower level processes, using the canopy morphology models as a scaling bridge and ecosystem models as a scaling instrument. UC researchers have made contributions to three issues in the study of mixed conifer forest in Sierra Nevada. First, they quantified and modeled the environmental controls of the magnitude, the temporal and spatial patterns of soil CO2 efflux (Qi and Xu 2001, Xu and Qi 2001a). Second, they characterized the temperature sensitivity (or the Q10 in exponential model) of soil CO2 efflux in terms of its spatial and temporal patterns and environmental controls (Xu and Qi 2001b) and they developed a general model for this key parameter (Qi et al. 2001a). Third, they developed a scaling scheme to quantify the total ecosystem carbon emission and its constituting components (Qi et al. 2001b; Xu et al. 2001). All three contributions have important implications for regional and global estimation and modeling of carbon sink and source of the terrestrial ecosystem. They reported the magnitude, diurnal, seasonal and spatial variation of soil CO2 efflux in a ponderosa pine forest (Xu and Qi 2001a). They found that the relationship between soil CO2 efflux and soil temperature was significantly controlled by soil moisture. Soil temperature and moisture explained most of the temporal variation in soil CO2 efflux, but they explained little spatial variation of CO2 efflux. The spatial variation of CO2 efflux was well explained by microbial biomass, fine root biomass, and soil physical and chemical properties. The researchers found that the effects of soil temperature and moisture can be separated (Qi and Xu 2001). They developed two analytical procedures to separate the effects based on continuous measurements of the CO2 efflux, temperature and moisture of the soil. The combined effects can be represented with the product of a temperature effect term and a moisture effect term. The relationship between soil

CO2 efflux and temperature can be described with a power function. This relationship was modified by soil moisture effect, which affects the coefficient, not the exponent, of the power function. This formulation can be used to model the seasonal trend of soil CO2 efflux of the forest based on temperature and moisture, two key variables influenced by climate and management practices. The sensitivity of soil CO2 efflux to temperature, most commonly represented by the Q10, is one of the most important parameters in global carbon cycle modeling. They reported great variations of the Q10 values in space and time, determined through field measurements (Xu and Qi 2001b). They further found that, like the soil CO2 efflux, the temporal variation of the Q10 values tended to be explained by soil temperatures and moisture. Q10 values derived from temperatures of different depth in soil also showed considerable variation along the vertical dimension. The Q10 variations calculated from different locations and from soil temperatures at various depths had significant influences on the estimation of soil CO2 efflux. These variations tend to affect the seasonality of the soil CO2 efflux more than the annual average (Xu and Qi 2001b).

Impact: This work is important for understanding how forests and their soils can reduce the effects of global warming by capturing and holding CO2 from the atmosphere. The study of the carbon dynamics in forest soil is of the utmost importance in understanding and managing the global environmental change. The soil carbon stocks are twice as large as all of the standing terrestrial biomass combined, and 80% of the soil carbon is in forest soils. A global warming of 0.03oC a year would enhance soil respiration, producing a net release of additional 60 Pg C between 1990 and 2050, equivalent to a 19% increase in fossil fuel combustion in the same period (Jenkinson et al. 1991). Understanding the factors affecting the spatial and temporal variations of soil CO2 efflux is critical to modeling the carbon sink and source dynamics of terrestrial ecosystems. Accurate and intensive measurements of the flux and affecting factors are the ultimate means for determining the responsible factors. Large seasonal variations of soil temperature and moisture under the Mediterranean climate provide an ideal condition for such measurements. The measurement study helps to uncover the factors that determine the temporal and seasonal patterns of soil CO2 efflux in the young ponderosa pine site. The variations of Q10 and its dependence on soil moisture and temperature had important implications for regional and global ecosystem carbon modeling, in particular for predicting the responses of terrestrial ecosystems to future global warming.

Funding Source: McIntire Stennis and State

Scope of Impact: State specific

Theme: 4.10 Global Change and Climate Change

Title: REGIONAL CLIMATE PREDICTION STUDIES

Description: The goals of this research are to use sophisticated meteorological data and climate models to elucidate the nature of the complex processes which control regional climate and climate change, and to utilize improved understanding to derive and test superior models for the prediction of climate for regions the size of the western United States. UC researchers have continued their work in three primary research areas: 1) cloud vertical structure and its influence on climate, 2) regional interactions associated with the 40-50 day Madden and Julian Oscillation

(MJO), and 3) regional modeling of vegetative surface fluxes of heat, mass, and momentum. Cloud Vertical Structure: They have maintained their participation in the Atmospheric Model Intercomparison Project (AMIP) stage II as a diagnostics subproject. Preliminary results, which have been accepted for publication, show that currently available models do not well simulate the observed vertical structure of cloud water or interactions between cloud amount and cloud water. Regional MJO Interactions: A recent publication describes an innovative use of composite singular value decomposition analysis to understand interactions of MJO filtered precipitation, winds, moisture and evaporation over the tropics. Continuing modeling efforts are based upon the use of the current version of the NCAR/Penn State MM5 regional atmospheric model. The initial results have been presented at two international meetings and are accepted for publication. Regional Vegetative Surface Fluxes: The researchers have published a description of the second phase of their implementation of a new mult-layer, third-order canopy/soil surface model in the MM5 regional scale atmospheric model.

Impact: The tropical data analyses and modeling studies are leading to improvements in seasonal weather predictions. The global data analyses and regional modeling provides more reliable estimates of climate changes induced by increases in greenhouse gases and aerosols.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.10 Global Change and Climate Change

Title: THE BIOGEOCHEMISTRY OF FLUCTUATING OXYGEN ENVIRONMENTS IN HUMID ECOSYSTEMS

Description: Nitrogen (N) and carbon (C) cycles are important regulators of net primary productivity and decomposition in terrestrial ecosystems, and significantly impact the atmosphere when emitted from soils as greenhouse gases. The production of nitrous oxide (N2O), carbon dioxide (CO2), and methane (CH4), three of the most important greenhouse gases emitted from natural ecosystems, is strongly influenced by soil oxygen (O2) availability and redox potential. Nitrous oxide is produced under mildly reducing conditions when nitrate (NO3) is used as a terminal electron acceptor following O2 depletion. Although N2O is emitted at a lower rate than CO2, it is approximately 300 times more effective at climate warming. Heterotrophic respiration produces CO2 in oxic soils; soil respiration via this pathway represents one of the largest terrestrial fluxes of C to the atmosphere. Methane is produced under strongly reducing conditions and is approximately 25 times more effective at radiative forcing than CO2 (Schlesinger 1997). Low and fluctuating redox potential can also result in the retention of N and C in terrestrial ecosystems. However, mechanisms of N and C retention in low O2 environments are less well studied. UC researchers recently measured dissimilatory NO3 reduction to NH4 (DNRA) under anaerobic conditions in upland soils, a process that has the potential to conserve N in the ecosystem (Silver et al. 2001). Similarly, soil C can accumulate under reduced conditions due to decreased heterotrophic respiration (Day and Megonigal 1993). The researchers hypothesize that this may in turn cause greater declines in soil O2 availability due to increased water holding capacity, decreased diffusional transport, and increased biological activity. The objectives of this study are to determine the effects of fluctuating soil O2 and redox

conditions on the retention and loss of N and C in humid ecosystems. Specifically they propose to: (1) determine the relative importance of denitrification and DNRA in fluctuating O2 environments (2) determine the effects of reducing conditions on C storage and fluxes, and feedbacks to soil O2 concentrations (3) determine the interaction of C and NO3 availability on the retention and loss of N The ultimate goal of this research is to improve our understanding of the relationship between soil O2 availability and biogeochemical cycling in forest and grassland ecosystems. This work will provide valuable information on the effects of soil aeration and C and N inputs on the production and consumption of greenhouse gases. This research will also explore the mechanisms responsible for N and C retention and loss in wet and irrigated ecosystems, and should identify means to better manage N, C, and water inputs. Fluctuations in the oxygen (O2) concentrations of humid soils have the potential to significantly alter the cycling of key nutrient elements in terrestrial ecosystems. The UC research has focused on the effects of fluctuating O2 concentrations (i.e., redox dynamics) on the retention and loss of nitrogen (N), the availability of phosphorus (P) in low P environments, and impacts on carbon (C) sequestration and loss in spring fed wetland ecosystems and annual grasslands. They found that fluctuating redox conditions in humid soils facilitated nitrification during aerobic periods and nitrate reduction during periods of low redox. The dominant reductive pathways were dissimilatory nitrate reduction to ammonium (DNRA), denitrification to nitrous oxide, and denitrification to dinitrogen. DNRA is a conservative process, removing nitrate from a pool where it is easily lost to groundwater and the atmosphere and keeping it in play for plant and microbial uptake. Denitrification is a permanent loss pathway; nitrous oxide is a potent greenhouse gas with important natural and anthropogenic sources. They found that natural forests in warm humid environments generally had higher rates of DNRA than nitrous oxide production, and DNRA greatly exceeded nitrous oxide emissions in young plantation forests. Cool temperatures appear to slow rates of DNRA and denitrification, but again DNRA exceeded denitrification in Mediterranean and boreal forest soils. The results indicate that DNRA, a previously unmeasured pathway in the terrestrial N cycle plays an important role in N conservation in a range of humid ecosystems, and may limit N losses via denitrification by removing nitrogen from the nitrate pool. Low redox conditions also have the potential to reduce iron (Fe). Short term fluctuations in soil O2 concentrations resulted in significant Fe reduction and increased P availability. Extended periods of low redox conditions did not further increase P release through Fe reduction, suggesting that only surface-bound P was available for release. Addition of labile C substrates increased both Fe reduction and P release; the highest rates of Fe reduction and P release occurred after the addition of a humic substance. Our results show that fluctuations in soil O2 have the potential to supply P to plants in low P environments and that the addition of labile C can dramatically increase P release. Climate change is likely to influence redox dynamics in wetland and upland ecosystems. Simulated early rains increase carbon dioxide emissions from soils in California annual grasslands. Although they have not yet decreased water inputs to wetlands, the pretreatment data show that wetlands are generally a net source of methane, an important greenhouse gas, and appear to maintain near constant anaerobic conditions throughout the year. They predict that wetland modification will result in fluctuating redox conditions stimulating increased nitrous oxide emissions, decrease methane fluxes, and increased carbon dioxide fluxes, generally increasing the total greenhouse gas emissions from these ecosystems.

Impact: This research identifies the role of fluctuating oxidation-reduction (redox) potential in soils in critical ecosystem processes including nutrient supply and nutrient retention. Results also show how expected changes in climate will affect redox sensitive processes that feedback on

carbon sequestration and greenhouse gas emissions. This work on nutrient dynamics, carbon, and greenhouse gas emissions is informing land managers and policy makers of key processes that affect ecosystem performance and sensitivity to changing environmental conditions, contributing to improved management decisions.

Funding Source: McIntire Stennis and State

Scope of Impact: State specific

Theme: 4.12 Integrated Pest Management

Title: A DEMOGRAPHIC APPROACH TO ASSESSING THE RISK OF NEW GENERATION PESTICIDES TO NATURAL ENEMIES IN WESTERN ORCHARDS

Description: Codling moth is the key pest of pome fruit production in the western US. This project aims to identify selective new generation pesticides that are least disruptive to the natural biological control of potential secondary pests in western orchards, as a complement to the recently implemented regional mating disruption program for codling moth. The objectives are (1) to develop novel bioassays to estimate the demographic impact of selective insecticides on natural enemies of secondary pests in western orchards and (2) to develop an effective risk rating system for selective insecticides through comparison of traditional exposure-effect indices with elasticity analysis of matrix model projections. The use of selective products for codling moth and secondary pests that minimize impacts on biological control agents is of critical importance in the development of effective IPM programs in western orchards. Standard acute toxicity tests are not sufficient for the detection of sublethal effects of selective products on natural enemies, and oral intake may be a more important route of uptake than topical or residue uptake. In this project UC researchers have tested a series of new products, Provado and Actara (neonicotinals), Esteem and Success (IGRs) and Intrepid for impact on the performance of the green lacewing, Chrysoperla carnea, an important predator of lepidopteran eggs, mealybugs and other small arthropods. Two different dose rates, the full field rate and a 10% field rate were compared to control sprayed with distilled water. Insecticides were applied in a Potter tower to give an even application of 1.5mg per cm2 of arena surface. Eggs and larvae were placed in glass petri dish arenas edged with Fluon and adults in small glass rings with glass base and gauze lids (all surface treated). As the neonicotinals show acute topical toxicity, a standard acute toxicity assay on 1d old eggs and 2d old larvae and 3d old adults to determine survival at 48h was used as a first tier assay to determine whether sublethal tests were necessary. Subsequent second tier tests on 2d old larvae and 3d old adults combined the three pathways of exposure (topical, residue and oral) by separately applying each product to the arena, the test insect and the food supply (1st 5 days only) before combining them together. Larval assays were based on 30 replicates which were followed through to egg hatch of the subsequent generation to determine development time for each juvenile stage, adult size, preoviposition period, oviposition rate over the first 14 days of adult life and the hatching success of eggs laid. Adult assays were based on 15 pairs of adults, which were followed through a complete generation to hatching of eggs of the subsequent generation to determine each of the parameters used in the larval assays. Provado caused almost complete acute topical toxicity at both the standard and 10% field rate for larvae, but only at the full field rate (0% mortality at 10% field rate) for adults. In contrast, Actara caused almost complete acute topical mortality at both rates among adults, and 60% (10% rate) or 100% (full

field rate) mortality for larvae. The two IGRs had no acute topical toxicity among larvae, and the only notable sublethal effect was a prolongation of the 3rd larval instar by Esteem. In contrast, Intrepid appears to reduce success of egg hatch in eggs laid by individuals treated either as larvae or adults. A Leslie matrix model is being developed for lacewing larvae, parameterized using the data collected from the control treatments in this study, to determine the population level consequences of larval, mortality, prolongation of development and reduced egg hatch on the population growth rate of lacewing populations.

Impact: This project identified benefits of enhanced biological control of primary and secondary pests through the identification of new generation insecticides that are selective enough not to impact natural enemies in western orchards. This is information that can be utilized in more effective, more ecologically friendly, pest control programs.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: ALTERNATIVE WEED CONTROL OPTIONS FOR CALIFORNIA STRAWBERRY AND VEGETABLE GROWERS

Description: The ultimate goal of the principal investigator is to develop integrated weed management systems for coastal California vegetables and strawberries. Present objectives are to: A. Evaluate new weed management systems for strawberry. B. Determine if preirrigation can be used to improve weed control in conventional and organic vegetable production. C. Evaluate new potential herbicides for lettuce. The principal research objective is to develop improved weed management options for vegetable crops. This project is focused on two principal areas: (1) the development of season-specific weed management programs for vegetables, and (2) the evaluation of herbicides in lettuce and celery. Season-specific weed management. The goal of this project is to develop season-specific weed management programs for vegetables. Seasonal weed emergence patterns and soil seedbanks in two vegetable fields were monitored for three years. Periods when weed seedbanks were highly germinable correlated with periods of high weed emergence. Annual bluegrass (Poa annua) has emergence peaks in the fall, while common purslane (Portulaca oleracea); and hairy nightshade (Solanum sarrachoides) have emergence peaks in summer months. Burning nettle (Urtica urens), common chickweed (Stellaria media), common groundsel (Senecio vulgaris), and shepherds-purse (Capsella bursa-pastoris) emerged all year. Soil surveys in organic fields found annual bluegrass more common in clay soils than in sandy soils. Survey results indicated that burning nettle, common chickweed, and shepherds-purse were more common in fields with higher organic matter. These data will be used to develop field selection criteria for organic vegetable fields, and this will be the next step in the process. Lettuce herbicide evaluations: The researchers are evaluating sulfonylurea herbicide tolerant lettuce germplasm from Idaho. Two field evaluations were conducted at Salinas, CA in 2003 to measure the tolerance of lettuce to eight sulfonylurea and imidazolinone herbicides. Injury estimates and yield results indicate that the Idaho germplasm was tolerant to both preemergence and postemergence imazamox and imazethapyr applications and preemergence applications of sulfosulfuron, and triflusulfuron. Nicosulfuron, rimsulfuron, trifloxysulfuron, and

halosulfuron, reduced lettuce yield and will not be evaluated further. The results of this study suggest that imazamox and imazethapyr both as preemergence and postemergence applications, and sulfosulfuron, and triflusulfuron as preemergence applications are safe on the Idaho germplasm and further evaluations are planned. Herbicide evaluations in celery: Celery growers are in need of a way to control yellow nutsedge (Cyperus esculentus). Crop tolerance and weed control efficacy of S-metolachlor, flufenacet and flumioxazin were evaluated in celery. S-metolachlor was applied at 0.5, 0.63 and 0.95 lb ai/A, flufenacet at 0.4, 0.5 and 0.6 lb ai/A, and flumioxazin at 0.063, 0.094 and 0.188 lb ai/A were applied just prior to celery transplanting. The commercial standards linuron at 1.0 lb ai/A and prometryn at 1.5 lb ai/A were applied approximately 2 weeks after transplanting. S-metolachlor and flufenacet controlled yellow nutsedge, while none of the other compounds controlled this weed. All herbicide treatments were found to be safe on celery in 2003. A 24c emergency label for S-metolachlor use in California celery has been requested from the California Department of Pesticide Regulation, and a decision is pending.

Impact: California vegetable producers sold over $5.0 billion in produce during 2002. The long-term profitability of California vegetable producers is threatened by the potential loss of vegetable herbicides to regulatory action. Integrated weed management strategies may allow reduced pesticide inputs and ease some of the regulatory concerns surrounding many of the older vegetable herbicides.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: ALTERNATIVES TO METHYL BROMIDE FUMIGATION OF SOIL FOR STRAWBERRY

Description: Objectives: 1) Evaluate the effectiveness of alternate soil fumigants and methods of fumigant application on diseases, growth, and yield of strawberry; 2) Identify microbial mechanisms contributing to the growth and yield response of strawberry to soil fumigation; 3) Evaluate non-chemical alternatives to methyl bromide fumigation of soil for management of Verticillium wilt and to optimize yield in strawberry. A field experiment on chemical alternatives to methyl bromide was repeated in 2002-03 near Watsonville, CA. Selected beds were fumigated with shank-applied methyl bromide/ chloropicrin (MBC, 67/33) at 325 lb/a (rates per unit treated bed area) and covered with standard black polyethylene mulch or black virtually impermeable plastic film (VIF). Chloropicrin at 200 and 300 lb/a and InLine (Telone C-35) at 283 and 425 lb/a were applied to beds under plastic in water emulsions through drip lines and there were nontreated controls. The use of VIF plastic as compared to standard plastic improved the control of buried inoculum of Verticillium dahliae significantly where chloropicrin or InLine was used. The ranking of the five varieties used for the final incidence of plants with Verticillium wilt (low to high) on nontreated soil was Camino Real, Aromas, Diamante, Camarosa, and Ventana. Control of Verticillium wilt by chloropicrin was generally less than that by MBC or InLine with standard plastic, but was improved somewhat with VIF plastic. The effects of fumigation treatments on berry yields varied with the time of harvest and variety. All

the chemical fumigation treatments more than doubled total yields and the effects of the various chemical treatments on the yields of Camino Real, Aromas, and Diamante, were generally similar. For the varieties Camarosa and Ventana, InLine at 283 lb/a gave the highest total yields. Ventana plants grown in soil treated with InLine at the higher rate tended to be more vegetative than those in other treatments. Bacterial growth promotion of strawberry following inoculation of bare-root transplants in the field was variable and depended on soil background treatment, strawberry variety and isolate. In nontreated soil, none of the bacteria decreased yield and 2-3 isolates increased yields of both Aromas and Camarosa slightly. While only one isolate increased yield of Camarosa in MBC- or metam sodium-treated soils, several isolates did so in chloropicrin-treated soil (200 lb/a). Aromas was generally less responsive, but 1-3 bacterial isolates gave measurable increases in yield on chloropicrin- or metam sodium-treated soils. A marked stain of one bacterial isolate used was found to colonize strawberry roots at high populations for at least 6 months after inoculation.

Impact: California produces over 80% of the nations strawberries and nearly 1 billion strawberry runner plants each year. The California strawberry industry relies heavily on methyl bromide fumigation of soil to control soilborne plant pathogens and obtain profitable yields in high-cost production systems. This research project is further identifying and optimizing some chemical and non-chemical alternatives to methyl bromide for strawberry production.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: AN INTEGRATED APPROACH TO MANAGEMENT OF RICE RESIDUE AND THE CONTROL OF RICE DISEASES

Description: Objectives: 1) Determine occurrence and severity of rice diseases under different residue management schemes. 2) Determine affects of residue management schemes (1) on levels of nitrogen and potassium required for optimum yield and minimum disease. 3) Determine affects of various residue management schemes on inoculum of rice blast and Bakanae disease. Rice Blast disease occurred more frequently in the 2001 California rice crop than in the 2002 crop although no new races of Pyricularia oryzae were identified. It is important to continue caution when possible to use seed sources free of the pathogen and to avoid the possibility of spread through transport of and use of equipment that may have residue or dust containing the blast pathogen. Continued study of the disease cycle of Bakanae disease (Giberella fujikouri) revealed that infection from overwintered residue may occur but that the major source of overwintering inoculum is from infested seed from the previous year. An extensive survey and evaluation of over 200 seed lots revealed a very high percentage of infested seed. Percentages of infested lots as determined on selective media (90 + %) were higher than revealed in grow out tests (41.0 %) indicating that not all infested seed results in infected plants. Studies under controlled conditions in the field revealed no plant to plant spread. The perfect stage (perithecia and ascospores) of the heterothallic pathogen was found in a few fields again this year indicating that the population of G. fujikuroi in California is variable and contains both mating types. The role of the ascospores in the overall disease cycle needs further study. This year the bakanae

disease was observed at varying levels in all rice producing counties with the exception of Fresno. The pathogen is abundant in residue of killed plants at harvest time providing the main source for infestation of seed. Studies have shown that the pathogen is primarily a surface contaminant of the seed but the possibility of internal infection needs further study since it may explain varying results obtained in studies to control the disease by various seed treatments.

Impact: Knowledge of P. grisea races in California allows breeders to proceed with confidence in attempts to produce resistant cultivars for California. Increased knowledge of the disease cycle of Bakanae disease allows us to better manage the disease by altering some cultural practices and to proceed in developing environmentally friendly seed treatments for control of the disease.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: AUTOMATED TRAP GIVES RELIABLE PEST COUNTS

Description: Traditional traps used to monitor pink bollworm populations in California cotton fields were unreliable. The numbers caught in traps varied from zero one day, to hundreds the next morning. Research indicated that entry into the traps by adult males was influenced greatly by temperatures and wind speed. A UC Professor of Entomology, Riverside, invented an automated pheromone trap, called Multipher(r), for pink bollworm adult males. He worked with Automata, a company that supplies weather stations for temperature monitoring and remote control functions. The automated trap was integrated into a weather station, with both installed in a cotton field on the Hull Farms in Palo Verde. The station automatically summed adult male entries every 29 seconds and sent the count, along with weather data, by infrared telemetry to a computer at the farm headquarters.

Impact: The automated pheromone trap provided reliable results of adult male pink bollworm populations in cotton fields. This enabled pest control advisors to determine the best course of action to control pest populations. Low pest populations monitored with the trap suggested that pesticides need not be applied and as a result, total cotton pesticide treatments were reduced, saving the grower money and environment a potential source of pollution.

Funding Source: Hatch and State

Scope of Impact: CA, AZ

Theme: 4.12 Integrated Pest Management

Title: BIOLOGICAL CONTROL IN PEST MANAGEMENT SYSTEMS OF PLANTS

Description: Goal A. 2. Conduct foreign exploration and ecological studies in native range of pest; 3. Determine systematics and biogeograpy of pests and natural enemies; 4. determine environmental safety of exotic candidates prior to release; 5. release, establish, and redistribute natural enemies; 6. evaluate natural enemy efficacy and study ecological/physiological basis for

interactions. Goal C. 10. assess biological characteristics of natural enemies; 11. conduct experimental releases to access feasibility; 12. develop prociedures for rearing, storing, quality control and release of natural enemies; 13 implement augmentation programs and evaluate efficacy of natural enemies; 15. evaluate the economic impacts of biological control. UC researchers continue to evaluate the efficacy of METAPHYCUS species near FLAVUS as a biological control agent against citricola scale, COCCUS PSEUDOMAGNOLIARUM (Kuwana), in San Joaquin Valley citrus and black scale, SAISSETIA OLEAE (Olivier), in southern California citrus. They finished releasing this parasitoid against citricola scale in the San Joaquin Valley of California as an augmentative biological control agent spring 2003. With the removal of the traditional spray practices in San Joaquin Valley citrus, citricola scale has re-emerged as an intermittent but serious pest of citrus. It was also an intermittent and serious pest in San Joaquin Valley citrus before 1950, but with the use of broad-spectrum pesticides, it was suppressed incidental to the control of other citrus pests such as California red scale. They have converted the mass production in which soft brown scale is gown on yucca leaves maintained hydroponically on which they grow the brown soft scale COCCUS HEPERIDUMN(L.). Brown soft scale then serves as the host on which they mass-produce M. sp. nr. FLAVUS. They have halved the costs of mass-producing M. sp. nr. FLAVUS and they now produce these biological control agents for about two-thirds the cost that are incurred by the only insectary producing soft scale parasitoids for use commercially.

Impact: This project continued to develop the understanding allowing the development of an ecologically based pest management program for California citrus. This program exploits natural enemies as the dominant means of pest suppression along with the judicious use of pesticides. This pest management strategy results in overall pest management costs that are equal to or less than that characterizing a traditional chemically based pest management strategy.

Funding Source: Hatch Multistate Research and State

Scope of Impact: ZA, CA, CO, GU, HI, ID, KS, MT, ND, NJ, NM, NYC, OR, SAM, UT, WA

Theme: 4.12 Integrated Pest Management

Title: BIOLOGY AND CONTROL OF STRUCTURAL INSECT PESTS

Description: There is an increasing awareness and concern by the public of the impact of insecticides on their health and the environment, especially with regards to termite control. UC researchers intend to emphasize research on the behavior, biology, nutritional dynamics, and physiological ecology of wood-destroying organisms with the objective of controlling them through environmental manipulation and slow-acting toxicants and baits. A secondary goal is to investigate means of reducing the amount and improving the efficacy of the chemicals they are currently using against termites. Dwellings and other buildings within the urban setting serve not only as residences and storage facilities for humans, but also provide ecological niches for numerous wood-destroying organisms. Human dwellings and structures represent tremendous financial investments and their protection is of utmost importance. Termites were exposed to soils treated with labeled amounts (50 and 100 ppm) of imidacloprid. When exposed to 100 ppm, imidacloprid was horizontally transferred between nymphal western subterranean termites,

Reticulitermes hesperus. The transfer was primarily due to contact. Transfer from tropallaxis, cannibalism, and coprophagy was insignificant. Exposure to 100 ppm inhibited locomotion and the spread of imidacloprid in simulated colonies. Imidacloprid soil treatments are not repellent, killing termites contacting treated soil. Movement of imidacloprid out of the treated zone by termite activity is unlikely. Hexaflumuron is efficiently passed to termites by trophallaxis. However, termites rapidly pass hexaflumeron through the body, the retention time being less than 3 days. About 115 ng of hexaflumuron are necessary to kill termites. Continuous feeding of western subterranean termites on hexaflumuron baits is needed to provide control of the colony.

Impact: Conventional soil treatments for termite control require large amounts of insecticide to provide long residual protection of structures. Understanding how these chemical barriers affect foraging termites is essential in developing less toxic barriers and eliminating the use of persistent chemicals in the urban environment. This is especially true for the recently registered non-repellent termiticides, imidacloprid and fipronil. These studies focus on termites found in the arid southwest and California and their control. The use of baits containing compounds such as hexaflumuron will reduce insecticide use in urban areas.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: BIOLOGY AND INTEGRATED PEST MANAGEMENT OF GRAPE PHYLLOXERA

Description: Grape phylloxera was probably imported into California during the 1850s and 1860s. After detection, damage and spread was well documented. By 1921, W. M. Davidson and R. L. Nougaret reported its presence in all California viticultural regions north of the Tehachapis. Rootstock trials began in earnest in 1905. A variety of rootstocks were used until L. A. Lider recommended the rootstock AXR number 1 for its superior viticultural properties. Failure of this rootstock to phylloxera began in 1983. The virulent phylloxera causing the damage was named biotype B to distinguish it from the then more common biotype A that did not damage AXR number 1. Grape production losses and replanting cost California about 1 billion dollars but is now substantially complete. Rootstocks used in California's cooler wine regions now tend to be only those that are strongly resistant to grape phylloxera while both susceptible own-rooted vines and rootstocks that are not as strongly resistant are used in the Central Valley which is less conducive to the insect and its damage. Pockets of phylloxera infestations and damage are not un-common in many regions and are due to farmers not yet having dealt with AXR number 1 problems or knowingly or unknowingly engaging in risk-taking. It is important to note that the only rootstocks to fail due to phylloxera populations over the approximately 130 years since they were first selected and hybridized, have been the weakly resistant rootstocks with partial V. vinifera parentage. This is not to say that the strongly resistant rootstocks are immune: they can support small, non-damaging phylloxera populations on their feeder roots and many have strong leaf-galling populations neither of which substantially decrease vine fitness. The main questions are: -Why has resistance of rootstocks to phylloxera been so durable? -What is the risk of failure and what are the risk factors that might accelerate failure? -What can we do to prevent or slow failure? -What tools do we need in order to be prepared to meet that failure if and when it

occurs? The long term goals of this project are to: 1. Evaluate and monitor worldwide risk for failure of strongly phylloxera resistant root stocks. 2. Develop methods to prevent rootstock failure and react after it has occurred. To accomplish these goals the 5 year objectives are to: 1. Identify reasons why failure of strongly resistant rootstocks has not already occurred and determine factors that may increase or decrease the probability of failure. This knowledge will be used to evaluate and monitor risks worldwide. 2. Determine viticultural methods that can predictably ameliorate phylloxera populations and vineyard damage. UC researchers studied high and low virulence secondary fungal pathogens (Fusarium oxysporum) from phylloxera-infested vines. 1) They tested virulence on 2 year grape rootstocks and a Vitis vinifera cultivar. They were inoculated last year and evaluated in spring this year. All rootstocks were susceptible and the low and high virulence was confirmed. No differences between rootstocks were seen. This field confirmation completes work indicating that F. oxysporum virulence is variable and predictable from lab bioassays. 2) They did replicated water stress and crop load stress tests on Cabernet vines at the UC field station in Hopland, CA to determine whether fungal virulence is influenced. The experiment achieved stress as indicated by pressure bomb measurements of leaf stem water retention for water stress and crop measurements for crop load stress. Results suggest that these stresses do not increase virulence of F. oxysporum isolates. A parallel test on the UC Davis campus suggested that water stress does not influence phylloxera vigor, either. These results were unexpected and suggest that viticulturally relevant stress physiology is not important to infection or infestation. Stress is frequently used in vineyard management for grape quality. These results suggest the hypothesis that field differences in vineyard decline from phylloxera activity is not based on vine physiology, but rather ecological conditions. The fourth year of the field trial using compost to ameliorate phylloxera vine damage in a mature vineyard was completed. Treatments included plots with and without compost cover, hay cover, and tillage. Treatment effects with regard to phylloxera populations, root necrosis, and vine production and vigor were not seen. The researchers will terminate this experiment. The results suggest that the cause of slow vine decline in phylloxerated organic vineyards is not simply soil organic matter. They are conducting laboratory tests of ethylene and ethylene inhibitor on phylloxera gall formation. Although treatments clearly impact callus production, the effects on the insect are not clear. They will continue trying to identify regulating mechanisms of phylloxera gall formation. This is important because gall formation is the limiting factor for phylloxera survival and population growth. They have begun collaborating with a colleague at the UC Davis Dept of Viticulture & Enology on phylloxera populations on rootstocks as observed in vineyards in buried tubes. Phylloxera were found on 3 rootstocks at the Napa field station by visual observation and emergence traps on the vineyard surface. These results suggest mechanisms by which rootstocks might prevent selection of virulent phylloxera strains. They are planning ways to test this suggestion. They began testing root and fungus CO2 production and O2 utilization as mediating factors for insect and possibly root health. Excised root pieces infected with F. oxysporum in closed containers can produce a sufficiently high CO2/O2 ratio in one week to inhibit phylloxera. They will continue these tests to determine whether this mechanism plays a positive or negative role in vineyards.

Impact: This knowledge will help the winegrape industry utilized rootstocks as a management tool for this serious pest.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: BIORATIONAL METHODS FOR INSECT PEST MANAGEMENT (IPM): BIOORGANIC AND MOLECULAR APPROACHES

Description: Objectives: 1. To identify and understand the origin and perception of insect semiochemical systems with the goal of applying this knowledge to insect management. Objective 3. To develop insect regulatory peptides and proteins, including various enzymes and insect-specific toxins as novel agents for plant protection.

Progress was made on several fronts. First, in a long-term collaboration with Gerhard Gries et al., UC researchers identified a new and more effective pheromone blend for the oak processionary moth. A manuscript describing this work is in press in the journal Chemoecology. Second, a collaboration initiated with a colleague at the University of Illinois, on the pheromone chemistry of woodboring cerambycid beetle pests, is starting to pay major dividends. They have identified the contact sex pheromones for several pest species attacking hardwoods, and in the late summer of 2003, identified the first fully verified a long-range aggregation pheromone for a cerambycid beetle, for the red-headed ash borer. They have also tentatively identified attractant pheromones for two other species. A USDA-NRI grant proposal has been recently submitted to carry this work forward on a group of eleven other target species. They are completing work on the identification and development of sex pheromones for the citrus peelminer, Marmara gulosa. They have identified, synthesized, and tested 4 possible pheromone components, but only one seems to be required for attraction. They have also initiated pheromone identification projects for the avocado seedworm, Stenoma catenifer, the citrus leafminer, and the pecan nursery casebearer, which are significant pests of avocado, citrus, and pecans, respectively. At the present time, the avocado seedworm is not established in the US, and efforts are directed towards developing an effective detection system for quarantine and related uses by US officials and growers.

Impact: The output from this collaborative project has included several papers describing new pheromone chemistry for pest species that can be exploited in monitoring and control programs. There have been several outcomes. First, the groundwork has been laid for a multi-year effort to elucidate the role of pheromones within this large insect family that includes numerous pest species. This, coupled with several initial publications from the project, has provided the critical nucleus of data and proof of concept required to submit a multiyear grant application to carry this work forward at a greatly accelerated pace. The project, although still in its early stages, has already had an impact: in addition to providing US foresters with a means of detecting and monitoring red-headed ash borer, pheromone-baited traps are being deployed in New Zealand to detect a recent invasion of this insect, with the overall goal of eradicating it before it can spread widely. For the longer term, American crops and forests are increasingly threatened by introductions of devastating cerambycid beetle pests such as the Asian longhorned borer. By studying the use of semiochemicals by selected cerambycid species that have different life histories, mating strategies, and host finding strategies, the researchers intend to develop an overview of the use of semiochemicals within this insect family, and from that, how they can exploit these semiochemicals to maximum advantage for insect sampling and management purposes.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AZ, AR, CA, CO, FL, MN, MT, NV, PA

Theme: 4.12 Integrated Pest Management

Title: CELL WALL POLYSACCHARIDE STRUCTURE AND METABOLISM

Description: Objectives: 1. Characterize wall changes in tomatoes with modified expression of PG and expansin (EXP). 2. Characterize the impact of reducing both PG and EXP presence in ripe tomato fruit on the integrity of particle-bound and soluble polysaccharides in processed tomato juice and on the consistency (viscosity and flow characteristics) of tomato juice concentrates and paste. 3. Identify the proteins in extracts of immature green tomato fruits that are responsible for the digestion of complex tomato pectins. 4. Use the tomato ripening-related alpha-arabinosidase isoform in conjunction with other tomato fruit enzymes to study enzyme interaction in pectin digestion. 5. Describe aspects of cell wall metabolism in ripening, chilled peaches that are different from those displayed by ripening peaches that have not been chilled in order to learn the wall metabolism factors that contribute to mealy texture in ripe fruit. 6. Determine whether PDOs accumulate in pathogen-infected fruit tissue and if the level of PGIP in the fruit affects the accumulation of PDOs. 7. Identify the genes that are activated by exposure of tomato fruits and vegetative tissues to PDOs extracted from infected tissues. 8. Identify signal transduction processes that are activated by tissue exposure to PDOs. UC researchers have been studying the development of Pierce's Disease (PD) in the xylem of grapevines and are testing a model that may describe the progression of the disease in vines. The genome of the causal bacterium (Xylella fastidiosa) contains genes whose structures indicate that they should encode the cell wall polymer-digesting enzymes, endo-1,4-beta-glucanase (EBG) and polygalacturonase (PG). The bacterial gene sequences have been cloned and attempts are being made to express them in E. coli. Expression of the putative EBG gene has been accomplished and the transformed E. coli produce EBG activity. Tests with the E. coli expressing the PG sequence are underway. Immunohistochemical observations have shown that pectin polysaccharides co-localize with clusters of X. fastidiosa in grapevine xylem. This suggests that the xylem blockage that is part of the PD syndrome is due, at least in part, to a vine response. They are in the process of raising antisera that will allow us to determine if some of the polysacharide that accumulates in grapevine xylem is bacterial in origin. They have developed NMR techniques that allow them to examine the functioning of vessels in stems of infected vines without damaging the vines. These approaches will be used to follow development of internal symptoms of PD in intact vines over several weeks. They have reported on the impact of transgenic modification of ripening tomato fruit expression of wall-modifying proteins on the quality attributes of processed tomato products. They have now begun a collaboration that will combine suppression of ripening-related PG and beta-galactosidase production in a single transgenic tomato fruit line. The plan is to determine if the two enzymes interact in the pectin polysaccharide digestion that normally accompanies ripening. Soon they will begin a similar collaboration to test the impact of combined suppression of tomato PG and the newly identified pectate lyase (PL).

Impact: The UC studies of the progression of PD in grapevines will identify key points in disease development that might be interrupted in a controlled way in order to reduce the impact of the disease on productivity. The alterations of wall-modifying enzymes in ripening fruits will

identify key aspects of fruit softening and may yield fruit lines with improved fresh and processed fruit characteristics.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: CHARACTERIZATION OF PROTEINS REQUIRED FOR SPORULATION IN THE FUNGUS ASPERGILLUS NIDULANS

Description: Filamentous fungi are often pathogens to crops and humans. Fungi disseminate by spores, which are mainly produced by asexual sporulation. An effective manner to contain pathogenic fungi is to block the asexual sporulation process. However, limited knowledge has been obtained about sporulation mechanisms in filamentous fungi. They use the filamentous fungus Aspergillus nidulans as a model system to dissect asexual sporulation mechanisms. This is because 1) many Aspergillus species are pathogens to agriculturally important crops (grapes, pistachios, etc.) in California, and 2) A. nidulans is an excellent model system with rich research tools for understanding the biology of Aspergillus species. The long-term goal is to facilitate the identification of molecules that are specifically required for fungal sporulation, and isolation of anti-fungal agents that target at these molecules. Most fungal pathogens of plants and animals are filamentous fungi. Because filamentous fungi reproduce in forms of spores, inhibition of sporulation is an ideal strategy to block their propagation. The species Aspergillus nidulans is a laboratory model organism for us to address general questions on fungal growth and reproduction. By analyzing proteins that are required for sporulation in A. nidulans, UC researchers aim to identify novel targets for designing anti-fungal agents. They have found the following three strategies would allow us to effectively inhibit/abolish asexual sporulation. 1. Deregulation of septation. Because filamentous fungi bear unique features in septation, they wish to isolate molecules that are not found in plants and animals, but are required for septation. Previously, they have found that the novel SNAD protein is required for timely execution of septation, and is essential for asexual sporulation. They have further characterized that SNAD is a scaffolding factor for regulation of septation. They have also identified a novel protein called AnMOB1, whose function is to promote septation progression. Both SNAD and AnMOB1 localized to the spindle pole body, but AnMOB1 translocated to the septation site upon completion of mitosis. The ongoing work focuses on understanding how SNAD affects the activities of AnMOB1 and how AnMOB1 translocates to the septation site. 2. Defect in nuclear migration. Nuclear migration is critical for both hyphal growth and sporulation. It has been known that the multi-subunit motor complex, cytoplasmic dynein is primarily responsible for nuclear migration in filamentous fungi. The goal is to identify regulators of the dynein motor in filamentous fungi. One of the regulators they are investigating is an 8-kDa protein called LC8. They have found that LC8 was only required for nuclear migration and asexual sporulation at elevated temperatures. Currently, they are investigating how this small protein plays roles in this temperature-dependent manner. 3. Defect in the microtubule system. They have also initiated a project to investigate unique features of the cytoskeletal element, microtubules in growth and development in filamentous fungi. The strategy they are currently employing is to identify microtubule-associated proteins that are found in A. nidulans, but not in yeasts. They have found

two of such proteins, which are in the category of microtubule-based kinesin motors. They have demonstrated that one of them plays a role in hyphal growth. Further functional studies are in progress.

Impact: Filamentous fungi constitute major fungal pathogens of crop plants. Currently there are limited tools to eliminate pathogenic fungi in the field and working places. Proteins that are required for filamentous fungi-specific activities may serve as novel targets for developing anti-fungal drugs. The goal is to discover such proteins by using A. nidulans as an experimental model.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: CHEMICAL AND CULTURAL PRACTICES AS ALTERNATIVES TO METHYL BROMIDE FUMIGATION FOR VEGETABLE CROP PRODUCTION

Description: The primary research objective of this proposal is to identify alternative chemicals and cultural practices to eliminate the use of methyl bromide for soil fumigation. Specifically, to test alternative fumigants and other agents that are effective, economical, and environmentally sound. Determine irrigation management practices that are efficient and will maximize yields under a range of pathogen pressures. Develop and demonstrate crop production practices under a range of pathogen pressures that provide acceptable yields and economic returns and minimize use of chemical fumigants and environmental damage from agricultural chemicals. Methyl bromide (MeBr) is applied extensively in CA as a preplant biocide for production of strawberries, vegetable crops, ornamental and cut flowers, and perennial crops. The main objective of this project is to develop, field test, and demonstrate crop production practices that will eliminate the use of methyl bromide in California. Two field research experiments and three demonstration projects were initiated to test and optimize chemical alternatives to MeBr in California. Research Trials: The objective of this study was to compare the efficacy of several alternative fumigants applied through drip irrigation systems for strawberry production in CA. Two research plots were initiated in Watsonville and Salinas. The alternative chemicals tested were chloropicrin (300 lbs/ac), Inline (300 lbs/ac), and iodomethane (300 lbs/ac). This research found that crop quality and yield under the alternative fumigants to be equivalent to those grown under MeBr/chloropicrin fumigated soils. On-Farm Demonstration Project: Three demonstration plots (each ~1 acre) were established on growers fields in Oxnard, Salinas, and Watsonville between July and October, 2003. Chloropicrin and Inline were applied at three rates (100, 200, and 300 lbs/ac) followed by 45 gal/ac of metam sodium. The purpose of this project is to demonstrate drip fumigation to growers and to evaluate reduced rates of fumigants under different soil types. Results suggest that reduced rates of these fumigants(< 200 lbs/ac)are sufficient to control pathogens if applied in combination with metam sodium.

Impact: The phase out of MeBr will result in great crop losses from soil-borne pathogens and weeds. This project evaluates alternative chemicals and practices for crop production. The research effort resulted in the development of techniques to apply alternative fumigants through drip irrigation systems for crop production (strawberry and vegetable crops). This research also

determined optimum parameters for applying metam sodium under various soil conditions. The demonstration project provides growers with application technologies of alternative fumigants through drip irrigation systems that are efficacious and lower risk, and lower cost than MeBr fumigation. According to recent data from the California Department of Pesticide Regulation, more than 20% of the strawberry land was fumigated with the alternative fumigants in 2003.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: CLASSICAL AND MOLECULAR GENETICS OF LETTUCE

Description: Objectives: To pursue a program of classical and molecular genetics on lettuce that emphasizes disease resistance. This project encompasses both classical genetics and genomic approaches to lettuce improvement. UC researchers are introgressing multiple genes for resistance to several diseases, particularly downy mildew, from wild species into leafy lettuce types as well as crisphead types. These are being combined with other genes for resistance to corky root and lettuce mosaic. They are introducing different resistance genes for the same pathogen into different lettuce types. This will fragment the pathosystem and result in divergent selection of the pathogen populations. This should lengthen the efficacy of individual resistance genes. Resistance genes are also being mapped and introgression will be aided by linked molecular markers. Molecular marker analysis of resistant wild germplasm demonstrated a large number of distinct haplotypes with little overlap indicating that there are many resistance genes available for introgression. They are also mapping genes of agricultural importance, particularly root and leaf traits, to develop molecular markers for marker-assisted selection. They are in the final stages of integrating mapping data from multiple crosses to generate a detailed genetic map containing over 2,000 molecular markers as well as disease resistance and loci of horticultural importance. This is accessible over the www in a database focused on Compositae species (http://compositdb.ucdavis.edu/).

Impact: This project develops basic and applied information for the control of diseases in lettuce. In addition, primary germplasm and advanced breeding lines are released to the industry. Both activities result in higher quality lettuce and less reliance on chemical protectants. In addition, they monitor the downy mildew fungus for fungicide insensitivity to avoid ineffective applications of chemicals.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: CONTROL OF CULEX DISEASE VECTORS OF CALIFORNIA

Description: The overall goal of this program is to develop and improve on current methods used for control of the mosquitoes Culex tarsalis and Culex pipiens complex members that are

vectors of disease in California. This goal is especially relevant today due to the inevitable invasion of West Nile virus into California. This goal will be achieved by focusing on two main objectives. The first objective is to develop and then use highly sensitive, selective and inexpensive methods for detection of pyrethroid resistance in California mosquitoes. In a small scale surveillance, high level resistance to pyrethroids was found in a California population of Cx. pipiens pipiens "molestus" and low level tolerance in two populations of Cx. tarsalis. The mechanisms of resistance in these mosquitoes appear to be complex and multifactorial and that the current tools available for identifying these mechanisms are non-specific and insensitive. Because of these shortfalls of resistance mechanism detection assays, state of the art chemical and fluorescence technology will be used to develop improved assays that will allow for earlier and more precise detection of resistance to pyrethroids in mosquitoes. The earlier that resistance can be detected the sooner mosquito abatement districts can respond and adjust control practices to mitigate further spread and increase in resistance. The second objective is to find and evaluate Culex mosquito attractants that will work more efficiently than current attractants. Presently California uses carbon dioxide baited traps for collection of mosquitoes for virus isolation testing and to provide estimates of mosquito population sizes. Mosquito abatement districts rely on the data received from CO2 baited trap collections to make decisions about the intensity and areas where mosquito control should be focused. However, the CO2 baited traps work very inefficiently as they collect predominantly mosquitoes that had never had the opportunity to be infected with viruses. Traps designed to collect gravid mosquitoes and hence mosquitoes that had taken a blood meal would work a lot more efficiently for collection of virus infected mosquitoes. Gravid traps are not currently used because the gravid female mosquito attractants available today do not work well. State of the art molecular and biological approaches will be used to find and synthesize better attractants and these will be evaluated in the field. No population of Culex pipiens complex or Culex tarsalis mosquitoes resistant to pyrethroids other than the one found in Marin County in 2001 has thus far been identified. Mass spectrophometry using cypermethrin produced direct evidence of enzyme mediated hydrolysis of pyrethroids in the resistant Marin mosquitoes. In our efforts to develop inexpensive but yet highly sensitive pyrethroid resistant monitoring tools, none of the novel fluorescent substrates for detection of selective pyrethroid metabolizing esterases and mixed function oxidases that they evaluated this past year produced conclusive results. However, many more still have to be evaluated which they anticipate to continue doing this year. A recently initiated project funded jointly by the IPM and UC wide Mosquito Research programs done in collaboration with a researcher from the Dept. Entomology at Davis revealed that Culex mosquitoes only slightly tolerant to pyrethroids were capable of surviving recent treatments of Lambda Cyhalothrin (Warrier) in rice. This implies that there will have to be greater vigilance about monitoring influence of agricultural use of pyrethroids in selecting for high levels of resistance in Culex mosquitoes in California. Additionally, coordinated efforts need to be initiated between agricultural and public health use of pyrethroids to preserve future long term effectiveness of these compounds in control of Culex mosquitoes. This past year, a detailed photomap of salivary gland polytene chromosomes representative of members of the Cx. pipiens complex was developed. Comparisons of chromosome banding revealed surprisingly little variation between members of the complex residing in California. The existence of a photomap has now allowed for the possibility of getting the entire genome sequenced of Culex quinquefasciatus which are important vectors of West Nile and Rift Valley fever viruses and filariasis in tropical and temperate regions. Genomic libraries of Culex quinquefasciatus enriched for microsatellites were produced this year. Appropriate polymorphic

microsatellites will be selected and when they are used in combination with the polytene chromosome banding patterns they will be in a position to tackle some of the long standing enigmas that currently exist in understanding the population structures and systematics of members of the Culex pipiens complex. A joint project with a faculty member from the Dept. Entomology at Davis revealed that sequence variation in mitochondrial DNA was limited amongst California Cx. pipiens sensu latu which precludes the use of mitochondrial DNA haplotypes as a population genetic tool for these mosquitoes. As part of a joint effort to develop a better oviposition attractant trap for collecting Culex tarsalis, for virus surveillance purposes, an odorant binding protein was characterized in this mosquito. This protein will be used to screen and find chemicals that these mosquitoes use as environmental cues to find appropriate oviposition sites.

Impact: The high use of pyrethroids in California against agricultural pests could very likely, unintentionally, select for pyrethroid resistance in medically important Culex mosquitoes. Resistance, monitoring using bio-assays must be vigorously pursued so that alternative chemicals can be used to reduce selection of high level resistance.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: DEVELOPMENT, EVALUATION AND SAFETY OF ENTOMOPATHOGENS FOR CONTROL OF ARTHROPOD PESTS

Description: Objectives: 1. Development, evaluation and safety of entomopathogens for control of leaf feeding insect defoliators 3. Development, evaluation and safety of entomopathogens used in cryptic and soil habitats. Bacterial insecticides have been used for control of nuisance and vector mosquitoes for more than two decades. Nevertheless, due primarily to their high cost and often only moderate efficacy, these insecticides remain of limited use for mosquito control, especially against mosquitoes that vector disease agents such as West Nile Virus. UC researchers have now used recombinant DNA techniques to markedly improve bacterial insecticide efficacy by increasing the synthesis of mosquitocidal proteins, and by enabling new endotoxin combinations from different bacteria to be produced within single strains. These new strains combine mosquitocidal Cry and Cyt proteins of BACILLUS THURINGIENSI with the binary toxin BACILLUS THURINGIENSIS, improving efficacy against CULEX mosquito species by tenfold, and greatly reducing the potential for resistance through the presence of Cyt1A. Moreover, although intensive use of B. SPHAERICUS against CULEX populations in the field can result in high levels of resistance, most of this can be suppressed by combining this bacterial species with Cyt1A, the latter which enables the binary toxin of this species to enter midgut epithelial cells via the microvillar membrane in the absence of a midgut receptor. The availability of these novel strains and newly discovered mosquitocidal proteins, such as the Mtx toxins of B. SPHAERICUS offers the potential for constructing a range of recombinant bacterial insecticides for more effective control of the mosquito vectors of filariasis, Dengue fever, and malaria. The initial recombinant mosquitocidal bacteria were constructed using erythromycin resistance as the selectable marker. As this selectable marker gene is now unlikely to be allowed

in commercial products, they have replaced this with a gene for kanamycin resistance. Limited field trial of B. THURINGIENSIS strains that produce the B. SPAHERICUS will be carried out during the next two years. More basic research on the mechanism of action of the Cyt1A protein indicates that this protein does not act by causing cation-selective channels in lipid membranes, but rather by forming non-specific lesions, most likely lipid faults in the microvillar membrane.

Impact: These results demonstrate that it is possible to recombine mosquitocidal proteins from different bacterial species into cost-effective single strains using selectable markers that are acceptable to the U.S. EPA. These new strains should become the next generation of bacterial insecticides used for mosquito control to control nuisance mosquitoes and those that vector human pathogens such as the West Nile Virus.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AL, AR, AZ, CA, CT, DE, FL, GA, IL, KY, LA, ME, MN, NJ, NY, OH, PA, SC, VT

Theme: 4.12 Integrated Pest Management

Title: DEVELOPMENT, EVALUATION AND SAFETY OF ENTOMOPATHOGENS FOR CONTROL OF ARTHROPOD PESTS

Description: Objectives: Development, evaluation and safety of entomopathogens for control of veterinary and structural arthropod pests. At the present time the number of options available for the control of pest and vector mosquitoes is quite limited. For larval control they have petroleum oil, one synthetic insect growth regulator and 2 microbial control agents. The microbial agents are widely used now in mosquito control, but one of the agents which is highly effective and safe is prone to the development of resistance. UC researchers have recently found that a mixture of the two or their rotation can delay and preclude resistance. They are studying various mixtures now to see if already existing resistance can be reversed and secondly to see if use of mixtures will delay or present resistance. The results of these studies are quite promising, it appears that mixtures are very effective in preventing development of resistance.

Impact: There is now two years of data showing that mixtures of the two microbial agents are very effective in preventing resistance. This strategy is now being commercially developed and soon will be placed for use in the operational mosquito control program.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AL, AR, AZ, CA, CT, DE, FL, GA, IL, KY, LA, ME, MN, NJ, NY, OH, PA, SC, VT

Theme: 4.12 Integrated Pest Management

Title: DISEASE FORECASTING IN VEGETABLE CROPS

Description: The development of spray forecast systems is critical to the judicious use of fungicides. Spray forecast systems address several critical risks associated with pesticide

applications. First, it tells the grower when sprays are needed to protect the crop, thus reducing the risk of yield loss. It also eliminates the risk of applying fungicides when they are not needed, reducing unnecessary liability risks and production costs. Finally, it may lower the potential of the pathogen to develop resistance to fungicides if the number of applications of a particular fungicide is reduced. In addition, where little is known on the epidemiology of a certain disease, basic information on the source of primary inoculum and spread of the pathogen must be elucidated. In many cases, descriptions of the environmental conditions conducive to disease development are needed. When this information is complete, an integrated approach to disease management with the widest array of options to control pests, including elements of plant genetics and breeding techniques, cultural methods, and crop protection through the judicious use of chemicals, can be implemented. In this project the weather variables most responsible for favorable conditions for several diseases were elucidated. When this information is coupled with detailed monitoring of weather and infection invents, forecast models were developed and implemented in grower fields. The objectives of this study were to (1) develop forecasting systems for certain diseases of vegetable crops in central and northern California, and (2) implement the predictive models to improve disease control in these crops. To monitor populations of spores in the air, spore samplers were placed within and outside fields. Disease incidence in selected fields was monitored to correlate inoculum pressure with disease outbreaks. Leafwetness, relative humidity, and air temperature were monitored continuously with weather stations. Plant development and disease incidence were monitored bi-weekly. The incubation periods of the causal agents of tomato powdery mildew and rose downy mildew under different weather regimes were determined using SAS discriminant analysis procedures. For each weather and biological variable, sub-variables (such as duration of leaf wetness at certain temperatures) were calculated for incubation intervals ranging from 1 to 16 days using a basic language computer program. The SAS discriminant analysis procedure was used to determine sub-variables and incubation intervals that correlated with disease incidence. The discriminant procedure was also used to develop a linear equation describing the relationship among significant sub-variables to disease incidence. The results of the discriminant analysis were used to develop forecast models. To evaluate timing and number of fungicide applications on control of these foliar diseases, field trials were established in grower fields.

Impact: A model to predict to tomato powdery mildew was developed and added to the UCIPM website for public use. The model to predict rose downy mildew was published; a private company is working with the rose industry in California for implementation. Both of these models allow for greater accuracy of disease control, thereby reducing economic losses for the grower. A model for forecasting blackmold of tomato was developed and awaiting implementation.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: DISEASE MANAGEMENT IN ORNAMENTAL CROPS

Description: Objectives: To continue development of alternatives to methyl bromide for ornamental crops; to continue development of methods for eliminating pathogens from recycled irrigation water; to complete work on a predictive model for powdery mildew in greenhouse roses; and to develop methods to detect and eliminate Phytophthora ramorum from ornamental nurseries. The UC research has continued to emphasize alternatives to methyl bromide for field-grown ornamental crops in coastal production areas. Researchers have sought to characterize various members of the Brassicaceae for their production of glucosinolates, soil factors that influence glucosinolate conversion to isothiocyanates, and the fungitoxicity of different isothiocyanates. The objective of this work has been to evaluate biofumigation as an alternative to methyl bromide. They also have continued their research into chemical alternatives. Experiments at different coastal locations in California have evaluated methyl bromide, Iodomethane, Chloropicrin, Metam sodium, Telone II, Telone C-35, and Dazoment at various rates and in various combinations. Among the various treatments, the combinations that have provided the most consistent and significant control of Fusarium spp. have been combinations of metam sodium (75 gal/acre) plus Telone C35 (35 gal/acre) and metam (75 gal/acre) plus Telone II (15 gal/acre) plus chloropicrin (200 lb/acre). These same treatments, in which Dazomet (at 200 lb/acre) is substituted for metam, also proved efficacious at all locations. They have found iodomethane plus chloropicrin (50:50 mix at 300 lb/acre) to be efficacious in locations with sandy loam soils, but inconsistent in locations with heavier soil types. Research also has begun on the survival and spread of Phytophthora ramorum in ornamental crops. Phytophthora ramorum is the causal agent of sudden oak death, and ornamental crops have been implicated in pathogen spread. They are seeking to determine propagule survival in container media and possible modes of spread within ornamental crops.

Impact: Flower growers in coastal regions of California urgently need alternatives to methyl bromide. The UC experiments have shown that a number of currently-registered or soon-to-be-registered chemicals will provide control of some key soil-borne pathogens. However, successful use of these materials will require very close attention to soil conditions at the time of application.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: EFFECT OF CULTURAL PRACTICES ON CONTROL OF DISEASES OF PRUNUS SPP.

Description: Objectives: To validate and demonstrate the use of various irrigation systems in a deficit irrigation program to manage hull rot disease of almond trees and to compare the effects of orchard management systems on incidence and severity of Alternaria leaf spot, fungicide efficacy, and orchard climate. Alternaria leaf spot, a defoliating disease of almond trees, originally was a problem restricted to the southern areas of the San Joaquin Valley. Recently, the disease also has been reported more frequently from other almond growing regions of the state. Severe defoliation by mid summer reduces yield and weakens trees. The disease is controlled by the use of fungicide sprays in late spring and summer. Because most fungicides are not registered

for use on almond this late in the season, growers make repeated treatments with one product, a practice that threatens to lead to the development of fungicide resistance in the pathogen population. To help prevent this, tools to aid in determining when and how often to treat and identifying fungicides of different chemistries would contribute greatly to long-term successful control. Thus, UC researchers concentrated on developing prediction methods and the further screening of candidate fungicides. They evaluated an epidemiological model developed for black mold of tomato, which is caused by one of the three species of Alternaria that causes Alternaria leaf spot of almond. In this model, disease severity values are assigned based upon the temperature during and the duration of leaf wetness periods. Rapid increases in disease severity values signal infection periods and thus predict the later appearance of symptoms. Dataloggers were placed in each of three orchards to monitor leaf wetness, relative humidity, temperature and rainfall. Approximately 100 leaves on each of four branches on each of three trees in each orchard were marked. The number of lesions and the number of leaves present were recorded weekly from 1 May to 31 July. Disease increased rapidly and was high in two orchards at the end of the evaluation period. Increases in disease levels were found 21-27 days after a rapid increase in disease severity values. Greater numbers of infection periods and greater disease severity values were found in the orchards with the worst disease. Thus, this model appears to be an adaptable tool for predicting infection periods and potentially for timing fungicide applications. In the fungicide screening, a pre-mixed combination of pyraclostrobin and nicobifen gave superior control, and a rotation beginning with chlorothalonil followed by either azoxystrobin or the pyraclostrobin-nicobifen combination also were very good. These possible choices would provide different chemistries from which growers could choose. In another ongoing experiment, the effects of tree architecture on the incidence of disease are being tested by imposing four pruning methods onto large plots of trees. Trees are hedged, topped, hedged and topped or lightly hand pruned. In this, the third year of the experiment, there were significantly more infected leaves in trees that were hedged than in other treatments, but no differences occurred in defoliation or any yield parameters.

Impact: The success of the tomato black mold model in identifying infection periods for almond Alternaria leaf spot greatly simplifies the task of developing a model for the almond disease. Confirmation of these results and demonstration that the system can be used successfully to time fungicide treatments must be completed before deployment. Both of the effective fungicide treatments should become available to growers. Chlorothalonil is now registered and available for use on almond, and the premix product is nearing completion of testing in the registration process. The pruned trees are now beginning to assume noticeable differences in shape, which may affect disease in the future. That no adverse effects on yield resulted from the pruning treatments is important information for growers considering these methods.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: ENHANCING BIODIVERSITY IN AGROECOSYSTEMS TO IMPROVE PEST REGULATION AND SUSTAINABLE PRODUCTION

Description: Objectives are: 1. To determine the species diversity and abundance levels of the arthropod fauna (herbivores, predators and parasites) associated with the various flowering plant species established in the diversified cropping systems. 2. To determine to what extent beneficial insects depend on the resources of the planned plant biodiversity continued existence in the vineyards and annual vegetable crops evaluated. Which attributes and resources (i.e., pollen, nectar, hosts, etc.) of the associated plants are important for the natural enemies? 3. To determine if the vegetational assemblages influence the species diversity and abundance of entomophagous insects and whether this enhancement of beneficial arthropods results in lower insect pest loads on crop plants. 4. To assess the population levels of insect pests in diversified crops and monocultures that have been subjected to organic or chemical fertilization regimes, and determine the mechanisms at play that may explain observed density differences on plants subjected to differential nutritional treatments. Cabbage plants intercropped with buckwheat (Fagopyrum esculentum), and fertilized with organic compost exhibited lower loads of the aphid Brevicoryne brassicae than plants grown in monoculture plots and under chemical fertilizer treatments receiving equivalent amounts of Nitrogen. Pest density reductions in the biodiverse plots were associated with higher numbers of syrphid flies and parasitic wasps (Diaeretiella rapae) attracted by the buckwheat flowers, but also to the lower foliar N content of the organically farmed cabbage. Apparently cabbage plants subjected to chemical fertilization had higher N content in the leaves that coincided with peak aphid population densities in the monocultures.

Impact: Lowering aphid populations in cabbage plants through intercropping with flowers and applications of compost seems a viable approach to significantly reduce use of external chemical inputs without sacrificing agronomic yields.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: ENHANCING POSTHARVEST QUALITY OF FRUITS WITH REDUCED DEPENDENCE ON CHEMICAL TREATMENTS

Description: Objectives: 1. Develop effective, nonchemical alternatives for decay control using heat, controlled atmospheres, and biological control. 2. Develop effective, nonchemical insect quarantine treatments using various methods of heat treatments and controlled atmospheres as alternatives to methyl bromide fumigation. 3. Develop methods to control postharvest insects and disease using safer chemistries. UC researchers continued developing radio frequency heating treatments as a non-chemical method to control insects in harvested produce. These treatments have the potential to be rapid (up to 5 minutes), on-line processes providing for insect control and maintaining product quality. These alternative treatments are essential to replace methyl bromide fumigation and to maintain the existing export markets for US crops. Treatment of in-shell walnuts is particularly promising. Nuts can be heated in as little as 3 minutes and all species and life stages of critical concern are controlled while nut quality is maintained and perhaps improved. This season they combined hot air with radio frequency heating and investigated the potential to use radio frequency heating on washed in-shell walnuts to accomplish re-drying and

insect control in one treatment. They have also exploring radio frequency heating for sweet cherries. This is a more challenging treatment because of issues with stem browning and reduced shelf life of the cherries. They have concluded that radio frequency heating shows little potential for use on sweet cherries. They are also exploring the use of surfactants to control surface insects on produce. This work looks very promising to completely control or greatly reduce surface insects on produce that can cause problems during the export of these crops.

Impact: The deadline for the phase out of methyl bromide is in January 2005. Alternative methods of postharvest insect control are needed for stored products such as walnuts and almonds to prevent excessive product damage in storage and to prevent loss of critical export markets. A nonchemical alternative is attractive to consumers in the US and abroad. Radio frequency heating would be a new tool for postharvest insect control and quarantine treatments for organic products where tools are currently unavailable or limited.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: EPIDEMIOLOGY AND MANAGEMENT OF DISEASES OF VEGETABLE CROPS

Description: Objectives: 1) Determination of the potential enhanced degradation of registered and experimental fungicides efficacious against Sclerotinia minor; 2)Comparison of lettuce drop incidence in different bed configurations and irrigation methods; 3)Determination of the genetic and virulence variation in isolates of S. minor and S. sclerotiorum and relate it to cropping practices, lettuce and soil types, and weather within a GIS framework; 4) Development of rapid molecular diagnostics for Verticillium dahliae infectious to lettuce; 5)Development of a decision-support system for lettuce based on the inoculum density-disease incidence relationships for lettuce; 6) Determination of the role of seedborne Verticillium dahliae in the transmission of Verticillium wilt on lettuce in the field and its potential to establish the disease in uninfested fields. A major thrust of this research over the past year was on lettuce drop, a serious disease caused by two different but related species of the fungal genus Sclerotinia, S. minor and S. sclerotiorum. UC researchers are attempting to elucidate a paradox associated with the prevalence of these two species in different regions of California. They have taken a methodical approach to examine soil factors and tillage practices for their possible influence on survival, germination, growth, development, and distribution of these two pathogens. Together these studies point to the importance of soil temperature on reducing the survival of S. minor in the San Joaquin Valley, and soil moisture on the formation of the sexual stage by S. sclerotiorum, and explain in part the geographic distribution of S. minor in California. Ongoing work is attempting to elucidate the reasons for the differential distribution of S. sclerotiorum in California. In addition to the work on pathogen biology, the researchers examined cultural practices such tillage, crop rotation and irrigation placement to provide practical and sustainable practices to manage lettuce drop disease. They are currently evaluating the recent cultural practices adapted by growers for their effect on altering the established distribution pattern of the two species. Another major thrust over the past year has been our work on Verticillium wilt, a disease that affects many important crops in the Salinas Valley and elsewhere in California. Over

the past year, they examined the occurrence of Verticillium wilt in pepper, studied the key etiological and epidemiological parameters of the disease as it occurs in this host in coastal valleys. Furthermore, in collaboration with researchers at Purdue, they identified VET1, the genetic locus for tolerance of Verticillium in the model host plant, Arabidopsis. In addition to the work summarized above, which captures the major thrusts of this project, they have also been working on the alternatives to methyl bromide, an effective soil fumigant that is being phased out due to its deleterious effects on the atmosphere. A UC faculty member organized a special symposium on methyl bromide at the APS national meeting in 2000, and an overview of that symposium that he wrote and all other papers presented at the Symposium appeared in January 2003 in Phytopathology. Other chronic disease problems in various crops and the identification and characterization of problems whose etiology was not previously known in California is also another dimension of this project. Over the past year, they have proven Phoma exigua as the causal agent of a new basal rot on lettuce. Although the disease was initially detected on Romaine lettuce, it has not appeared on all types of lettuce and appears to be another serious threat to lettuce production in California.

Impact: Because of the applied nature of the work, the results always have a direct impact on disease management in many vegetable crops. They have identified the production practices that would have a major impact on lettuce production in the Salinas Valley. A number of lettuce breeding lines with resistance to S. minor and V. dahliae have been developed. Nearly all of the research conducted as part of this project is directed towards developing disease management strategies with the twin purpose of increasing sustainability and reducing the pesticide burden in vegetable production systems through integration of strategies. These strategies are rooted strongly in the principles of ecology, epidemiology, soil microbiology and sustainable agriculture.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: ETIOLOGY, EPIDEMIOLOGY, AND CONTROL OF VIRUS DISEASES OF GRAPEVINES, FRUIT AND NUT TREES, ROSES, AND STRAWBERRIES

Description: Objectives: Identify the viruses and other graft-transmissible pathogens associated with specific disease problems of grapes, fruit and nut trees, roses and strawberries; to conduct studies of the etiology and epidemiology of these virus and virus-like diseases; to develop improved detection and elimination technologies for these disease agents; using the knowledge gained above, develop integrated control strategies for these diseases which result in improved planting stock and, ultimately, greater agricultural productivity. Using the mealybug Pseudococcus longispinus, UC researchers have been able to confirm the transmission of GLRaV-5 and establish that GLRaV-9 can also be transmitted by mealybugs. Plants inoculated with GLRV-9 (LR118) were PCR tested 3, 6, and 9 months after inoculation using HSP70 and coat protein primers for GLRV-9. At this time, 13/74 inoculated plants have tested positive. More tests are planned after the plants go through a dormant season, after which, in our experience, virus titers increase and distribution in the plant becomes systemic. Plants inoculated

with GLRV-5 (LR100) were PCR tested 3 months after inoculation. Preliminary results show that single infections of GLRV-5 were transmitted by Ps. longispinus in experimental conditions. This confirms the earlier evidence that GLRV-5 can be transmitted by P. longispinus. Additional tests are in progress. The researchers were able to demonstrate significant and rapid natural field spread of leafroll disease in a Napa Valley survey vineyard. The vineyard they surveyed had been free of any leafroll symptoms for nearly a decade. By 2002 when they first surveyed, symptoms had developed in 23.3% of vines. In 2003, symptomatic vines were 41.2% of the vineyards. The symptoms were concentrated closer to where the old, symptomatic vineyard had been. The end of the vineyard furthest from the old vineyard had very few symptomatic vines. Results of ELISA testing found only GLRV-3. Visual symptom rating was very accurate, although not in perfect agreement with the ELISA testing. 100% of those vines that were visually rated as positives also tested positive for the virus; 2/20 (10%) of those rated negative tested positive for GLRV-3; and all of the plants rated as questionable tested negative for virus.

Impact: The researchers have confirmed anecdotal reports that grapevine leafroll virus is spreading in vineyards at an unexpectedly rapid rate. Growers need to be aware of this news which is contrary to past observations. This will allow them to take preventative measures which should include insuring that older infected vineyards are not maintained in close proximity to newly planted virus-free vineyards

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: FUNCTIONAL CHARACTERIZATION OF VASCULAR PLASMODESMATA

Description: The overall objective of this project is to characterize the properties of both the plasmodesmata that interconnect the CE-CC complex and the proteins that traffic through these highly specialized intercellular organelles. These studies will provide much needed information on the manner in which higher plants utilize macromolecular transport, across the plasmodesmata connecting the CC-SE complex, to establish and maintain the phloem long-distance transport system, and particularly the cambium. The plant vascular system plays a pivotal role in the long-distance delivery of water and nutrients to distantly located organs. Our research has demonstrated that the phloem component of the vascular system is also engaged in the trafficking of information macromolecules (proteins and RNA). The concept that RNA molecules, circulating around the plant via the phloem translocation stream, provides a novel mechanism for controlling developmental and physiological processes in distantly located organs, continues to gain experimental support. As these macromolecular signaling molecules must enter the phloem translocation stream by passage through the plasmodesmata that interconnect the companion cells to their sieve element counterparts, they have focused on the characterization of the unique set of proteins engaged in the non-cell-autonomous trafficking of proteins and RNA molecules. Using a combination of biochemical, molecular, cellular and genetic approaches the researchers identified the first receptor in this macromolecular trafficking pathway. This receptor was shown to interact with over 200 phloem-mobile proteins, including those that bind RNA, and hence it likely mediates the exchange of RNA across this cellular

boundary. Ongoing studies are aimed at identifying additional genes involved in this pathway. In conjunction with these studies, the researchers continued their work on the functioning of the plant RNA surveillance system that operates at the level of the phloem. Biochemical and cellular experiments allowed them to identify the first plant protein that displays the unique property of selective binding to small single-stranded RNA molecules; these-25 mers are at the route of gene silencing, an epigenetic process that appears to have evolved to protect the plant from viral and transposon challenge. This phloem mobile protein has the capacity to mediate in the cell-to-cell and long-distance trafficking of small RNA molecules. Finally, they are continuing to investigate the molecular basis for viral entry into and egress from the phloem long-distance translocation system. Here they have been able to unravel the basis for viral genome size reversion in the Begomoviruses, a molecular/genetic event that reflects RNA/DNA surveillance at the level of the plasmodesmata. Collectively, these findings are providing insight into the evolution of a novel long-distance communication system that allows the plant to respond to environmental and endogenous input signals.

Impact: Information on the evolution and function of the plant vascular system is providing a foundation for the study of long-distance signaling in plants. Developing novel methods of transporting genetic information, in the form of RNA, from mature leaves into developing meristems may well open new avenues for bioengineering of unique plant traits as well as allowing for the development of novel mechanisms to control the systemic infection of plants by viral pathogens.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: GENE TRANSFER IN INSECT SPECIES OF ECONOMIC IMPORTANCE

Description: Objectives are: 1.To increase the efficiency and applicability of genetic transformation technologies in insects of medical and agricultural importance. 2.To use these to understand the molecular basis of pathogen transmission occurs in these insects and, in doing so, to devise genetic and chemical-based strategies designed to control disease transmission. The UC researchers have achieved significant progress during 2003. First they have shown that transgenic lines of the yellow fever and dengue-transmitting mosquito, Aedes aegypti, are significantly less fit than their conspecific, non-transformed counterparts. These data are the first to directly measure components of fitness in transgenic mosquitoes and, in doing so, illustrate the need to quantitate these parameters in transgenic insects that are generated for the purposes of genetic control. In 2003 they also identified, isolated and characterized a new transposable element, Herves, from the malaria mosquito, Anopheles gambiae. Herves was initially identified in silico and then cloned from genomic DNA from this species. They have shown that Herves is a functional element and, as such, is the first functional element identified from any mosquito species. They have also shown that this element is possibly still active in field populations of Anopheles and that it also displays slightly different mobility properties to the related Hermes and hobo elements. Herves may well provide an illustration of how active transposable elements can move through wild insect populations and so may well serve to bridge the gap between field

behavior and laboratory design of genetic control experiments. They have also recently identified part of what they believe to be a related transposable element from Aedes aegypti. In very related, an ongoing, work, they continue to investigate the structure:function relationships of the Hermes element with the aim being to improve its use as an agent in the genetic control of insect pest species. Results of these studies will be applied to the Herves element.

Impact: The UC researchers are seeking to enhance genetic control strategies for the control and/or eradication of insect pest species. Genetic control strategies are environmentally benign and sustainable. Applied to the vectors of human disease, they should be effective, based on previous strategies that have targeted the vector species. The outcome of the successful application of these technologies will be sustainable agricultural practices with little or no environmental cost and the control of vector borne (for example mosquitoes) human disease.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: GENETIC VARIABILITY IN THE CYST AND ROOT-KNOT NEMATODES

Description: Objectives: Define nematode genetic variability for phenotypes including morphology, responses to resistance, environmental variation, and biotic interactions. In the previous report, UC researchers described the development of two robust phylogenetic trees intended to understand affinities within the nematode family Mermithidae.. This nematode taxonomic group includes ROMANOMERMIS, a potentially useful biological control agent for mosquitoes, and other insect-parasitic nematodes. They continued to make progress in several related areas: (i) further validation of tree topology using Baysian methodologies to analyze mitochondrial cytochrome oxidase I (COI) and nuclear 26S rDNA D3 sequence alignments within the genus ROMANOMERMIS and among genera in the mermithid family. Our studies include the species R. CULICIVORAX, R. NIELSENI, R. IYENGARI, R. COMMUNENSIS and R. KIKTOREAK. These ROMANOMERMIS species represent isolates along a north/south transect that ranges from Northern Canada to Mexico. The results have unmasked likely speciation events along this cline and signal mosquito host migrations and additional vectoring into these regions. (ii)) They have obtained nucleotide sequence and determined mitochondrial gene order for the entire THAUMAMERMIS COSGROVEII mitochondrial genome. They have mapped and determined the transcriptional organization of the expected 12 protein coding genes and two ribosomal RNA genes about the mitochondrial DNA molecule. They have also mapped five of 22 anticipated tRNA genes. The T. COSGROVEII mitochondrial gene order is significantly different from all other nematodes for which complete mitochondrial genome sequence is available. However, similar to its Adenophorean mermithid relatives, this mitochondrial DNA contains duplicated copies for several mitochondrial genes, though the amplified genes differ from those found in the R. CULICIVORAX mitochondrial genome. This year they have also finished the complete nucleotide sequence for the R. CULICIVORAX mitochondrial DNA molecule and have completed 70% of the related R. IYENGURI mitochondrial DNA molecule. R. IYENGURI carries repeated mitochondrial genes that differ from R. CULICIVORAX and T. COSGROVEII. By understanding comparative mermithid

mitochondrial gene order, insights into molecular events sponsoring the generation of genetic diversity can be achieved. By overlaying this information on the molecular phylogenies established using the COI and D3 regions will enable an understanding of how host-preference evolved. In turn, this scientific information will assist furthering the use of entomophagous nematodes as efficient biological control agents.

Impact: Specific information on the evolution of nematode parasitism among insect hosts will help define the utility of nematodes as efficient biological control agents. By using DNA sequences derived from both the nuclear and mitochondrial genomes, precise predictions as to which nematodes might attack a broad range of hosts will be enabled. The expectation remains viable goal, namely that one or several nematodes will be identified that can simultaneous parasitize and destroy multiple insect pests. Broad scale insect pest management of this sort will diminish the cost of employing nematodes as biological control agents.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AR, AZ, CA, HI, MI, NE, NM, OR, WA, WY

Theme: 4.12 Integrated Pest Management

Title: GENETIC, CULTURAL AND CHEMICAL APPROACHES TO MANAGING PIERCE'S DISEASE

Description: Objectives: Determine whether vegetation barrier between riparian areas and vineyards and/or insecticide-treated trap crops on the ends of vineyard rows can reduce the incidence Pierce's disease (PD). Evaluate the efficacy of plant micronutrients such as zinc, iron and managnese as bactericides for Xylella fastidiosa (Xf). Develop transformation/transposon mutagenesis systems for Xf. During 2003 UC researchers continued basic and applied research on Pierce's disease (PD) of grapevines, which is caused by the bacterium Xylella fastidiosa (Xf). Approximately 1,000 Xf Tn5 mutants were inoculated into individual Vitis vinifera grapevines growing in the greenhouse. Four months following inoculation an expectedly high percentage (30%) did not develop typical PD symptoms; they are now testing these symptomless plants for the presence of Xf using ELISA. Approximately 3% of the Tn5 Xf mutants were hypervirulent as compared to the wild type parental strain. Sequence analysis showed 2 were in putative LPS genes and 1 was in a hemagglutinin-like gene. They developed an E.coli/Xf plasmid shuttle vector based on the plasmid RSF1010 that replicates autonomously in Xf however this plasmid is only stably maintained in Xf cells that are kept under kanamycin selection. Therefore, this shuttle vector will be useful for in vitro studies of Xf gene function; however it cannot be used to study the function of Xf genes in plants. Another plasmid, containing an Xf native plasmid, a KanR cassette was cloned into pUC18 and used to transform Xf; unfortunately this vector was also unstable without antibiotic selection. For the past 4 years they have been evaluating plant micronutrients and inducers of systemic acquired resistance (SAR) as prophylactic agents to protect grapevines against infection by Xf or as therapeutic agents to cure PD. To date, none of the plant micronutrients or compounds that induce SAR in plants showed efficacy in preventing Xf infection of healthy grapevines. Evaluation of plant micronutrients and two antibiotics as therapeutic agents for curing PD-affected grapevines, was more encouraging. Many of the PD-affected Merlot grapevines that were injected with zinc or streptomycin in Fall, 1999 remained

free of PD symptoms 3 years following treatment, while all of the untreated control vines were dead. However, some of the vines that were symptomless in 2002 have now developed some early symptoms of PD. These symptoms may be the result of residual Xf populations that were not killed by the bactericide treatment or they may be the result of recent inoculation of treated vines by infectious-PD vectors. Over 1000 putative bacterial endophytes were isolated from healthy, PD-affected and escape grapevines growing in Napa and Davis, CA from 2000 to 2002. There were no differences occurred in total populations of endophytes in Napa versus Davis, however higher populations were recovered from PD-affected versus healthy vines. Endophytes were identified by RFLP and sequence analysis of 16S rDNA. 19 of the isolates completely inhibited the growth of Xf in an in vitro plate assay. Approximately 80 of 138 isolates were classified as grapevine colonists because they could be recovered more that 6cm from the point of inoculation. 13 of the endophytes were classified as both Xf-antagonists and grapevine colonizers. 5 of these isolates were inoculated into and exposed to Xf-infectious sharpshooters. None of the endophyte-inoculated vines prevented infection by Xf but some decreased the severity of PD symptoms.

Impact: Additional plasmid vectors were developed that readily transform Xf and can be used as tools to identify and characterize genes that mediate Xf pathogenicity and insect transmission. However, additional work is needed to find an Xf shuttle plasmid that is stable in Xf without antibiotic selection. Attempts to find compounds that could prevent Xf infection of healthy grapevines were unsuccessful, but streptomycin and zinc were used to cure or greatly suppress symptom development in PD-affected vines. Grapevine bacterial endophytes were found that prevented Xf growth in vitro but they did not prevent infection in plants.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: HIGH-PRESSURE WASHER REMOVES RED SCALE FOR CITRUS FRUITS

Description: California red scale is one of the key pests of citrus in California. This pest can damage and kill citrus trees when it attains very large populations, which is a rare occurrence. The more common economic damage results from these scale insects settling on the fruit, causing cosmetic flaws and a downgrading of the fruit. Significant economic losses from this cosmetic damage occur at much lower population densities than the high densities required to damage the trees. Consequently, there is a very low threshold for California red scale in citrus orchards. To keep populations below the threshold, growers have traditionally relied on high-volume sprays (up to 1,000 gallons per acre) of insecticides. A team of Agricultural Experiment Station researchers from the University of California, Riverside collaborated with the FMC Corp. in the mid-1990s to develop a device that removes California red scale from fruit after harvest, thus greatly reducing the need for pesticide use in the field. The device, referred to as a high-pressure scale washer, relies simply on a high-pressure water spray without any pesticides. Scale are removed by the physical impact of the sprays.

Impact: This method of pest control has been very successful, and today high-pressure scale washers are used in the great majority of citrus packinghouses in California. This method has

aided the use of biological control strategies by reducing pesticide use that might otherwise interfere with the natural enemies that control citrus pests. It also increases the economic threshold for field pesticide applications (low to moderate scale populations need not be treated in the field because scale can be removed from the fruit in the packinghouse using the high pressure washer), thus reducing pesticide use and possible impacts on the environment and human health.

Funding Source: Smith-Lever, Hatch, and State

Scope of Impact: CA, AZ, FL

Theme: 4.12 Integrated Pest Management

Title: IMPACT ANALYSIS AND DECISION STRATEGIES FOR AGRICULTURAL RESEARCH

Description: Objectives are: 1. To estimate the expected and actual flow of benefits and costs of research for agriculture, and related areas including the incidence of their distribution. 2. To determine and quantify the relationships between research and other public sector policies and programs for agriculture. 3. To analyze decision strategies for agricultural research funding by different public institutions and private organizations. The work conducted under this project involves studies of agricultural science policy and its consequences, conducted jointly with colleagues at the University of Minnesota, NC State University, Pennsylvania State University, UC Davis, and the International Food Policy Research Institute. It has included three main continuing elements: (1) an international comparisons project involving the documentation and analysis of institutional arrangements and investments in agricultural research around the world; (2) empirical studies of agricultural productivity patterns and their determinants, and (3) empirical studies of the benefits and costs of agricultural R&D and technological change. Highlights for 2003 include: (1) A report was published on measuring the benefits from pest-management research conducted by the University of California. (2) Substantial progress was made in a project on the benefits and costs of check-off funded programs, including agricultural research and generic commodity promotion programs. One article has been accepted for publication and another is in review. (3) Further progress was made on a project on measuring the non-pecuniary benefits from corn-rootworm resistant transgenic corn technology.

Impact: The completed work on pest-management research demonstrates a high payoff to California's investment in IPM research. The continuing work demonstrates that check-off funded programs can be highly beneficial to growers, the state, and the nation, but care must be exercised in the design of programs to assure that managers' incentives are compatible with state and national interests.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AL, AZ, CA, FL, GA, ID, IL, IN, IA, KS, MD, MI, MO, MT, NE, NJ, NY, ND, TX, VA, WI

Theme: 4.12 Integrated Pest Management

Title: INTEGRATED PEST MANAGEMENT OF INSECTS IN AND AROUND STRUCTURES

Description: The objectives are to investigate and develop principles and practices contributing to effective insect pest management in and around homes, apartments, commercial buildings, museums, parks, and recreational areas. Major areas of research will include the behavior, physiological ecology, and insecticide resistance of urban insect pests and factors influencing the action of insecticides. Emphasis will be focused on the use of low-impact toxicants in baits to control ants and yellowjackets, and non-chemical control approaches such as structural modifications and cultural control. Nitenpyram is a fast acting, orally administered flea treatment for cats and dogs, providing 100% kill of cat fleas, Ctenocephalides felis, at the time of treatment and up to 24 hours. Between 24 and 48 hours, there was a 98.6% reduction in fleas. From 48 to 72 hours, there was only a 5% reduction in flea numbers. Foraging range of Argentine ants, Linepithema humile, in urban situations extended at least 61 m. Fipronil sprays (0.06%) and aqueous sucrose baits (0.0001%) provided significant reductions for 4 weeks. After 4 weeks, the increase in ant populations was attributed to immigration of ants from untreated areas. Quantifying the impact of systemic insecticide treatments of plants infested with homopterans producing honeydew for Argentine ant control has proved difficult. Barrier sprays and granular treatments of pyrethroids have provided inconsistent control of Argentine ants. Baits containing low concentrations of fipronil, imidacloprid, and thiamethoxam look very promising.

Impact: Argentine ants are the major pest in urban settings in California. The use of insecticides for ant control has been cited as one the major sources of insecticide pollution in bays and aquatic habitats in California. Our research into the use of alternative pest control strategies and baits looks extremely promising. The use of baits will dramatically reduce the amounts of pesticides applied in sensitive urban areas and reduce pollution of the watershed.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: INTEGRATED PEST MANAGEMENT OF SAN JOAQUIN VALLEY CITRUS THROPODS

Description: Overall objective: To develop ecologically and economically sound methods for controlling citrus arthropod pests that reduce dependency on broad-spectrum pesticides and maximize nonchemical methods of control. Individual objectives: 1) Improve arthropod sampling methods, and develop economic thresholds where needed. 2) Evaluate pheromone traps and degree-day units to predict pest population development. 3) Evaluate timing and placement of registered and new pesticides to improve selectivity favoring natural enemies, prevent phytotoxicity to the tree, and effectively reduce pest populations. 4) Screen pests and beneficials for resistance to pesticides. 5) Study augmentation or protection of natural enemies and demonstrate that natural enemies have an economic impact on their host or prey. 6) Set up

Demonstration plots in commercial groves to document the economics and pest management success of IPM programs. Research was conducted to advance the integrated pest management (IPM) program for citrus arthropods in the San Joaquin Valley. 1) Multiple applications of various insecticides were tested against the citrus peelminer (MARMARA GULOSA) and found to be somewhat effect in reducing the rate of mining. A program to release the parasitic wasp (CIRROSPIULUS COACHELLAE) to biologically control citrus peelminer was continued. A citrus peelminer rearing program was established using zucchini squash and should greatly aid parasite production and releases. 2) A field trial revealed that increasing the distillation point of spray oil (415 to 470 degrees Fahrenheit) did not result in significantly greater California red scale (AONIDIELLA AURANTII) control. 3) Field trials demonstrated that the cottony cushion scale (ICERYA PURCHASI) is not controlled by pesticides when it is in the adult stage and that its predatory beetle, vedalia beetle (RODOLIA CARDINALIS) is not sensitive to organophosphates but is very sensitive to the insect growth regulator buprofezin. 4) In laboratory tests, the lower developmental threshold of vedalia beetle was determined to be 10 degrees Celsius. Field sampling demonstrated there are two generations of cottony cushion scale and the population is nearly uniformly adults in March-May (ideal for vedalia beetle control) and nearly uniformly 1st instars in June (ideal for insecticidal control). 5) Pesticide trials in nursery citrus documented that carbaryl and foliar neonicotinoids exert the best control of emerging glassy-winged sharpshooter (HOMALODISCA COAGULATA) nymphs. These insecticides are useful for treating trees just prior to shipment to other areas of the state to help reduce the risk that nymphs will successfully emerge from egg masses that were missed during visual inspections. 6)Ten commercial orchards in the Tulare County area were sampled for pests and beneficials as a demonstration of citrus IPM tactics. Growers in the project applied 0.7 treatments for thrips (SCRITOTRIPS CITRI) and katydids (SCUDDARIA FURCATA), 0.2 treatments for scale insects, 0.1 treatments for worms and 0.1 treatments for ants (a total of 1.1 treatments per orchard). Field days, newsletters, and cooperator meetings were held to communicate the results of the sampling and to demonstrate that citrus can be grown with very few insecticide treatments. 7) A web site was updated to keep citrus growers informed about key pests, new insecticide registrations, degree day units for predicting major events in the lifecycle of citrus pests, and to report the pest events in the Tulare County demonstration blocks. 8) A brochure was produced and an education program was conducted to teach citrus growers and packinghouses about the causes of citrus fruit scarring. 9) An interactive web site was established that allows growers to submit information about the distribution of citrus peelminer and the level of damage it causes their citrus.

Impact: San Joaquin Valley growers and their pest control advisors have gained knowledge about the biology of various insects, how to effectively use natural enemies, and how to effectively use insecticides to manage citrus pests. The outcome of this work is a reduction in the use of disruptive insecticides, a reduction in wasted application of insecticides, and greater adoption of natural enemies for control of citrus pests. This is improving the long-term management of citrus pests as well as improving worker safety and the environment. Information was provided to the citrus nursery industry for the most effective use of insecticides for disinfestation of glassy-winged sharpshooter prior to shipment of citrus trees. Nurserymen who follow this strategy will find insecticides to be more effective and will reduce the chance that the sharpshooter will be transported to uninfested areas of the state on citrus nursery stock.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: INTEGRATED PEST MANAGEMENT STRATEGIES FOR CALIFORNIA HORTICULTURAL CROPS

Description: Objectives are to: 1. Evaluate alternative controls for key insect and mite pests of horticultural crops which are potentially affected by loss of widely used insecticides and acaricides. 2. Evaluate mortality and sublethal effects of specific pesticides on natural enemies of pests in horticultural crops. 3. Develop practical monitoring methods and thresholds for key pests of horticultural crops. 4. Integrate new and available tactics into IPM programs for various horticultural crops. IPM research was conducted on strawberry, tomato, almond, prune, peach, grape and olive insects. Strawberry research focused on control of two spotted spider mite TETRANYCHUS URTICAE and greenhouse whitefly TRIALEURODES VAPORARIORUM. Treatment timing research for the neonicotinoid insecticide imidachloprid and the insect growth regulator pyriproxifen to control whiteflies led to emergency use labels for both products in California. Tomato research focused on the consperse stink bug EUSCHISTUS CONSPERSUS and the potato aphid MACROSIPHUM EUPHORBIAE. Eight fields were monitored in 2003 which had one host border and no hosts present on the opposing border confirmed the hypothesis that bug densities and fruit damage in tomatoes adjacent to weedy host borders are significantly greater than on the opposing side of the same fields where weed stands were controlled or never established. Continuing evaluation of alternatives to organophosphate insecticides confirmed that combinations of pyrethroid and neonicotinoid insecticides afforded better control of EUSCHISTUS CONSPERSUS than did candidate chemicals of either category alone. A number of pyrethroid and neonicotinoid insecticides also provided better control of MACROSIPHUM EUPHORBIAE than the organophosphate standard. Almond and stone fruit research focused on dormant season control of peach twig borer ANARSIA LINEATELLA and San Jose scale QUADRASPIDIOTUS PERNICIOSUS, mitigation of stormwater runoff containing dormant season pesticides applied for their control and developing San Jose scale treatment thresholds. Lab assays showed that copper added to dormant spray tank mixes as a fungicide with an organophosphate insecticide catalyzes the hydrolytic decomposition of the organophosphate, requiring higher rates to achieve control. A field trial confirmed a significant reduction in ANARSIA LINEATELLA control as a result of copper hydroxide added to the organophosphate chlorpyriphos as a dormant spray tank mix. Pyrethroids and the biologically-based insecticide spinosad were shown to provide equivalent control of ANARSIA LINEATELLA to the organophosphates diazinon and chlorpyriphos in a field trial. High rates of mineral oil applied as a dormant spray successfully controlled moderate densities of QUADRASPIDIOTUS PERNICIOSUS in another field trial. Studies of the reproductive biology of the glassy-winged sharpshooter HOMALODISCA COAGULATA indicated the presence of 2 and possibly 3 generations in southern California, and the capacity of this important insect vector of Pierce's disease of grapes to continue to be reproductively active throughout the winter in that area. Research on the exotic olive pest BACTROCERA OLEAE continued in 2003 and included monitoring of 20 sites in 12 California counties. Methods for caging olives and evaluating fruit

quality parameters were established that will allow monitoring throughout the year to determine at which stage olive fruit will successfully host the flies.

Impact: This project provides California's fruit, nut and vegetable producers with mitigation measures for organophosphate insecticides and/or IPM alternatives for key arthropod pests affecting fruit quality, yield and the environment. Decision support tools developed for monitoring pest abundance, pest resistance and phenology provide economical pest control.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: INTERACTIONS BETWEEN CLOSTEROVIRUSES AND THEIR PLANT HOSTS

Description: This effort will take new and much needed approaches towards understanding factors affecting closterovirus biology, molecular biology, disease development and control. UC researchers will build from our experience with Lettuce infectious yellows virus and Citrus tristeza virus, and take specific approaches with each of these closteroviruses. They will attempt to gain an understanding of some of the complicated factors affecting closterovirus biology and the potential for controlling the diseases they cause. The specific objectives of this effort are: 1)To evaluate and compare molecular determinants affecting insect-vector transmission of closteroviruses. 2) To assess protein:protein and protein:plant cell interactions in closterovirus infections of plants in reference to disease development. 3) To evaluate the role(s) of closterovirus genes/gene products in suppressing post-transcriptional gene silencing. The researchers have continued to assess the genetic diversity of Citrus tristeza virus (CTV) isolates, and are working to optimize reverse transcription polymerase chain reaction (RT-PCR)-based approaches to give efficient, accurate and rapid identification of CTV infections in all host plants in all seasons. They have developed a sensitive, simple one-tube RT-PCR assay that works well on citrus plants and does not require the use of organic solvents in template preparation. Ongoing efforts are to identify the best oligonucleotide primers that will prove capable of detecting all CTV isolates. They also have further studied the qualitative and quantitative transmission of Lettuce infectious yellows virus (LIYV) by its whitefly vector, Bemisia tabaci. An in vitro acquisition, using defined amounts of purified LIYV virions was developed. B. tabaci could efficiently acquire and transmit LIYV to plants even when acquisition solutions contained only 1 ng/ul of purified LIYV virions. They co-inoculated protoplasts with LIYV and an engineered LIYV defective RNA (D-RNA) in order to determine if LIYV could be used to deliver and express specific genes/proteins in whole plants. In vitro acquisition was used to transfer virions from protoplasts to plants and RT-PCR and northern hybridization analysis showed that the recombinant LIYV D-RNA was transmitted to, and replicated and moved within whole plants. However, the D-RNA was not maintained during subsequent serial transfer to new plant hosts. They also developed specific, marked LIYV constructs and determined that these could be transmitted to plants and even from plant-to-plant by B. tabaci.

Impact: This work provides important information that will be of practical importance in CTV detection and ultimately, control. The researchers also made good progress in determining interactions between LIYV its whitefly vector, B. tabaci and its plant hosts. In the long term this

information will be useful in implementing environmentally sound approaches for disease control.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: IPM PROGRAMS FOR CELERY, TOMATOES AID GROWERS, AND THE PUBLIC

Description: North American vegetable growers face a compelling need to reduce pesticide use for several reasons, including the decrease in available and effective pesticides due to the development of resistance in pests and to increasingly restrictive state and federal legislation. A UC Professor of Entomology at UC Riverside has led research on novel, low-input pest management strategies that have greatly reduced the use of toxic class-one and class-two pesticides by California celery and tomato growers. His research provided substantial background information needed to develop and implement new IPM programs. This information included new and effective monitoring techniques; an understanding of plant compensation for insect herbivory, which will affect plant growth, chemistry, physiology, and photosynthesis; and determination of economic thresholds.

Impact: Pesticide use in California for tomatoes and celery has decreased by more than 50 percent in the past eight years alone due to the development and implementation of new IPM programs. Aside from obvious economic benefits, which drive the acceptance of the programs, other significant benefits have accrued. Major advantages include a reduction in the potential for environmental contamination and pesticide poisonings and related health concerns for farmworkers, the virtual elimination of the development of pesticide resistance in key pest species, and a potential reduction in the consumption of fossil fuels used in pesticide applications.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: LOW-TOXICITY PEST MANAGEMENT OF ANTS

Description: The primary focus of this project is the development of low-toxic baiting strategies for pest management of ants in urban and agricultural environments. Objectives include: 1.To develop low-toxic ant baits and delivery systems for use in urban and agricultural environments. 2.To investigate the biological activity of borates when ingested by ants.

This UC laboratory has made considerable progress in the technology transfer of urban ant control to the agricultural sector. The researchers are focusing on controlling ants in two economically important crops in southern California, citrus and table grapes. The two species of ants that are pests in these crops are Linepithema humile and Formica perpilosa, respectively. In

large-scale efficacy trials, they achieved significant reductions of pest ant populations in both cropping systems. For example, in citrus groves they were able to reduce the numbers of ants by greater than 50% and maintain this level of control over the entire growing season plus a carry-over into the following year. The baits they have used consist of 25% sucrose water with fipronil, imidacloprid, or thiamethoxam as active ingredients at ultra-low concentrations. In collaboration with another UC laboratory, they continue to screen new active ingredients for ant baits, as well as design and test new bait delivery systems that are economical and practical for growers to use. They conducted a cost analysis of the use of ant baits in citrus and found that during the growing season it would cost growers about $20.00/acre/month for labor and materials. However, this is a worst-case scenario as the labor costs over the fall and winter months would be negligible as the ants are not as active during these seasons. In addition, the servicing of stations could be considerably streamlined with an all terrain vehicle equipped with a 25 gallon spray tank for refilling stations, and once baits become available for ant control in citrus, bait formulation would no longer be necessary. In table grape vineyards they integrated ant control with a biological control program for vine mealybugs. In collaboration with FAR Insectary, they made augmentative releases of the parasitic wasp Anagyrus. Currently, growers are using contact and systemic insecticides to control ants and mealybugs, so the goal is to provide them with control measures that reduce pesticide use and are more target-specific.

Impact: The UC researchers have developed alternative strategies for ant control in the urban and agricultural environment that significantly reduce pesticide use and environmental contamination of the urban environment, agricultural crops and beneficial organisms. Additionally, they are providing methods that indirectly provide control of major homopteran pests in urban landscapes and agriculture, such as mealybugs, scales, and whiteflies. By reducing the ant problems in an environmentally safe manner, they allow biological control to play its role in pest management. In the long run ant bait delivery systems offer a more sustainable approach to pest control that will avoid resistance problems while reducing environmental impact.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: MANAGEMENT AND CONTROL OF GLASSY-WINGED SHARPSHOOTER

Description: The primary objectives are to 1) develop degree-day developmental models for glassy-winged sharpshooter and predict where this insect can successfully live and reproduce, 2) develop and evaluate of techniques to minimize sharpshooter density and Pierce's disease incidence in vineyards, and 3) optimize laboratory/greenhouse rearing methodologies for glassy-winged sharpshooter. Under this reporting period, this UC lab focused on three major research areas: (1) developing and evaluating 'layering' of various techniques to minimize Glassy-winged sharpshooter (HOMALODISCA COAGULATA) and Pierce's disease (XYLELLA FASTIDIOSA) incidence in vineyards, (2) continuing the efforts to develop a standardized treatment protocol to eliminate this insect in commercial nursery stock and (3) evaluate a variety of so-called biorational pesticides for controlling. A variety of plant and insect treatment combinations were evaluated as to their ability to prevent/limit Pierce's disease of grapes. A

combination of neonicotinoids (imidacloprid plus acetamiprid) and kaolin film provided the best protection against glassy-winged sharpshooter, reducing densities by approximately 90%. The same treatment combination reduced sharpshooter oviposition by 75%. Egg parasitism was unaffected by any of the treatments. The layering of neonicotinoids and kaolin limited the incidence of PD to 30% after 18 months, but PD incidence climbed to above 70% in all treatments after 30 months. Antibiotic therapy (metalosate), alone or in combination, did not affect PD incidence. Carbaryl, fenpropathrin, deltamethrin and acetamiprid were evaluated for their ability to kill glassy-wing sharpshooter nymphs emerging from the egg mass under standard commercial nursery operations (including transportation). Carbaryl provided the best overall results resulting in near absolute control (>98%) of emerging nymphs on all plant types (trees, shrubs, bedding plants). Fenpropathrin also achieved very good control. Control of emerging sharpshooters was poorest on bedding plants; this is largely due to the tremendous number of densely packed leaves within a small plant canopy and the resultant difficulty in achieving adequate coverage of the insecticides. Few of the biorational/organic/reduced products tested are applicable for glassy-winged sharpshooter control or eradication (poor mortality, slow knock down activity, poor residual activity). None of the products tested achieved high mortality against both adult and juvenile sharpshooters. Rotenone and 10% rosemary oil (Ecotrol) may be the only exceptions when used strictly against adults; however, their level of control is below that of the pryrethroids, chloronicotinyls, organophosphates, and carbamates. With the possible exception of rotenone and pyrethrins (PyGanic), conventional pyrethroids, organophosphates, and chloronicotinyls were more effective than all other compounds tested.

Impact: The work with controlling sharpshooters has demonstrated that the layered application of neonicotinoid pesticides coupled with a foliar barrier, such as kaolin, reduced the spread and incidence of Pierce's disease in grapes. This approach failed however after two years under heavy sharpshooter infestation. The UC researchers have provided a working list to state agricultural authorities of biorational pesticides that should not be considered for use in urban eradication efforts for the glassy-winged sharpshooter. Finally, they are in the process of developing strategies of controlling the movement of glassy-wing sharpshooters in intra-state shipment of nursery products.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: MANAGEMENT IMPLICATIONS OF PLANT GROWTH IN FLOODED ENVIRONMENTS

Description: The objectives of this project can be summarized as four sequential, interlocking items: 1. Measure the responses of plants to variable flooding regimes. 2. Determine the interactions of other variables to flooding and local hydrology. 3. Develop simulation models of rhizosphere processes. 4. Conduct field experiments and tests of predictions regarding the vegetation under manipulated hydrology and associated variables. In 2003 UC researchers continued experiments on the effects of water depth and fertilization timing on plant growth in rice fields. This research was conducted to determine if differential emergence and availability of

fertilizer could significantly affect the growth of important weeds in California rice. They confirmed that water depth can slow the emergence of watergrass without having strong negative effects on rice. The impact on late watergrass (Echinochloa phyllopogon) is greater than on early watergrass (E. oryzoides), great enough to make rice competitive with late watergrass if water depths are maintained at greater than 8 in. However, early watergrass, while slowed by water depth, maintains higher growth rates and can make up the differences with rice to maintain its competitive advantage. The interaction of immediate availability of fertilizer with water depth favors both watergrass species, but especially early watergrass. Delaying fertilization generally has a smaller effect on rice productivity than on watergrass growth, so that delays are less unfavorable to rice than its competitors. Stable isotope analysis is being completed to confirm that relative uptake rates are consistent with the differences in growth rate observed in the experiments. This research shows that manipulation fertilization alone is unlikely to lead to sustainable suppression of Echinochloa in California rice, but it has revealed relationships that suggest how programs involving multiple factors can reduce farmer dependence on a diminishing suite of herbicides for weed control.

Impact: This project has demonstrated that fertilization timing can have a beneficial impact on weed control in rice. Field testing and implementation programs have been started and are leading to practical programs enhancing weed control through fertilization practices.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: MANAGEMENT OF FORAGE QUALITY IN STRIP-CUT ALFALFA

Description: Lygus bugs prefer alfalfa to many other crops, but don't damage it. Alfalfa can sustain high populations of lygus, but when the fields are cut every month the pest moves into neighboring susceptible crops. Retaining lygus populations in alfalfa fields is the centerpiece of a promising regional pest management strategy. This involves leaving strips of uncut alfalfa, which act as a temporary habitat for lygus bugs, thus limiting their movement out of the field. The method works well, but growers are concerned about the effect that the strips of more mature alfalfa have on hay quality and marketability. A strip cutting trial has been conducted for the past three years. At each of three cuttings during each production season, hay bales were produced with various mixtures of old and new growth alfalfa, ranging from no old growth to 100%. Bale compositions were created during swathing and raking. Chemical analysis as well as visual inspection detected reduced quality of bales containing 14%, 25% or 50% old hay. However, bales containing only 7% old hay were similar in quality and appearance to bales with 100% new hay. When quality is lower, the hay value is less and the markets may be limited. For example, dairy hay must meet a very high standard of quality. Blended hay with more than 7% old hay would not be acceptable to this market, but could be used in the beef or horse markets.

Impact: Forty-five percent of cotton growers surveyed said they use strip or block cutting of alfalfa as part of their pest management program. Using the information developed by UCCE, they can now make informed decisions how to manage the hay in the uncut strips. They may choose to blend it with the new growth and handle the lot as a single unit, or they may segregate

out the bales containing the old hay. By having a much better idea of the reduced quality that will result from blending old hay with the new, growers may be more willing to use this strategy to limit lygus migration from alfalfa hay fields.

Funding Source: Smith-Lever, Hatch, and State

Scope of Impact: CA, AZ

Theme: 4.12 Integrated Pest Management

Title: MANAGEMENT STRATEGIES FOR ARTHROPOD PESTS AND NATURAL ENEMIES ON CITRUS AND AVOCADOS IN CALIFORNIA

Description: Objectives are to: 1.Evaluate the impact of various pesticides in control of citrus and avocado thrips. Emphasis will be on selective chemicals that allow effective biological control of other pest species. Monitor pesticide resistance development. 2.In order to improve biological control of black scale in southern California and citricola scale in the San Joaquin Valley, study parasitoid basic biology, import new parasitoid species, develop economical laboratory/insectary rearing methods for various parasitoids, and evaluate the potential of various parasitoids for use in inoculative or augmentative field releases. 3.In order to evaluate the potential for biological control of citrus thrips, determine what predators feed on citrus thrips to various degrees in commercial citrus orchards and determine what prey are fed on by the predaceous mite Euseius tularensis. Import Goetheana incerta from South Africa, clear it through quarantine, screen it against beneficial thrips species, develop a method of laboratory rearing, and evaluate it against citrus and avocado thrips. 4.Evaluate the impact of various pesticides on important natural enemies of citrus. Emphasis will be on new insect growth regulators being developed for California red scale control and new materials anticipated for use against citrus thrips. 5. Develop improved means of dealing with two pests of quarantine significance -- bean thrips as it impacts shipment of navel oranges to Australia, China, and New Zealand and Fuller rose beetle in relation to shipments to Japan and other countries in Asia. Research this last year focused on solving pest management problems facing the citrus and avocado industries in California (2001 crop values of $814.3 and $315.8 million, respectively) as well as research designed to assist the Mediterranean fruit fly sterile insect Preventative Release Program (PRP). The Medfly PRP involves releasing 125,000 (male-only) sterile flies per square mile per week over 2,155 square miles in southern California in order to prevent feral fly establishment. The annual cost of this program is ca. $18.6 million. Research with the Medfly examined the potential for increasing the efficacy of sterile fly releases or reducing release levels by exposing the flies to ginger root oil ('Medfly viagra') prior to release; the impact of spinosad bait sprays on wild versus sterile Medflies; the impact of irradiation on performance characteristics of the new Vienna 7 male-only sterile Medfly strain; and how different ratios of male to female Medflies affect their mating dynamics (with the recent move towards the use of male-only release strains these dynamics may change). Recent research on citrus has focused on evaluation of several METPHYCUS parasitoid species for control of citricola scale in the San Joaquin Valley and black scale in southern California as well as evaluation of photoactive dyes mixed with molasses as a selective control for citrus thrips. With increased interest in reducing pesticide use and adopting integrated pest management, selective tools for control of these pests are needed. Avocado arthropod pest management in California prior to the 1990s emphasized biological

control with minimal pesticide use. Persea mite and avocado thrips that are native to Mexico, were discovered in California in 1990 and 1996, respectively. These two pests have changed California avocado pest management and an economic analysis was conducted to quantify this impact. Research is continuing to develop effective, selective, and economical means of managing field populations of avocado thrips and persea mite

Impact: The $18.6 million cost of the Medfly preventative release program is borne 50% by both the state and federal governments. Economic analysis has indicated that if the Medfly became established in California, the annual cost would be $1.3-1.9 billion. Our research on Medfly in cooperation with the Preventative Release Program, California Dept. of Food & Agriculture, and USDA scientists was focused on attempting to improve the PRP. Improvements in this program are resulting in a lower cost of the program to the people of California and a greater likelihood that exotic strains of the Medfly will not establish in the state, thus eliminating the costs of lost agricultural production, embargoes limiting fruit and vegetable shipments, and increased pesticide use to control the fly. In addition, backyard fruit and vegetable production would be severely limited in many areas of the state if the fly were to establish. Research on citrus and avocado is aimed at providing effective management tools for key pests of these crops while minimizing crop damage and the use of broad-spectrum or toxic pesticides. This research emphasizes using only selective pesticides on an as-needed basis, thus maximizing levels of predators and parasitoids that provide biological control. Thus, this research contributes to the positive economic benefits of these commodities to the state of California while reducing levels of broad-spectrum or toxic pesticides in the environment.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: MANAGING DISEASES FOR THE RAPIDLY INCREASING SPINACH INDUSTRY

Description: During recent years, consumers in California and throughout the country have greatly increased their consumption of spinach. As a result, the state's growers are producing more spinach that ever before. Monterey County alone grows over 16,000 acres, about 60% of the state's spinach crop. Spinach has an extremely high vitamin and nutrient content, and contains high levels of beneficial carotenoids such as the antioxidant lutein. Being a leafy vegetable, spinach is susceptible to damaging leaf diseases that reduce the yield and quality of the harvested crop. Coincidentally, several new spinach disease problems have developed while acreage has expanded, increasing the potential for significant losses. These diseases must be managed effectively so that the spinach industry can meet increasing market demands for fresh, high quality spinach. Because spinach is a focus of CE, a CE Farm Advisor’s plant pathology research program in Monterey County is where considerable spinach disease research has been conducted to date. In collaboration with UC, University of Arkansas, USDA, and industry cooperators, he has helped devise disease management strategies. His projects have tested fungicides for short-term control of downy mildew and have helped develop varieties that resist new races of the fungus. He set up the state's only public testing laboratory that can identify different races of spinach downy mildew. The lab continues to analyze the race population of

downy mildew in the state and will serve as an early warning system if other new races appear. Two diseases found for the first time in California, Stemphylium leaf spot and bacterial leaf spot, were identified and characterized by his lab. Resistance screening is underway to uncover varieties that will not succumb to Stemphylium leaf spot. Bacterial leaf spot is being monitored so that it will not become a significant threat to the state's spinach crop.

Impact: This UC program has helped develop fungicides that protect the state's spinach crop. Also, in conjunction with industry groups, varieties have been released that resist the new downy mildew races. Planting of this resistant stock has helped reduce the amount of chemicals applied to spinach. Results of these research projects in the Salinas Valley are being extended to spinach growers throughout California, enabling the state's spinach industry to remain profitable and produce high quality spinach products.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: MOLECLAR DETECTION, CHARACTERIZATION AND MANAGEMENT OF PLANT DISEASES CAUSED BY GEMINIVIRUSES

Description: Objectives: 1) Detection and characterization of geminiviruses. 2) Develop geminviral infectivity assay to determine host range and screen germplasm. 3) Apply molecular tools to investigate geminvirus ecology and epidemiology. Surveys were conducted to assess the incidence and severity of a newly described whitefly-transmitted begomovirus, Cucurbit leaf crumple virus (CuLCrV), in melons in the Imperial Valley of California. No symptoms of CuLCrV infection were observed in spring melons (March-May 2003). However, whitefly populations increased in the summer and CuLCrV symptoms were observed in fall melon production (September-October 2003), with some fields having a high incidence of infection. PCR tests with CuLCrV-specific primers confirmed CuLCrV infection in representative symptomatic plants. Interestingly, infected cantaloupe plants underwent recovery from severe symptoms and no major losses were reported. A whitefly-independent CuLCrV agroinoculation system was developed and used to screen melons and other cucurbits for susceptibility to CuLCrV. Squash was highly susceptible, watermelon was moderately susceptible, cantaloupe was moderately resistant and honeydew melon was highly resistant. Cantaloupe plants that developed symptoms after agroinoculation underwent recovery from symptoms. Together, these results suggest that CuLCrV does not pose a major threat to California melon production and that there are potential sources of virus resistance in melon germplasm.

Impact: The results indicate that CuLCrV does not reach high levels in California melons until late in the season and that melon plants have the ability to recover from viral symptoms. A whitefly-independent inoculation system was developed that allows for efficient screening of melons for resistance to CuLCrV and indicated a high level of resistance to CuLCrV in cantaloupe and honeydew melon. Thus, melon production should not be greatly impacted by this virus, which is good news for melon growers in the Imperial Valley of California.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: MOSQUITO AND AGRICULTURAL PEST MANAGEMENT IN RICELAND ECOSYSTEMS

Description: Objectives: 1. To develop a database on the bionomics of rice pests, riceland mosquitoes and beneficial aquatic fauna coming to associate with harvested rice fields flooded during the winter. 2. To update and refine existing data bases on the local distribution, genetic relationships and disease vector potential of mosquito species occurring in rice-producing areas of the U.S. The temporal pattern of abundance of mosquito species in a riverine wetland in southern California was similar to that observed in rice fields of the Central Valley of California. Mosquito production increased directly with emergent vegetation coverage as the wetland aged and was concentrated at between 2 and 5 meters from the periphery of stands of emergent macrophytes. Newly flooded areas of the wetlands that had undergone a drawdown-vegetation knockdown-reflooding cycle for vegetation management produced significantly more mosquitoes (nearly 100-fold more larvae per sample) than did control marshes that had not undergone vegetation management and marshes in which knocked down vegetation was removed. The relationship between length of the drying period for cattail, TYPHA SPP., and the abundance of mosquitoes was studied in replicate pools. The abundance of the western encephalitis mosquito, CULEX TARSALIS, in pools containing vegetation aged two weeks was significantly greater than in pools containing vegetation aged five weeks, freshly cut vegetation or without vegetation. Food resources and potential predators of mosquito larvae did not differ significantly among the vegetation treatments suggesting that factors associated with egg laying by mosquitoes might have contributed to the differences in mosquito abundance among the vegetation treatments. Long-term selection studies investigating the evolution of resistance in the mosquito CULEX QUINQUEFASCIATUS to mosquitocidal toxins of two BACILLUS species were completed. Mosquitoes rapidly evolved resistance to BACILLUS SPHAERICUS (BS), a bacterium that is used widely to control mosquitoes and lacks the Cyt1Aa protein. The Cyt1Aa toxin from BACILLUS THURINGIENSIS ISRAELENSIS (BTI) was the key protein responsible for the lack of resistance evolution in populations of mosquitoes. The pattern of resistance evolution against BTI differed from that against BS in Cyt1Aa's presence; nevertheless, Cyt1Aa was found to hinder the evolution of resistance to BS. The inference from these results is improved bacterial insecticides, with lower risk for insecticide resistance and enhanced toxicity against mosquitoes, could be produced by incorporating Cyt1Aa into transgenic bacteria.

Impact: The results of this study will help to provide criteria for the management of pest and pathogen-transmitting mosquitoes that utilize rice fields and constructed treatment wetlands as developmental sites. Mosquito abatement and resistance management of mosquitoes to control agents must be included as part of any comprehensive plan for the design and operation of multipurpose constructed treatment wetlands, particularly where human residences are situated near wetlands. The work summarized here will assist a multiagency effort to develop criteria for the construction of large-scale wetlands systems that will be designed to conserve precious water resources, promote the biodiversity of endemic wetlands organisms, and protect the public from mosquitoes and the diseases that they cause.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AR, CA, FL, IL, LA, TX

Theme: 4.12 Integrated Pest Management

Title: MOSQUITO AND AGRICULTURAL PEST MANAGEMENT IN RICELAND ECOSYSTEMS

Description: Objectives are: 1. To determine the best chemicals to use in riceland systems in terms of their providing maximum control of rice pests (esp. the Rice Water Weevil) and riceland mosquitoes while causing the least of harm to non-target organisms. 2. To determine the best nonchemical tactics to use in riceland systems to manage problems with rice pests, weeds, and mosquitoes. This UC research program strives to conduct long-range and short-term studies that will develop and improve integrated pest management programs for field and vegetable crops in California. The gross value of agricultural production in California is about $32 billion with affiliated industries and value added products multiplying this total several-fold. Optimizing agricultural production does not always dovetail well with the goals of protection of the environment and with the wants/needs of the urban sector in California. The use of pesticides is one area where there are potential conflicts. Refined IPM programs and thereby a reduction in insecticide usage can help to minimize the detrimental impacts of agriculture. Discovering non-chemical controls, less obtrusive insecticides (so called reduced-risk), improved application methods and timings, and most importantly, when and if to attempt control measures are all aspects of improved IPM programs. The UC researcher has also conducted some more basic research on how plants respond physiologically to injury caused by insects and mites. Specifically, over the last 10 years he has conducted research on management of insect and mite pests in the field corn, sweet corn, cotton, rice, sugarbeet, dry bean, alfalfa, broccoli, and celery cropping systems. Individuals (growers, pest control advisors, UC Farm Advisors, marketers, warehousemen, etc.) dealing with these crops would be my primary stakeholders. He has taken an active role in delivering the results to the end-users (facilitated by his CE appointment), but this also occurs through the cooperators on his projects. Several aspects of my research such as being in the field to collect data, talking to pest control advisors in the design of the studies, working on grower farms, communicating with Farm Advisors, etc. provide opportunities to deliver the results of these studies as well as other to discuss other IPM issues.

Impact: Arthropod pests can significantly reduce rice yields and hinder profitability to the grower. Management programs must be designed to mitigate these losses but protection of the environment is of utmost concern as well as minimizing possible concerns of rice production and the urban sector.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AR, CA, FL, IL, LA, TX

Theme: 4.12 Integrated Pest Management

Title: MOSQUITO AND AGRICULTURAL PEST MANAGEMENT IN RICELAND ECOSYSTEMS

Description: The objective is to develop a database on the bionomics of rice pests, riceland mosquitoes and beneficial aquatic fauna coming to associate with harvested rice fields flooded in the winter. This year UC researchers performed two studies as part of our project 'Mosquito and agricultural pest management in riceland ecosystems'. The first extended their work on how a pyrethroid pesticide, lambda-cyhalothrin (Warrior), affects mosquitoes and beneficial predators (Lawler et al, in press). Warrior is used to control agricultural pests but is not labeled for use against mosquitoes. they tested whether mosquito abatement would benefit from agricultural use of Warrior or whether it would disrupt biological control. This work also included a field assay of survival of pyrethroid resistant mosquitoes, done in collaboration with Anton Cornell. Results show that Warrior controlled non-resistant mosquitoes for several weeks, however control of resistant mosquitoes was much poorer. There was a gradual 'tail-off' in pesticide activity and the pesticide persisted in the sediment. The gradually decreasing mortality caused by the insecticide could favor the emergence of pyrethroid-resistant strains of mosquitoes. This is of concern for public health because pyrethroids are often used to control adult mosquitoes. Beneficial insect predators recovered faster in this full-scale field study than they did in a prior mesocosm study, indicating that biological control disruption problems might not be as serious as they first feared. The second project assessed how timing of flooding and different rates of fertilizer applications might affect mosquito populations in rice fields. This was a smaller-scale pilot study. Unfortunately, few mosquitoes bred in the one subdivided field allocated to this study, and they doubt they will have conclusive results for mosquitoes. They continued to analyze data on other invertebrates, to test whether beneficial predators responded to flooding or fertilization treatment

Impact: The work demonstrates that agricultural use of pyrethroids may help breed resistance to similar pesticides used for mosquito control. UC members have made presentations to both mosquito control agencies and rice growers, to raise awareness that they should coordinate pesticide rotations if pyrethroid resistance begin to spread.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AR, CA, FL, IL, LA, TX

Theme: 4.12 Integrated Pest Management

Title: MOSQUITOES AND ARBOVIRUS TRANSMISSION

Description: The probability of a mosquito surviving from one day to the next and how frequently it bites a vertebrate host are the 2 most sensitive components of that mosquito species role in transmission of a pathogen. Most mathematical models that are used to predict the quantitative relationships between vectors and pathogen transmission assume that survival and feeding behavior are constant throughout a mosquito's life; that they do not change as the mosquito grows older. This is a critical assumption because mosquitoes must first incubate the pathogen in their bodies before they become infectious and can transmit it to a susceptible vertebrate. It is the older mosquitoes, therefore, that are most epidemiologically important. Those

assumptions have not been challenged because methods did not previously exist for estimating how old a wild mosquito is across a range of different ages or for identifying exactly which people a mosquito had bitten. Precise measurement of the chronological age of mosquitoes and the exact host they had fed from were difficult or impossible. Because UC researchers have developed novel, accurate methods that can for the first time estimate a mosquito's chronological age and their frequency of human host contact, they can now test the long standing question regarding whether survival and blood feeding frequency increase as mosquitoes grow older. They will study the mosquito Aedes aegypti and its role in the transmission of dengue virus because dengue is the most important arboviral disease of humans and Ae. aegypti is a mosquito species whose biology is amenable to the kind of field studies they propose. They will use 2 new methods-cuticular hydrocarbon age-grading and DNA fingerprinting of mosquito blood meals-to test the hypothesis that Aedes aegypti's daily probability of survival and frequency of human blood-feeding are positively correlated with mosquito age. The study has 2 objectives that will be carried out in northwestern Thailand, where Ae. aegypti-borne dengue virus is endemic. The researchers will determine (1) the age structure and blood-feeding frequency of wild Ae. aegypti populations and (2) whether the daily probability of Ae. aegypti survival and blood-feeding frequency increase with advancing chronological age. Results from the studies are not limited to the Ae. aegypti-dengue system. They will be applicable to other less tractable arthropod-borne viruses (arboviruses) that are public health threats in California and elsewhere in the United States. Western equine encephalomyelitis and St. Louis encephalitis viruses are important arboviral public health threats in California that like dengue are transmitted by mosquitoes. Knowledge gained from the proposed studies on dengue and Ae. aegypti can be applied to Culex tarsalis, the vector of those viruses, as well as other medically and veterinary important mosquito species-for example, Cx. pipiens, Ae melanimon, Ae dorsalis, and Ae sierrensis-in order to abort or altogether prevent outbreaks of arboviral disease in humans, domestic animals or wildlife in California and other western states. Material on three initiatives was published this year. The first concerns the role that different mosquito species will play in the transmission mission of West Nile (WN) virus when it arrives in California. Interestingly, the virus arrived during late 2003, after these studies were published, and the species they identified turned out to be the key vectors. The researchers evaluated the vector competence of ten California mosquito species; all became infected and were able to transmit WN at some level. Considering their behavior, ecology, laboratory vector competence, and role in WN transmission in the Old World and the eastern United States, Culex species were identified as likely to play the primary role in the maintenance and transmission of WN in California. Differences in vector competence within a genetically complex group of important mosquito vectors indicated that their role in WN transmission may vary from one geographic location to another. These entomological results will be useful for vector control and indicated that if WN is introduced it will become established in California. The second initiative concerns the use of genetically modified mosquitoes to interfere with or prevent transmission of pathogens. In a booked edited by UC faculty the ecological issues associated with genetically modified mosquitoes were outlined and discussed in detail. In a series of studies, they examined empirically and theoretically the use of the bacteria Wolbachia as a mechanism to drive transgenes for refractoriness into mosquito vector populations. The third initiative concerns identification of the person a mosquito bit and thus the people who are at greatest risk of infection with mosquito-borne pathogens. Feeding was non-random with a bias towards young adults and males receiving most of the bites. These results

confirm that feeding frequently on different people is an important component of a mosquito's role in dengue virus transmission.

Impact: The UC studies on WN provide crucial information that identities mosquito species responsible for virus transmission so that surveillance and mosquito control programs may target suspect vector species. The studies on the ecology of transgenic mosquitoes help resolve key issues associated with the application of that novel technology as a public health tool.

Funding Source: Animal Health and State

Scope of Impact: State specific

Theme: 4.12 Integrated Pest Management

Title: NEW APPROACHES TO MOSQUITO CONTROL

Description: To develop and test new chemicals and formulations designed to prevent biting offemale mosquitoes; to identify specific factors that attract gravid female mosquitoes to oviposition sites; to identify population structures and patterns of gene flow among mosquito vectors. For the 5-year period July 1, 1997 to June 30, 2002, research focused on improved surveillance for arboviruses in California. The scope of the research ranged from analysis of trapping strategies for adult mosquitoes, use of sentinel animals to detect active virus transmission, studies of enzootic viral activity, and new methods of data analysis and reporting. The UC researchers completed a comparative analysis of traditional fixed light traps operating on standard 110VAC and small portable battery operated traps. A large-scale mark-release-recapture experiment in the Delta region demonstrated that CULEX TARSALIS dispersed from a release point at least 5 km per day over the period of one week. A cost analysis comparing the maintenance of sentinel chickens with trapping of wild birds for arbovirus surveillance showed that the latter is considerable more cost effective and generally preferable. Further improvements were made to the system of electronic reporting of surveillance information by the establishment of databases directly linked to testing laboratories and maintained on a central server. A historical database of arbovirus isolations from mosquitoes, detection of arbovirus antibodies in sentinel chickens, and estimates of mosquito abundance based on light trap collections covering the period 1960 to the present was created from written records. Preliminary models linking historical weather data with enzootic viral activity were constructed.

Impact: The operation of a modern surveillance system for detection of mosquito borne viruses is vital to preparedness for human disease in California. Surveillance is required not only for early evidence of viral activity, but also for human susceptibility to viral strains encountered, and for the status of susceptibility to various insecticides by mosquito vector populations. Experience has shown repeatedly that when these components of disease control are developed only after an epidemic has begun, there are needless numbers of humans infected, and needless preventable deaths.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: OUTBREAK OF NEW DISEASE AFFECTS ALMOND ORCHARDS STATEWIDE

Description: During wet years in the 1990s a new and unknown plant disease, later identified as an anthracnose fungus, occurred throughout most of California's almond growing region. It destroyed flowers and developing nuts, producing toxins that killed almond tree branches up to two inches in diameter. Losses continued throughout the season whenever rains occurred. Growers were at a complete loss for control of this disease and believed they might have to remove the affected orchards. Processors also were concerned because nuts infected near harvest could have internal discoloration that was difficult to detect and reduced product quality. A UCCE farm advisor recognized the problem as a new disease on almond trees and a plant pathologist at UC Riverside succeeded in identifying the pathogen as the fungus Colletotrichum acutatum. UCCE, UCR researchers and the almond industry then established a partnership to determine the disease life cycle and develop control strategies. Since most registered fungicides had no effect on the disease, initial field work focused on identifying materials that could begin to control anthracnose on almonds. These trials led to the eventual registration of four new fungicides that were effective and also more selective and environmentally friendly. Potential resistance to the fungicides was managed by rotating use of materials. Meanwhile, research to identify susceptibility of almond varieties indicated where efforts were most needed to help control the problem, and which varieties growers might choose to plant in new orchards. Other field trials confirmed that sprinkler irrigation contacting the tree canopy increased disease pressure. The irrigation industry developed new sprinklers with lower trajectories and growers modified their sprinkler systems. UCCE also determined that the fungus over-winters in dead wood where infected nuts had been the previous year. Field trials confirmed that meticulous pruning to remove the dead infected wood is essential. As these results unfolded, the UC research pathologists and UCCE farm advisors have communicated their findings at numerous local meetings, in newsletters, in trade journals and at the statewide Almond Industry Research Conferences. Work continues to investigate additional fungicides and to develop a disease-forecasting model that will result in still more effective control with fewer sprays.

Impact: This comprehensive program involving cultural controls and fungicide rotation has led to adoption of effective management strategies by almond growers. Through UCCE's work, the almond industry now knows how to handle this problem and substantial crop loss has been prevented. Returns to growers have improved and production of top quality almonds for the consumer is the end result, with a reduction in pesticide use due to partial use of cultural controls.

Funding Source: Smith-Lever, Hatch, and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: REDUCED CHEMICAL WEED CONTROL IN FIELD AND VEGETABLE CROPS

Description: Objectives: Evaluate the infestation level of field dodder in relation to dodder resistant tomato varieties in commercial tomato fields. Optimize herbicide approaches for the

control of field dodder in vegetables and agronomic crops. Develop efficient weed sampling methods for prediction of subsequent weed populations and geo-referenced location within a field. Evaluate weed populations and crop yield in relation to variable-rate, preemergence herbicide treatments based on geo-referenced weed maps and compare these to conventional weed control practices. Determine the economic returns and change in herbicide use in ventional (uniform) and variable rate applications (geo-referenced weed map). Dodder is a stem parasite which attacks a wide range of crop plants. Once attachment occurs, it is very difficult to control without killing the host plant. In 2003, field studies were conducted for the control of field dodder (Cuscuta pentagona). An herbicide, sulfosulfuron, was examined for selective control of dodder in processing tomatoes. Dodder control was 50 to 90% in this years field studies, compared to rimsulfuron treatments. Additionally, a dodder resistant tomato variety, H9888, was shown to suppress dodder attachment and growth. In 2003, they continued studies on pre-irrigation followed by weed removal to deplete the weed seed bank prior to crop planting. A field trial in tomatoes was conducted which addressed the critical timing necessary between pre-irrigation and the subsequent weed control method. The study utilized a split-split plot design. The main plots were pre-irrigation method, which were sprinkler, furrow, or no pre-irrigation. The first split of the main plots was initial weed control after pre-irrigation. Initial weed control was performed at either 10 or 17 days after pre-irrigation using either flaming (propane) or shallow cultivation. The split-split plots were the subsequent level of weed control in the crop. Three herbicide programs were evaluated: full label rates, half label rates, or no herbicide. These results were presented at the 2003 Western Society of Weed Science meetings. **Impact:** Sulfosulfuron has shown potential to provide selective post-attachment control. Safety of sulfosulfuron appears very good in tomatoes. A new dodder-resistant tomato variety, H9888, gives growers another option in managing dodder. Pre-irrigation with followed by shallow cultivation or flaming greatly reduced weed pressure in the subsequent crop. Shallow cultivation appeared to be more effective in removing emerged weeds. Approximately 125 degree-days were required for maximum weed emergence. Although pre-irrigation and weed removal before planting reduced weed pressure in the crop, the amount of time required for hand weeding was still further reduced by the rate of herbicide used in the crop. If full or half rate of herbicides were used, weed pressure was visibly less and hand weeding was much easier. Weed emergence data is being compared to cumulative degree-day units in an attempt to accurately predict optimum time between pre-irrigation and subsequent removal.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: RESEARCH TEAM PROVIDES BETTER CONTROL OF WALNUT BLIGHT DISEASE

Description: Walnut growers throughout the state have recently experienced increased difficulty controlling a bacterial disease called walnut blight. The disease, which is spread by spring rains, can reduce nut quality and production. Northern California walnut growers, who are hardest hit as a result of more spring rain, have asked for more effective and economic methods of controlling this disease. A new chemical providing improved control has been discovered but

registration has been allowed only on a year-to-year basis. Continued investigation by a team of UC ANR researchers revealed that the sudden decrease in disease control was caused by resistance to copper pesticides that have long been the standard control. Research by two Northern California UCCE farm advisors then demonstrated that adding the chemical Manex to the copper treatments provides control levels 50% better than copper treatments alone. The ANR research team has successfully obtained annual registration of Manex, but new data must be provided each year to the Department of Pesticide Regulation in order to continue the temporary registration. This effort, as well as the search for better control methods, is the focus of the research team's current program.

Impact: Information on these discoveries has been shared with clientele through trade magazines and grower meetings held by local UCCE farm advisors throughout the state and internationally. Manex is now part of most walnut growers' treatment program when combating walnut blight. Butte County "Pesticide Use Reports" indicate that over 90% of growers there now use Manex, "providing excellent improvement" in disease control.

Funding Source: Smith-Lever, Hatch, and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: SELECTIVE MANAGEMENT OF LEPIDOPTEROUS PESTS IN ORCHARD ECOSYSTEMS

Description: The overall objectives are to develop environmentally sensitive tactics to suppress lepidopterous pests in orchard ecosystems. The focus will be to increase our understanding of the mechanisms of pheromone mating disruption systems by examining the neurological and behavioral changes of moths in pheromone permeated environments. In addition, the effects of environmental or agronomic variables on pheromone plume concentrations, shape and structure, and functional activity will be studied. These data will be used to re-design and develop alternative pheromone dispensing strategies so as to optimize the interplay between program cost, risk of failure, and to program efficacy. Alternative formulations of pheromone were examined in 2002 including sprayable formulations of microencapsulated codlemone, the sex pheromone of codling moth. The sprayable pheromone technologies performed less well than expected from 2001. Codling moth traps were consistently shut down in all trials, yet damage was still observed in one walnut location (Locke). As such, this experiment was terminated mid-season to prevent further damage to the commercial site. In pears, where the sprayable formulations have looked less promising presumably due to the more open canopy, light penetration, and potential changes in codlemone stability, the sprayable plots produced commercially acceptable control of less than 1%, but increasing moth flight counts were also observed late in the season. Initial efforts with aerial applications of sprayable formulations looked positive in walnut orchards with equal trap suppression of sterile moths in areas treated with fixed wing plane or ground air blast sprayers. Monitoring with lures baited with a pear ester in pheromone treated walnut orchards also looked positive until late July after which moth trap counts were lower than pheromone baited traps in control plots. Interactions between changes in walnut volatile chemistries throughout the growing season and the attractiveness of the pear ester

as an alternative semiochemical for tracking moth phenology in pheromone treated orchards will be pursued in 2003. Additional benefits of pheromone mating disruption programs include the enhanced opportunities for biological control of other pests including the pear psylla. Further studies using molecular probes to detect fragments of pear psylla DNA in the guts of generalist predators were conducted with generalist predators successfully collected during the growing season for analysis.

Impact: Low application rates of sprayable formulations of codlemone are now being implemented in 2002 within walnut management programs to enhance overall performance without increased risk to the user in 3 regions of CA walnut growing areas.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: SHEEP GRAZING REDUCES PESTICIDE USE IN ALFALFA

Description: Of the approximately half-million acres under irrigation in Imperial County, almost half is seeded to alfalfa that had a gross value in 2001 of $144,846,000. A continuing problem is winter weed control in alfalfa. Each year 200,000 to 300,000 lambs graze winter alfalfa in Imperial County, the largest concentration of sheep in the nation during that period. In the late 1990's, in collaboration with a UCCE Weed Science, researchers compared lamb grazing with herbicides for weed control in seedling alfalfa. Three trials demonstrated that grazing lambs were just as effective as herbicides in controlling winter weeds. In 2001 and 2002, in collaboration with an Entomology Advisor, grazing lambs were compared to insecticides for insect control in winter alfalfa. In this two-year trial, lambs provided insect control as effectively as insecticides.

Impact: Today, as a result of this research, alfalfa growers often complain that there are not enough sheep during the winter for weed control in alfalfa. The need for herbicides has been reduced, thereby improving drain water quality. Lamb grazing of alfalfa benefits the sheep industry because the demand for lambs for grazing increases, and benefits the environment because the need for pesticides decreases.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: SPATIAL DISTRIBUTION AND SPREAD OF HERBICIDE RESISTANCE IN ECHINOCHLOA ORYZOIDES AND E. PHYLLOPOGON INFESTING CALIFORNIA RICE FIELDS

Description: The research focuses on the evolution and spread of resistance to herbicides in early and late watergrass (Echinochloa oryzoides and E. phyllopogon), two important weeds of California rice fields. Specific objectives of the research are to: 1. Quantify the spatial

distribution, incidence, and nature of herbicide resistance in early and late watergrass in rice fields that vary in rice and watergrass management practices. 2. Identify the management practices that are associated with the lowest frequency of herbicide resistant plants. 3. Quantify the origin and spread of herbicide resistance within and among rice fields of California. The study was initiated during the 2003 rice growing season. To date, greater than one hundred rice growers in the Sacramento and San Joaquin Valleys of California have been surveyed for their herbicide, crop rotation, water, fertilizer, tillage, straw/residue, and rice cultural (cultivar, seed source, seeding method, planting date) practices in 131 rice fields. This information forms a baseline data set of management practices, and thus selection pressures, acting on Echinochloa populations. In addition, seeds of Echinochloa oryzoides (early watergrass) and E. phyllopogon (late watergrass) were collected from all surveyed fields where the species were present. Screening of the seed samples for resistance to the major herbicides used in California rice, namely, molinate and thiobencarb (thiocarbamates), fenoxaprop-ethyl (ACCase-inhibitor), and propanil (amide), as well as to bispyribac-sodium (ALS-inhibitor), a newly introduced acetolactate synthase (ALS) inhibitor for Echinochloa spp. control in California will begin in January 2004. Once the screening is completed, the incidence and nature of resistance to the five herbicides will be correlated with management practices and cropping areas.

Impact: The watergrasses, Echinochloa oryzoides and E. phyllopogon, can cause rice yield losses exceeding 50 % and cost rice farmers millions of dollars every year. Herbicides are essential tools for watergrass management but their continued use is severely threatened by resistance. This research will identify crop and weed management practices feasible for implementation by rice farmers that are associated with the lowest incidence of herbicide resistance. Further, it is expected that the research will provide strong evidence to farmers of the benefits of IPM over herbicide intensive methods for watergrass management.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: STONE FRUIT DISEASES: ETIOLOGY, PATHOGENICITY MECHANISMS AND HOST RESISTANCE

Description: Objectives: 1) To identify several of the most promising cling peach selections that possess the desired characteristics of brown rot disease resistance and horticultural traits for subsequent multiplication and distribution in test orchards. 2) To analyze these selections for additional value-added qualities, with emphasis on phenolics, polyphenoloxidase activity, carotenoids and fruit surface architecture. 3) To determine mechanisms by which redox active compounds regulate the display of selected depolymerases that the pathogen, Monilinia fructicola, may use for penetration and/or nutrient acquisition, and to identify genes that are selectively regulated by changes in the redox environment of the fungus. UC researchers have continued evaluations of peach genotypes for resistance to brown rot disease caused by Monilinia fructicola, using similar approaches reported in the previous year. Mean lesion diameters and incidence (proportion of infected fruit) were determined in inoculated fruit for each genotype, and from these values disease severity values were calculated. Fruit color, an

indicator of quality and ripeness, was estimated by analysis of digital images of the fruit surface. Consistent with results from previous years, fruit from the various peach genotypes displayed significant differences in disease resistance to the brown rot fungus, with a number of the genotypes showing high levels of resistance. During the 2003 season, UC researchers evaluated over 260 genotypes, bringing the total number of genotypes that they have screened in the program during the past 9 seasons to over 1800. The evaluations indicate that the disease resistance of some of the lines, which have been evaluated over several seasons, is stable. Basic studies on Monilinia pathogenicity mechanisms have continued, with focus on redox regulation of potential pathogenicity factors. One such factor, the Monilinia cutinase MFCUT1, has been studied in some detail. Analysis of variant MFCUT1 mutants in which the novel serine and histidine residues were replaced by site-directed mutagenesis indicated that these residues had an important effect on enzyme activity. They have cloned and sequenced the flanking DNA of the Mfcut1 gene by inverse PCR which has enabled them to 1) isolate several putative cutinase knockouts by gene replacement of the endogenous gene to functionally test this gene's role in pathogenesis, and 2) construct a promoter-reporter gene fusion system to test this gene's regulation in response to numerous redox active compounds and during pathogenesis. In order to genetically manipulate M. fructicola, they have developed a transformation system utilizing Agrobacterium tumefaciens to transfer and integrate DNA into the fungus' genome. In addition to the functional characterization of Mfcut1, they intend to utilize this efficient transformation system to generate tagged mutants of M. fructicola affected in pathogenicity and extracellular redox modulation.

Impact: These findings are advancing the ongoing efforts to select a range of promising peach genotypes for further development within the stone fruit breeding programs, with the goal of developing cultivars with improved fruit chemistry and resistance to brown rot disease. Developing the methods to study Monilinia at the molecular level will enable the researchers to elucidate mechanisms of fungal pathogenesis and quiescence. This information may help identify vulnerable targets in the host-pathogen interaction to reveal novel disease management strategies.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: SYSTEMATICS OF THE TRICHOGRAMMATIDAE (HYMENOPTERA) AN IMPORTANT GROUP OF INSECT-EGG PARASITOIDS.

Description: The major objectives for future work in the Trichogrammatidae are as follows: (1) Redefinition of genera and selected generic reviews. (2) Phylogenetic classification of the family. (3) Continuing to build and database the UC Riverside collection of Trichogrammatidae to facilitate objectives 1 & 2. The Trichogrammatidae represents an important group of parasitoid wasps that attack the eggs of other insects, many of them of considerable economic importance. For this reason trichogrammatid wasps are one of the most commonly employed enemies used in biological and integrated control. Most of the work on Trichogramma, the group of historical interest to biological control was completed in 2002. However, this year did see the

acceptance and publication in the journal Biological Control (on-line only as of Feb. 13) of the final paper associated with the Trichogramma minutum complex, whose species are available commercially and widely employed for control of Lepidoptera pests of orchard crops and timber. This study describes a relatively simple method of differentiating species using mitochrondrial DNA. An earlier paper summarizing reproductive and allozymic relationships of these species was published in 2003. Additional work with Trichogramma has involved data basing all North American collection records. This effort was virtually completed this year with the entry of almost 5000 records. It will allow users to quickly determine geographic distribution, locality records, and, perhaps most importantly, host associations for all of the North American species. Most work on this project focused on other genera of Trichogrammatidae. This family includes 80 genera, all insect egg parasitoids. Studies are attempting to better define generic limits, describe new taxa as they are discovered, and resolve relationships within the family. A sabbatical leave focused on additional field work to bolster collection holdings, museum visits to study type material, and reviews of various segments of the family. To this end a review of the tribe Oligositini, the largest tribe of Trichogrammatidae, was completed and submitted for publication. In addition, the genus Doirania, was reviewed and a new North American species was described (manuscript accepted for publication); and two new genera were described (both manuscripts accepted for publication). Students working in the UC laboratory currently are in the process of revising the higher classification of the Trichogrammatidae using molecular characters (18S and 28S [D2 and D3 domains] regions of ribosomal DNA).

Impact: Work clarifying relationships in the Trichogramma minutum complex impinges immediately on several biological control projects utilizing these parasitoids for pest control. Projects involved with control of codling moth on apple and other orchard crops, and spruce budworm on timber, have had need to correctly separate the two species of this complex. Because of the absence of morphological differences, utilization of the correct species for various situations previously could not be assured. The molecular methods developed (electrophoresis, DNA markers) now provide the methodology for separation. This work will also impact the various commercial insectaries that commonly provide species of this complex to growers and researchers. Completion of the Trichogramma database will soon allow all researchers interested in this group for control to determine the species that occur in their area, and the hosts they are known to attack. Studies on the other genera of Trichogrammatidae and family classification will provide more long-range infrastructure support for biological and natural control

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: THE ECOLOGY OF HERBIVORE-PLANT INTERACTIONS IN SUSTAINABLE VEGETABLE CROP PRODUCTION

Description: Objectives are to: 1. Develop sustainable, low input pest management programs and test for economic viability in California vegetable crop production systems. 2. Improve potential of biorational microbial control agents by investigating new isolates, protein activity

and characterization, and ecology of use. 3. Develop sustainable solutions for new pest problems such as the western flower thrips/tomato spotted wilt system and the new biotype of the leafminer, L. huidiobrensis. 4. Determine how key air and water pollutants will influence plant-herbivore interactions in sustainable agriculture. A series of studies were completed. Our work focused on the development of new chemistries for use in IPM of vegetable crops. Extensive studies were conducted on both tomatoes and celery on both insect control and non-target effects of pesticides.

Impact: The study of new insecticidal chemistries is providing better economic returns for growers while reducing potential for human health concerns and environmental damage.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: UCR SCIENTIST COMBATS MAJOR MELON DISEASE

Description: Vine decline of melons, also known as the "cannonball disease," is a major problem for melon crops in the desert regions of the Southwest, including in California. The disease, which results in the collapse of vines near harvest time and frequently total crop loss, has plagued the industry for more than 40 years. Until recently, the only known way to curb the disease was to fumigate the soil prior to planting with methyl bromide, a chemical due to be banned worldwide by 2015 because of its ozone-depleting characteristics. In 1991, a UC professor of Plant Pathology discovered that the cause of the cantaloupe disease was a root-infecting fungus, Monosporascus cannonballus. His research during the past decade determined that 1) ascospores function as the primary inoculum for root infection; 2) significant crop losses are associated with ascospore populations of about two or more per gram of soil; and 3) production of more ascospores occurs primarily in infected melon roots left in fields after harvest. Drawing from these conclusions, he developed a two-phase disease management strategy. Phase 1 reduces the number of ascospores in the soil with either methyl iodide or chloropicrin, which he identified as alternative pre-plant soil fumigants to methyl bromide. Phase 2, which is based upon the identification of the weak link in the life cycle of the fungus, maintains reduced pathogen populations in the soil by inhibiting pathogen reproduction in infected melon roots left in the field after harvest. He identified two effective post-harvest strategies: 1) cultivation, which results in rapid air-drying and death of infected melon roots, or 2) application of low dosages of metam sodium, a chemical that kills the roots and the fungus in infected roots.

Impact: As a result of this research, growers in California's Imperial and Coachella valleys have effective control methods for a troublesome crop disease. The use of a pre-plant fumigant significantly reduces the pathogen population in the soil and the percentage of roots infected and substantially increases the number of marketable harvested fruit. Post-harvest treatments inhibit pathogen reproduction, enabling growers to reduce the application frequency of the more costly pre-plant soil fumigants.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: UCR SCIENTISTS DEVELOP ENVIRONMENTALLY SAFE RECOMBINANT BACTERIAL INSECTICIDE TO COMBAT THE MOSQUITO VECTORS OF WEST NILE VIRUS

Description: The West Nile virus has arrived in California, with one confirmed case in Los Angeles in 2002. Since 1999, the virus has killed 259 Americans, and there have been more than 3,000 debilitating, but non-fatal, cases. To help control the mosquitoes, mainly Culex species, that transmit this virus, University of California, Riverside scientists led by an AES Professor of Entomology developed a recombinant bacterium based on the endotoxins of two environmentally safe, registered bacterial insecticides used for controlling mosquito larvae. These two bacteria are Bacillus thuringiensis subsp. israelensis (Bti) and B. sphaericus (Bs). In general terms, the process involved cloning the gene coding for the major mosquitocidal toxin from B. sphaericus and then engineering this gene into B. thuringiensis subsp. israelensis so that it produced large amounts of the B. sphaericus toxin along with the normal complement of Bti toxins. Against the vectors of West Nile Virus, the Bti/Bs recombinant is 10 times more effective than either of the parental (wild type) mosquitocidal bacteria. Bacterial larvicides are one of the main tactics used throughout the United States to control the vectors of West Nile virus. Given the importance of the disease, the U.S. Environmental Protection Agency has given the professor and his research colleagues permission to test the recombinant Bti/Bs strain in small-scale field trials in California and Florida.

Impact: Initial results have confirmed the improved efficacy of the recombinant strain in comparison with the commercial bacterial insecticides currently used in mosquito control. The Bti/Bs recombinant has been turned over to industry for further development and commercialization, with the primary aim to develop this strain for control of West Nile virus vectors. This novel bacterium is likely to be one of the first field uses of molecular technology that has significant potential for operational use over the next several years. It will provide an effective method of mosquito control with minimal environmental impact, sparing environmental and human exposure to traditional pesticides.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management

Title: WEED CONTROL OPTIONS FOR COOL-SEASON VEGETABLE CROPS

Description: Weeds are a constant threat to vegetable production. If left unchecked, they reduce yields and their seeds contribute to future infestations. As a result, weed control costs are a continuing and significant burden for Salinas Valley growers. To stay competitive in the market place, they need to use the most up-to-date and economically viable weed control practices.

Until recently, cultivation, herbicides and hand labor have been the mainstays of weed control in vegetable production. In the Salinas Valley, two UCCE researchers have teamed up to study new methods and new technology that can help growers control weeds and reduce costs. A CE Weed Specialist and a Farm Advisor have evaluated non-chemical means of weed control such as alternative mechanical cultivators, cover crops and pre-irrigation, as well as new reduced-risk herbicides. Their research has secured registration for reduced-risk herbicides on celery, peppers and spinach. In addition, they have developed information on weed biology that has proven useful to organic growers, who use it to time crop plantings to avoid weed infestations.

Impact: This UCCE work has provided growers with information to improve cultural weed control such as using pre-irrigation for weed removal and integrating the use of cover crops into weed management programs. Reduced-risk herbicides alone have saved California growers several hundred thousand dollars yearly in hand weeding costs.

Funding Source: Smith-Lever, Hatch, and State

Scope of Impact: State Specific

Theme: 4.13 Land Use

Title: POLICY OPTIONS FOR FARMLAND PROTECTION; FOCUS ON AGRICULTURAL EASEMENTS

Description: The purpose of this project is to evaluate the performance and impacts of agricultural easement programs in a way that is useful to public policy leaders and other researchers. This requires developing a consistent set of measures of impact and applying them comparatively to different local programs. The challenge here is to look beyond the individual properties that are put under easement, to see how larger areas of farmland and urban growth are affected by easement placements. This is a different and more strategic standard of effectiveness than traditionally employed by easement programs with environmental and natural resource purposes, which usually have focused on preserving the unique values of the properties put under easement. By this definition, they have four general standards of effectiveness as summarized in the following project objectives: A. Evaluate the impacts of easement programs in protecting from urbanization large blocks of farmland, particularly in redirecting the path of urban expansion. B. Evaluate the impacts of easement programs in minimizing the rate of farming conservation in particular areas. C. Evaluate how easement programs complement or work against local government planning and land use policies. D. Evaluate how easement programs affect local agricultural economies. The major activity this past year has involved substantial work on a UC faculty member's continuing national study of the effectiveness of the agricultural easement technique for protecting farmland from urban conversion. He is directing The National Assessment of Agricultural Easement Programs in cooperation with the American Farmland Trust (AFT), the nations leading nonprofit organization concerned with farmland protection issues. This national project builds on his 1999-2002 comprehensive study of the application of the easement technique in California that covered landowner, local program organization and achievements, funding, land use implications, and Central Valley aspects of the use of agricultural easements in this state. The research sample for the national study includes 46 local and state agricultural easement programs (including six in California) in 15 states, the top

programs nationwide in acres and farms put under easement. Extensive phone interviews with program managers and others constitute the principal data collection method. The highlight of the year was the publication in September of the project's first report (see below), which presents detailed information and maps for each of the 46 sample programs, introduced by a comparative analysis of program achievements, organization, funding, staffing, origins, acquisition strategies, and relationships to local planning processes. This descriptive, 184-page monograph is the foundation for three later, more analytical reports on aspects of impacts and effectiveness that are scheduled for publication through 2004. They will deal with easement acquisition strategies, connections with local planning policies, and subjective and objective measures of effectiveness. A second project largely completed this year was a study of California agricultural landowners--their views of and experiences with various compensatory techniques for conserving their farms and ranches, including easements, preferential property taxes (Williamson Act), and USDA conservation payments. Supported by the California Department of Conservation, this study was based on a mail survey of 276 landowners in six counties. The final paper from this research was presented at a Sacramento conference in April on compensatory techniques for conserving agricultural land, which he organized and which brought researchers from throughout the nation to discuss the topic with a California audience of program managers, policymakers, and representatives of agricultural and environmental organizations.

Impact: The first systematic effort to evaluate the effectiveness of the easement technique in protecting significant amounts of agricultural land in the face of urban development. Most research in this area has concentrated on more simple measures of activity, such as funding and acres put under easement, without delving into the central question of the relative benefits produced by the major investment of public funds. Given the unique policy relevance of the project, our first report in both its hard copy and website versions has been reviewed and commented on by a large of number of governmental, agricultural, and environmental leaders. It is known that the program managers of state and local agricultural protection programs, national environmental organizations, nonprofit land trusts, national and state staff of USDA, and academic researchers are using information from the report. It is especially notable that the Congressional Research Service of the Library of Congress found these findings to be the only objective assessment of the ag easement technique to date and that the first and later reports will be an important basis of their policy advice to Congress on the utility of federal funding in this area.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.14 Natural Resources Management

Title: ADDRESSING FIRE IN THE CALIFORNIA'S FOOTHILLS

Description: Fire has always been a natural part of California's ecosystem, but more than 50 years of fire suppression have allowed large amounts of fuel to accumulate. This has increased both the intensity of fires and their impact on the environment. To add to the dilemma, more people are moving into these forest lands, increasing the chance of a fire starting and complicating management of fires once they start. UC Cooperative Extension led in the

formation of Fire Safe Councils in both Butte and Yuba Counties. The Butte Fire Safe Council was chaired by UCCE for its first three years of operation. The Yuba Watershed Protection and Fire Safe Council was formed and, under the direction of UCCE staff, obtained over $1 million in grants to demonstrate to local residents what could be done to make their homes and communities safe from fire. UCCE and other agencies worked together to develop the educational programs.

Impact: The Butte Fire Safe Council, held up as the model for integrating science into a sound fire prevention program, has produced community protection and evacuation plans and constructed over 11 miles of fuel breaks. The work of the Yuba Watershed Protection and Fire Safe Council in creating 22 miles of fuel breaks and forest health demonstrations on 2,180 acres around communities has been highlighted with the national Smokey Bear Award by the U.S. Forest Service. With guidance provided by these projects, six other Fire-Safe Councils have used the information to implement similar projects in their local areas. This has provided a quick start to communities concerned that catastrophic fire conditions threaten their homes and environment.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 4.14 Natural Resources Management

Title: AGRICULTURAL WATER MANAGEMENT TECHNOLOGIES, INSTITUTIONS AND POLICIES EFFECTING ECONOMIC VIABILITY AND ENVIRONMENTAL QUALITY

Description: Objectives are to: 1. Evaluate the farm-level economic and environmental implications of alternative resource-conserving irrigation technology and water management systems. 2. Apply alternative methodologies to evaluate economic, environmental and social impacts of potential technology, policy, and institutional changes affecting water resources for irrigated agriculture. UC researchers continue to evaluate allocation of water resources in the semi-arid and arid Western States, but within another context of effects of irrigation development in an upstream on downstream basin irrigation. For example, in the upper and lower Rio Grande River valleys, a number of irrigated areas have developed during the past 150 years resulting progressively reduced crop production in downstream areas as a result of upstream development. Upstream development removes water resources from the River as well as reducing River stream power such that aggradation occurs downstream exacerbating what were historically short-term water logging problems. Decreased water supply in turn then results in water shortages later in the season, such that crop production declines dramatically from the combined effects of early season water logging and later season water deficiency. Drainage research in the past has largely focused on alleviation of persistent shallow water tables (eastern states) or salinity control (western states), but has not considered the combined effects of water logging and water deficiency on crop production. In reviewing the literature, water logging and water deficiency result in similar water stresses on the plant stimulating ethylene production and related side-effects. Water logging limits root penetration and plant ability to collect solar radiation (i.e. epinasty) that reduce the crops ability to withstand later water deficiency. Resulting crop

production is dramatically lowered. The interconnection between irrigation projects in different sub-basins of the same river in the more arid western states requires additional investigation in terms of river flows, geomorphology and associated impacts on crop production. Such an assessment may include a historical evaluation of non-impacted crop yields and lost production costs. The spatial and year-to-year distributions crop yield efficiencies across different western states was found to effect water use efficiency and value. Although the intensive use of water resources has increased agricultural productivity, it has also resulted in water depletion as well as soil and water contamination. To capture positive and negative environmental impacts in the analysis of irrigation-drainage projects, a broader hydrologic analysis across a larger a range of scales is necessary to adequately include various processes. Internalizing environmental and economic impacts requires inclusion of larger groundwater and surface water systems. They discuss scaling issues and research as they apply to irrigation hydrology with the hope of helping the irrigation-drainage engineering/science profession better address scaling problems in formulating designs, local, state and national policies affecting water resources and irrigated agriculture. In addition, an automated canal operation optimization model is under development to help provide better distribution of available water resources as needed. A new RR proposal is under development.

Impact: Results from this project will impact allocations of water resources for crop production as well as municipal needs in the Western states. It sets a base-level, or reference yield efficiency in terms of water use while developing improved methods of delivering water when and where needed.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AZ, CA, CO, HI, ID, KS, ND, NE, NM, OR, TX, UT, WA

Theme: 4.14 Natural Resources Management

Title: BIOGEOCHEMICAL AND HYDROLOGICAL CONTROLS OF AQUEOUS ELEMENTAL ACTIVITIES

Description: The primary objective of this project is to provide research and technical support for development of the dissolved oxygen TMDL in the San Joaquin River watershed, California. Specific objectives are to: 1) determine spatial and temporal concentrations of major water quality constituents (e.g., nutrients, chlorophyll, dissolved organic carbon, biological oxygen demand) within the lower San Joaquin River watershed, 2) quantify loads of major water quality constituents, 3) identify the major contributors to biological oxygen demand, 4) identify factors regulating the algal biomass concentrations and loads at the annual, seasonal and diel time-steps, and 5) evaluate the efficacy of flow-through wetlands to treat water to reduce loads of oxygen-demanding substances from irrigation return flows. Oak woodlands occupy about 3 million hectares in California and represent the landscape where California's urban-wildland-agricultural interface is most pronounced. The role of oak trees in controlling biogeochemical cycling and stream water chemistry was investigated in three California oak woodlands having contrasting soil parent material. UC researchers examined biogeochemical processes in soils beneath oak trees and in adjacent grasslands to determine the effect of oak trees on soil nutrient pools and soil quality. They further examined the effects of oak tree removal on soil fertility and quality by

following changes in soil properties for up to 30 years following oak removal. At all three sites, blue oaks created islands of soil fertility and enhanced soil quality beneath their canopy as compared to adjacent grasslands. They found evidence of improved soil quality under blue oaks for physical (bulk density, aggregate stability, water infiltration), chemical (pH, exchangeable cations, nitrogen and phosphorus availability) and biological (microbial biomass, soil respiration) properties. Nutrient concentrations beneath the blue oak canopy were generally 1.5 to 3 times greater than those found in open grassland soils. There were no appreciable differences between islands of soil fertility and soil quality between grazed and non-grazed sites; this indicates that grazing is neither responsible for formation of these islands nor does grazing destroy these islands. The type of vegetation (oak versus grassland) has a much stronger influence on soil organic matter and nutrient pools than soil parent material does. Removal of oak trees resulted in a rapid deterioration of soil fertility and soil quality with the majority of the loss occurring within 10 to 20 years after tree removal. The presence of oak trees increases net primary production and may enhance species diversity, water quality, forage quality, and wildlife habitat. Planting oak trees can sequester relatively large amounts of carbon into California soils; however, the sequestered carbon may be quickly released back to the atmosphere upon oak removal. Because oak trees play many beneficial roles in the ecosystem, land managers should carefully consider oak conservation in managing California oak woodlands.

Impact: The findings of this research are important for assessing the potential environmental impacts of managing California oak woodlands. Land managers are using this information to develop management strategies that enhance water quality, species diversity, forage production and wildlife habitat.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.14 Natural Resources Management

Title: BIOLOGY OF PATHOGENS AND INSECTS IN NATURAL FOREST ECOSYSTEMS OF CALIFORNIA

Description: Objectives: 1) Examine the interacting roles of pathogens, insects and fire in vegetation development in Yosemite Valley. 2) Determine the spatial distribution at local and regional scales of pathogens and insects in forests of the Sierra Nevada. 3) Examine effects of logging and prescribed fire on the distribution and functioning of pest complexes in Sierran mixed-conifer forests. UC researchers have shown that a new canker disease of oaks and tanoak caused by P. ramorum has reached epidemic proportions in oak forests along approximately 300 km of the central coast of California during the past eight years. Initial work on the disease in California concentrated on oaks and oak mortality. They have now confirmed P. ramorum on 40 plant species in 12 families. Their data indicate that the majority of woody plant species in coastal forest types may be hosts for P. ramorum. Across the range of known hosts, they can distinguish two different types of diseases: non-lethal foliar and twig infections, and lethal branch or stem infections. Non-lethal foliar lesions appear to play a key role in the epidemiology of P. ramorum by serving as a source of inoculum which is then spread aerially through rainsplash. They have shown experimentally that the most important substrates for spread of the

pathogen are bay laurel leaves and tanoak branches. They have collected baseline data on pathogen distribution and spread over several years. Plots have been established in mixed-evergreen (dominated by coast live oak) and redwood-tanoak forests in Sonoma, Napa, Marin, Santa Cruz and Monterey counties. Over 7000 trees and shrubs have been permanently mapped, tagged, and sampled for P. ramorum in these plots. All plots have been revisited the last year to determine disease progression on previously infected plants and to determine spread of the pathogen to previously uninfected plants. On each plot, the researchers monitor leaves, rain water, soil and stream water year round for P. ramorum to determine survival in these substrates and sources of inoculum. The winter of 2002-2003 was found to be much more conducive to production of P. ramorum spores than the previous years. Collection of spores in rainwater resulted in pathogen numbers up to 30 times higher in some plots than in 2001-2002. This also resulted in higher infection levels on some host species. They have also discovered two other undescribed species of Phytophthora in the forests of California and Oregon. One new species, P. nemnorosa, infects tanoak, coast live oak, bay laurel and redwood. Its geographic range is larger than P. ramorum and extends from Big Sur to central Oregon. Although, clearly a pathogen P. nemorosa does not appear to cause the landscape level mortality of oaks as does P. ramorum. A second species, P. pseudosyringae has also been found causing disease on coast live oak and bay laurel. This species has also been reported from Germany. They do not know if P. pseudosyringae is native to California or is an exotic as suspected for P. ramorum. They are currently studying the biology of these new species and their potential competitive interactions with P. ramorum.

Impact: The information gathered on sudden oak death has played a significant role in the past year in the continued development of management and regulatory practices for this disease. The data continues to be used by many government agencies (APHIS, CDFA, DEFRA) to write regulations for quarantines

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.14 Natural Resources Management

Title: CALIFORNIA GRAZING ACADEMY

Description: Ranchers who manage livestock on private or public rangeland or pasture are a crucial audience in improving resource use and conservation, as well as efficient production of quality beef. The California Grazing Academy is a three-day, live-in course emphasizing the practical application of controlled grazing principles that emphasize management, not technology, to solve problems and improve rangeland and irrigated pasture. The unique aspect of the Grazing Academy is its emphasis on hands-on activities. Participants learn by actually applying principles in real pastures and rangeland with live cattle. Over 300 producers and agency people have attended the 10 Grazing Academies held so far. These participants manage over 1,000,000 acres.

Impact: A prior survey showed 18.5% of respondents practiced controlled grazing. After attending the Academy, the number climbed to 58.5%. Grazing planning was being used by 64.3% of respondents to plan and record rest and graze periods, severity of grazing and the

number of stock days removed from a paddock. Monitoring, in use by 87% of respondents, included photo transects, grazing planning charts, paddock walks, vegetative cover, forage utilization and riparian areas. (Results from monitoring can be used to assess health of rangeland and implement management changes.) Herd effect rather than use of chemicals was used by 65% of participants to heal eroding gullies and reduce weed infestations.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 4.14 Natural Resources Management

Title: CHANNEL ISLANDS MARINE PROTECTED AREAS CONSERVING MARINE LIFE

Description: The steady deterioration of marine resources in the California Channel Islands has led biologists and resource managers to question current approaches to fisheries management. No-take marine reserves can be used to supplement traditional fisheries and enhance fish populations. However, it is important to design reserves using sound ecological principles while maximizing long-term economic potential and also enhancing educational and research opportunities. State marine resource managers need strategies that incorporate the economic and conservation implications of different reserve network scenarios. Such strategies can help to rebuild California fisheries and the fish species and habitats they depend on. Serving on the 17-person Marine Ecological Reserve Working Group (MRWG), a UCCE Marine Advisor helped bridge the gap between science and policy in order to develop a network of reserves that were scientifically sound and acceptable to society. Other members of the Group included the California Department of Fish and Game (CDFG), the Channel Islands National Marine Sanctuary (CINMS), the National Marine Fisheries Service, the Coastal Conservancy, and representatives of commercial and recreational fishing, kelp harvesting, etc. The advisor, who at UC Santa Barbara had previously helped develop the science-based methodology used by the Group, provided copies of her 1997 publication, "California Marine Protected Areas"; gave presentations on existing MPAs; helped to facilitate small working group meetings with commercial fishermen and non-profit organizations; kept the Group informed of ongoing state, national and international MPA activities; posted the Group's activities on her international MPA listserv, and gave interviews to newspaper reporters. She also provided a communication link between the MRWG members and the MRWG's science panel. After the reserves were approved by the California Fish and Game Commission in 2002, she continued to inform stakeholders and the public by designing and partially funding a 4-page publication in cooperation with CDFG and CINMS that describes the new MPAs at the Channel Islands.

Impact: The Channel Islands MPA network, established in April, 2003, consists of 12 MPAs that cover 142 square nautical miles. Ten of the 12 MPAs (132 square nautical miles) are no-take reserves. The network design that she helped to develop is science-based and incorporates stakeholder concerns. It improves state marine resource management and places California on the cutting edge of marine resource conservation worldwide. There also is now a local, state, national and international stakeholder community that is better informed about conservation and resource management due to McArdle's educational efforts during and after her participation on the MRWG. The no-take reserves will enable fish to grow larger, more abundant and more

fecund. This will ultimately benefit commercial and recreational fishermen in Santa Barbara County and throughout the state, since many species migrate. The reserves will also conserve the threatened and rare habitat that the fisheries depend on.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 4.14 Natural Resources Management

Title: ECONOMIC INCENTIVES TO IMPROVE QUALITY IN A BINATIONAL COASTAL WATERSHED

Description: The objective is to develop and apply an economic model to evaluate the costs and benefits of water pollution control and habitat protection alternatives in a binational coastal watershed. The project has generated economic information to determine that it is feasible to clean up the Tijuana binational watershed through enhanced fiscal resources by passing on costs to the larger public served by the watershed. The project has produced realistic estimates of monetary value of improving the water quality for recreational (swimming) and aesthetic viewing of wildlife in the downstream Tijuana River National Estuarine Research Reserve. These estimated benefits from improved water quality outweigh the costs of improvement. The initial focus on costs has been on wastewater treatment. The current focus of the project is on the more complex routes of generating finance to cover costs related to other than wastewater treatment to improve the binational watershed. Data collection efforts have been focused on the Tijuana River National Estuarine Research Reserve to obtain cost and restoration measurement information for Mexico, in Canon de los Laureles or Goat Canyon that is the 4.6 square mile area of the binational watershed where sedimentation control and riparian habitat restoration have taken place in addition to the model restoration marsh downstream in the U.S. part of the Estuary. Additionally, the municipal level financial information from Tijuana and San Diego has been compiled to enable a complete assessment of paying for binational watershed management. By connecting the industrial, commercial and residential activity linked to Tijuana's economy and NAFTA consumers, it is possible to explore binational policies for paying for better environmental quality in the binational watershed.

Impact: The analysis finds that the downstream transfer payment from the U.S. to Mexico can and should be larger to abate water pollution and sedimentation upstream for net benefits. These findings are significant in directing available resources in a binational context to solve both countries joint watershed problems.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.14 Natural Resources Management

Title: ENGAGING LATINO YOUTH AND FAMILIES IN WATER RESOURCE ISSUES

Description: In Santa Barbara, the highest Latino population density is also where the creeks are the dirtiest from upstream sources. These polluted creeks drain into the Santa Barbara Channel, forcing beach closures. Like everyone else, many of the Latino community go to the beach and the kids play in the creeks. It has been shown that Latinos are generally interested in environmental issues, and that they are particularly concerned about the health impact of a polluted environment. However, because of language and cultural issues, they are often not engaged in water protection activities. Agua Pura (Pure Water), began in 1999 as a partnership of the University of Wisconsin Cooperative Extension's Give Water A Hand, Santa Barbara County UCCE 4-H Youth Development Program and Santa Barbara City College. Its goal was better understanding of how community educators and youth leaders can involve Latino youth and the Latino community in watershed protection and adaptation of resources to meet the community's needs and interests. Agua Pura has been sustained by the Santa Barbara County 4-H Youth Development Program. It is assisting the county in meeting best practices under NPDES (National Pollution Discharge Elimination System) guidelines.

Impact: Agua Pura has significantly contributed to engaging the Latino community in watershed resource issues:

--A six-week, hands-on after-school watershed education program that has graduated over 560 Latino children.

--Incorporation of watershed education into a nine-week summer day camp for over 1,200 Latino children from low-income families.

--The local Housing Authority, whose leadership is primarily Latino, has led in development and delivery of the ongoing "Splash to Trash" watershed education program. Sixty-two Latino young people from public housing have graduated from the program.

--Publication of the Agua Pura Leadership Institute Planning Manual (available on line at: http://www.uwex.edu/erc/apsummary.html).

Agua Pura has served as a model for Latino leadership development involving watershed resource issues at national conferences (Coastal Zone '99, NAAEE '01 and '02) and in professional journal articles.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 4.14 Natural Resources Management

Title: HABITAT FRAGMENTATION AND BIODIVERSITY OF AQUATIC HABITATS IN CALIFORNIA

Description: This project assesses the importance of several anthropogenic factors on the regional persistence of a threatened insect species in California, and applies ecological theory to its conservation. The Valley Elderberry Longhorn Beetle (Desmocerus californicus dimorphus) is endemic to California's Central Valley and is vulnerable to extinction because it feeds on a single patchily-distributed resource in riparian woodland, elderberry (Sambucus spp.). The beetle

has the center of its range around Sacramento, CA, where most riparian areas have been destroyed by development (e.g., Smith 1980). Additionally, mitigation efforts have had low success, and it was recently discovered that the presence of invasive Argentine ant (Linepithema humile) predators was negatively correlated with occurrence of the threatened beetle (Huxel 2000). There are three interrelated objectives. 1. To construct a population viability model to serve as a decision-making tool for beetle conservation and management. The probability of metapopulation and landscape scale persistence will be predicted with a spatially explicit simulation model, by using various combinations of initial beetle density, mortality across life stages, dispersability, habitat availability (e.g., suitable elderberry tree size/age and density), Argentine ant presence and mitigation site location. Earlier field work (Collinge, Holyoak, Barr and Marty, in press) revealed the need for more detailed information about the above factors, and for their influence to be jointly evaluated in a numerical model. Data will come from Objectives 2 and 3. The model will be used to generate predictions about critical habitat and mitigation site location for use in beetle and riparian conservation plans. 2. To determine the beetle's distribution, abundance and the extent of population fluctuations within sites (elderberry clumps) and metapopulations (tributaries). Data on variation in beetle abundance (and presence) from various spatial scales (from bushes to tributaries) will be used to estimate extinction probability. Patterns of site colonization across space will also allow calculation of probabilities of colonization of sites that are separated by different distances. 3. To assess the relative importance of factors influencing beetle presence or abundance. A small amount of field data suggests that associations between predatory Argentine ants and the beetle are of prime importance for beetle persistence (Huxel 2000). This project will determine the robustness of negative correlations between beetle and Argentine ant presence, and experiments will test whether ant predation could account for the putative negative correlation. Within sites, this work will test the hypotheses that ants and beetles only partially overlap in space, and that open areas are refuges for the beetle. Monitoring will also determine spatial and temporal variation in the abundance and age of elderberry branches on which beetle larvae can feed; statistical analyses will test for associations between beetle presence or abundance and branch abundance (or age). This knowledge of site suitability for beetles will aid mitigation efforts. In 2003 this project completed its first 2 aims, to determine the Valley Elderberry Longhorn Beetle's distribution, abundance and the extent of population fluctuations within sites and to assess the relative importance of factors influencing beetle presence or abundance. Preliminary findings for Aim 1 found VELB in 3-26% of bushes. Investigations under Aim 2 elucidated 6 separate correlates of variation in VELB occupancy, including that occupancy is greater for bushes closer to rivers and when tree and shrub canopy cover is present. Statistical analyses will allow the model for Aim 3 to be parameterized and constructed. A paper presented novel findings (Huxel et al. 2003).

Impact: The project has improved mitigation and conservation practices for a threatened species, the Valley Elderberry Longhorn Beetle. The work benefits society by providing management information that reduces management costs while improving habitat conservation practices.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.14 Natural Resources Management

Title: IDENTIFICATION OF CANOPY CHEMISTRY USING REFLECTANCE AND IMAGING SPECTROSCOPY

Description: Objectives are to: (1) Develop techniques to measure canopy reflectance and predict canopy biochemistry. (2) Test and refine techniques to evaluate portability of methods to different conditions and times. (3) Define relationships between leaf, plant canopy, and soil properties and reflectance spectroscopy. (4) Develop remote sensing data for inputs into ecosystem/hydrology process models. This year UC researchers continued to develop and test image analysis methods to assess canopy condition and map the spatial distribution of environmental factors that affect agriculture and ecosystem processes. Vineyards are difficult to measure using standard remote sensing data due to the vertical structure of the canopy and the wide row spacing. They extended last year's study by showing that they can detect and quantify canopy reflectance and predict leaf density from airborne imaging systems, a canopy property that is managed to improve quality of wine grapes. In investigations using hyperspectral image data they also demonstrated that they could detect late blight infestation in tomatoes based on changes in reflectance consistent with senescence and stress (leaf chlorosis, leaf drying, and low leaf area index), and they used this information to map the infection across tomato fields in the Salinas Valley. Wildfires remain a significant environmental and health risk in many ecosystems. As an extension of our previous work, they demonstrated that canopy moisture can be detected from hyperspectral airborne and satellite sensors and that this measure can be related to fuel moisture, as part of developing a methodology to predict and monitor wildfire risk. They also used airborne lidar data to estimate fuel load and fuel ladders in a related study. They have developed a new spectral analysis method using Gaussian fitting parameters to estimate soil moisture in shortwave infrared reflectance data, which promises to improve remotely sensed estimates of soil properties which have absorptions in the 2000-2500 nm region of the spectrum (e.g., clays, carbonates, etc.). This method produces a significant improvement in the accuracy for estimating soil biochemical properties, which opens the potential for improved mapping of soil quality parameters and can lead to methods for quantifying soil carbon, among other possibilities. Lastly, they successfully quantified a combination of canopy biochemical properties detected in hyperspectral image data to map the presence of invasive species against a vegetated background.

Impact: The application of digital remote sensing methods provides spatially explicit information about the properties and condition of plants and soils that can improve agriculture and natural resource management. The data provides a permanent record of site conditions at specific times, providing an objective basis to evaluate the efficacy of management, restoration, and mitigation activities

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.14 Natural Resources Management

Title: INTEGRATED USE OF PRESCRIBED BURNING AND CLOPYRALID FOR YELLOW STARTHISTLE CONTROL AND OPTIMUM RANGELAND HEALTH

Description: Objectives: 1) Determine the effectiveness of prescribed burning, clopyralid treatments, and varying combinations of the two on yellow starthistle control. 2) Evaluate the effect of the varying combinations of burning and clopyrelid on rangeland health, as determined by changes in plant diversity and desirable forage quality and quantity. 3) Assess the impact of a two-year strategy using prescribed burning, clopyralid and combinations of the two methods on the insect biological control populations. In California and other western states, rangeland productivity and health have been greatly compromised by infestations of noxious thistles, particularly yellow starthistle. Recent research efforts have led to the development of effective control methods for yellow starthistle, particularly prescribed burning and the herbicide clopyralid (Transline). However, repeated use of either technique can be impractical or may selection for other undesirable species. The solution to these potential problems is the development of effective integrated weed management strategies (both burning and clopyralid) that improve rangeland health and vigor. This project was established in three California counties to address this issue. In 2001, vegetative cover was evaluated in all treated plots. In Siskiyou County the lack of rainfall (<40% normal) resulting in the absence of yellow starthistle cover even in the untreated plots. In the other two counties, however, two consecutive years of clopyralid reduced yellow starthistle cover in the following year by more than 90%. However, in Yuba County, this treatment increased medusahead (Taeniatherum caput-medusae) cover from 12 to 19%. Two consecutive years of prescribed burning gave nearly complete control of both medusahead and yellow starthistle in Yuba County, but did not reduce yellow starthistle in San Benito County because of the incompleteness of the second year burn. Clopyralid treatment the first year followed by prescribed burning in the second year did not significantly reduce starthistle in either site, but gave complete control of both ripgut brome and medusahead. Best combination for yellow starthistle control was a first year prescribed burn followed by a second year clopyralid treatment. With this treatment, yellow starthistle was reduced to less than 1% cover in both sites. In addition, this combination also reduced ripgut brome and medusahead cover in Yuba County. Prescribed burning stimulates yellow starthistle germination the following winter, thus rapidly reducing starthistle seedbank and increasing the efficacy of a subsequent clopyralid treatment. In 2001-2002 the researchers took these results to a large-scale field site (Ft. Hunter Liggett) and showed a similar response as the smaller plot experiments. In two locations within the base a first year prescribed burn was followed by a second year clopyralid treatment. In both areas, the seedlings count in the third year was reduced by 99.4% compared to the adjacent untreated plots. In the third year, hand pulling of the few remaining plants was all that was necessary to obtain complete control. Thus, it is possible to achieve complete eradication of yellow starthistle from infested areas at low cost and minimal herbicide inputs. In another study conducted with this project at Ft. Hunter Liggett associated, they demonstrated that clopyralid toxicity in Fowlers toad was low. A wide safety margin was shown when used under field conditions. In addition, monitoring of clopyralid drift following aerial application demonstrated that 30 m buffers between treatment areas and water sources provided adequate drift protection for both an adjacent stream and vernal pools.

Impact: The results show that the most effective and environmentally safe approach for yellow starthistle and noxious annual grass control is either two consecutive years of prescribed burning or integrating prescribed burning with a second year clopyralid treatment. This strategy is now being used in large scale management projects. Used properly, toad toxicity and drift potential for clopyralid is minimal.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.14 Natural Resources Management

Title: INVASIONS AND DIVERSITY IN CALIFORNIA GRASSLANDS: STUDIES AT THE LANDSCAPE SCALE

Description: The analysis of patterns of alien species invasion and remnant native species diversity in Californian grasslands. Major variables to be analyzed include soils, slope, land-use, and distance from sources of invasion (primarily roads). The study area includes the Putah and Cache Creek watersheds (Napa, Yolo, Lake and Colusa Counties). A primary goal is to determine whether within this region, spatial isolation from roads provides a refuge for remnant native grasslands. Since initiating this project, UC researchers have found that (1) Roadside grassland communities (10 m from a road) are more invaded by exotic species than grassland communities 100 m or 1000 m from the nearest road. The effect of roads on grassland composition also interacts with soil type, slope and grazing. (Gelbard and Harrison, 2003). (2) Both fire and grazing by cattle enhance native forb richness in serpentine grasslands, and exotic forb richness in nonserpentine grasslands (Safford and Harrison 2001; Harrison, Inouye and Safford, 2003). (3) Disturbance and seed supply limit the spread of exotic species equally in heavily invaded oak woodland, and lightly invaded serpentine grasslands (Williamson and Harrison, 2002). (4) Roads and distance from the "mainland" both affect the distribution of exotic species on a peninsular nature reserve (Harrison, Hohn and Ratay, 2003). (5) Roadside grasslands are more invasible by yellow starthistle (Centaurea solstitialis) than isolated (1000 m from roads) grasslands, and this difference is associated with biotic rather than abiotic factors (Gelbard and Harrison, submitted). (6) Small grasslands surrounded by chaparral are less invaded if they are not connected via roads to larger grasslands; this effect appears to be associated with disturbance levels, rather than with propagule supply (Gelbard, submitted). (7) In serpentine as opposed to nonserpentine chaparral, native and alien species diversity increase less strongly in response to fire, and the recovery time of biomass and species composition is considerably slower.

Impact: This project has demonstrated the effect of roads, interacting with natural environmental variation, on the distribution of native exotic species at a landscape scale. This project also identified how the impacts of livestock grazing on exotic species invasions and native species persistence may vary along natural environmental gradients. Finally, the project has produced one of the first studies of fire ecology in serpentine plant communities, which are a major reservoir of unique native plant diversity. These results provide critical information for landscape-scale maintenance of native species and the strategic control of exotics. Aspects of these results are being incorporated into management plans being prepared for the California Department of Fish and Games Knoxville Wildlife Area and the McLaughlin UC Natural Reserve.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.14 Natural Resources Management

Title: LONG-TERM DEMOGRAPHY OF ARID-LAND SHRUBS: APPLICATIONS FOR ECOSYSTEM RESTORATION AND MANAGEMENT

Description: Objectives are: 1) To document long-term demography of two species of perennial shrubs, rabbitbrush (CHRYSOTHAMNUS NAUESOSUS) and greasewood (SARCOBATUS VERMICULATUS) along the environmental gradient created by the receding Mono Lake spanning multiple episodes of ENSO; 2) To use the projected transgression of Mono Lake after the 1994 water rights decision as a natural (uncontrolled) experiment to document effects of ground-water depth on seedling recruitment and recruitment of juveniles into the reproductive class; 3) To continue to investigate seedling recruitment in detail with field observations and field and greenhouse experiments; 4) To develop a population project matrix model based upon data collected over the past >20 years at this site and in particular with the detailed data on seedlings collected in the previous 5-year segment (1999-2004); 5) To apply information obtained at Mono Lake to design lakebed restoration protocols in the Owens Valley and other desiccated lakebeds or arid-land restoration projects. This project is long-term study (22 years) on demography of perennial shrubs in arid, California rangeland. Applications of this research are primarily in the restoration of native vegetation on dry desert lakebeds to suppress dust pollution and uphold public trust values. This research investigates two species, the rabbitbrush CHRYSOTHAMNUS NAUSEOSUS and greasewood, SARCOBATUS VERMICULATUS, and the ecology of their establishment on former shorelines of a receding Mono Lake. In 2003, UC researchers continued long-term demographic studies of the older shrubs and published a paper on 18 years of data. This research showed that seedlings compete strongly for their first three years, but, however short, this competition has life-long consequences, determining which shrubs reach reproductive age, and when. They discovered that size-differentials early in life determine which individuals survive this competition. This finding is crucial to designing viable restoration plans. In 2003 they continued to explore the mechanisms of seedling competition, through the research of a graduate student. This research will determine how environmental heterogeneity, intraspecific competition, and variation among individuals all interact to influence the initial spatial distribution and establishment of seedlings. Using field observations and experiments, they are testing the following hypotheses: 1) environmental heterogeneity causes seeds to be unevenly distributed in the landscape; 2) microsites promoting seed retention will not necessarily promote seedling survival; 3) intraspecfic variation among seedling size and/or time of emergence interact with density to influence a seedling's competitive ability and survival within aggregations; 4) variation in seedling emergence time and initial seedling size interact with environmental heterogeneity to influence seedling establishment. The seedling project is in progress and will be completed in 2004.

Impact: The broad perspective of this project is to understand the development of arid-land ecosystems through time by learning the demographic patterns of key shrub species. This approach provides the information necessary for cost-effective restoration where diversion of water for urban and agricultural use has degraded natural habitats and created environmental hazards such as air pollution from dust.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.14 Natural Resources Management

Title: MICROIRRIGATION TECHNOLOGIES FOR PROTECTION OF NATURAL RESOURCES AND OPTIMUM PRODUCTION

Description: Objective #1: To evaluate and refine microirrigation management strategies to promote natural resource protection and optimal crop production. Objective #3: To assess and develop decision criteria for adoption of microirrigation technologies. Objective #4: To promote appropriate microirrigation technologies through formal and informal educational activities. In many locations across California, grower demonstration dried plum (prune) orchards are being managed using a Regulated Deficit Irrigation (RDI) regime developed as part of this research project. The current RDI recommendation in prunes is based on allowing mild to moderate deficits in stem water potential (SWP) over the season, allowing SWP to reach -15 bar by harvest. Three northern California sites (Tehama, Butte and Yolo counties) which have been using this RDI regime for the past 2-3 years were selected for a detailed irrigation study. The uniformity of the microirrigation systems at these sites was evaluated, and plots were instrumented to accurately record the amount of water being applied under RDI. The applied water averaged 18.6 inches for the three sites in 2003, compared to an average calculated crop water demand of 41.6 inches, with yields and fruit quality at or above normal yields for these growing areas.

Impact: Compared to the calculated crop water demand, the range in water savings documented in this study was 49% to 80%, with an average of 56%. Compared to the currently recommended levels of irrigation for prune, the substantial water savings that the reseachers have observed will accrue to the great benefit to the states' water supply as more prune growers adopt midday SWP for the management of RDI.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AZ, CA, FL, GU, HI, ID, IA, KS, MN, NM, TX, VA, WA, WY, VI

Theme: 4.14 Natural Resources Management

Title: OAK MANAGEMENT IMPACTS ON WATER YIELD AND NUTRIENT CYCLING IN ANNUAL RANGELAND

Description: The first objective is to continue watershed monitoring. This involves collecting stage height and precipitation records and water quality samples. The work from this project will be integrated with that from other projects at the Sierra and Hopland field stations. A second objective is to learn more about the nutrient dynamics in the watershed. This includes developing more data on the characteristics of the suspended sediment. A third objective of the project is to develop an understanding of the source of baseflow. Previous work indicates that they do not have a full understanding of the source of base flow (the flow when it is not raining) in the watershed. Base flow has a significantly different chemistry than storm flow. A final objective is

to provide more of a teaching component to the watershed research. This project interfaces with water quality on California rangeland watersheds by providing a long-term record of water flow and water quality against which management impacts on watersheds can be assessed. Annual rangelands occupy three million hectares in California, and represent the landscape where California's urban-wild land-agricultural interface is most pronounced. The watershed-scale impacts of grazing and prescribed fire on watershed processes are not well known. The 2002-2003 water year represents the twenty-third year of continuous stream flow and periodic water quality data collection on this watershed at the University of California Sierra Foothill Research and Extension Center. For the twenty year period 1981-2000, the average daily nitrate-nitrogen flux from the 103-hectare watershed was 0.51 kg/day. The fluctuation around the mean ranged from close to 0 kg/day to nearly 70 kg/day. The mean annual export of nitrate-nitrogen was 186 kg/year. The lowest export for the twenty year period was 19 kg and the largest export was 681 kg. The average daily suspended sediment flux from the watershed was 0.9 kg/day. The fluctuation around the mean ranged from 0 kg/day to 15,924 kg/day. The mean annual export of suspended sediment was 21,149 kg/year. The lowest annual amount of suspended sediment over the twenty-year period was 2,470 kg and the highest was 49,375 kg. Minimum flux occurred during base-flow periods that coincide with the dry late spring, summer and early fall months. Maximum daily events coincide with large rainfall events during the rainy winter season. The timing of rainfall events, in particular the numberof days between major events in the winter control the daily hydrographs and the flux of nutrients and sediment from the watershed. The large variability in these two key environmental variables indicates that setting total maximum daily loads will be difficult and should not be based on either short-term records or annual values. The generally low concentrations of nitrate-nitrogen and suspended sediment leaving this grazed watershed indicate that proper watershed management can produce animal products, oak products, wildlife and recreation without significant negative impacts on water quality.

Impact: This study is providing important information linking rangeland management effects to water quality. Our data provides important information for the development of total maximum daily loads (TMDLs) to address non-point source pollutants from California rangeland watersheds.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.14 Natural Resources Management

Title: PROTECTING GRAZED ANNUAL RANGES

Description: In the early 1980's, managers of grazing on California's annual rangelands were beset with a host of problems exacerbated by drought. Needed was a simple and yet scientifically defensible method for determining grazing capacity and regulating grazing intensity. The available science was primarily based on work by federal agencies outside of the state and on perennial-dominated grasslands. Using AES funding, a CNR-UC Berkeley Range Professor had been conducting a state-wide experiment to test his ideas about the relationships between what he called natural mulch, the local environment, grass growth, and grazing. A CNR-UC Berkeley colleague collaborated with him to produce a landmark 1980 publication

summarizing their ideas about grazing management. This work has recently been updated in ANR publication 8092.

Impact: Recommendations based on the their work were quickly disseminated by UC Cooperative Extension, adopted by state and federal agencies, and incorporated into guidelines for managing annual-type ranges. This method of managing grazing, called "management of residual dry matter" or "RDM", is now the standard for determining the degree of grazing use and was recently issued as a revised and updated ANR publication. The RDM approach has been combined with use of modern remote sensing and geographic information systems, allowing several San Joaquin Valley Counties to save millions of dollars in assessment expenses. Adopted by the US Fish and Wildlife Service, the Bureau of Land Management, the US Forest Service, the National Park Service, and many state and local land management agencies, the RDM approach has protected millions of acres of annual rangeland by improving water quality, protecting wildlife habitat, and enhancing forage quality and quantity.

Funding Source: Hatch, Smith-Lever, and State

Scope of Impact: State Specific

Theme: 4.14 Natural Resources Management

Title: RANGELAND CARRYING CAPACITY EVALUATED THROUGH SCIENCE-BASED METHODOLOGY

Description: The California Land Conservation Act of 1965, popularly known as the Williamson Act, applies to all forms of agriculture including the extensively managed rangelands which cover 40 percent of California. It is one of the major public policies that conserves rangeland open space values, which are provided mostly by private livestock producers. In establishing values, the Williamson Act considers actual use of the land instead of potential use. Livestock carrying capacity estimates for Williamson Act parcels in Tulare and Fresno Counties historically had been developed though landowner surveys. County assessors identified a need to determine livestock carrying capacity through science-based methodology in order to more accurately assess the lands in accordance with the requirements of the Act. Carrying capacity estimates are one part of determining present-use land values, and remotely sensed image analysis and geographic information systems (GIS) provide a second part--a science-based, defensible, repeatable and widespread method for modeling carrying capacity. A system was developed for Tulare and Fresno counties which utilizes grazing capacity score cards based to accurately determine the carrying capacity of individual parcels and ranches. This system developed by UC faculty and CE advisors and specialists is based upon rangeland science principles. The score cards take into consideration (1) rainfall, (2) influence of woody species canopy cover on herbaceous production, (3) effect of slope on animal use and (4) residual dry matter standards. A colleague established validation and verification parcels for AUM capacity by using elevation, precipitation, slope and canopy cover data in a GIS system. These layers were used with the scorecards to estimate grazing carrying capacity per parcel, and the AUMs per acre were then calculated.

Impact: This project provided a science-based method for determining carrying capacity and appraising 977,617 acres of rural land under Williamson Act contract in Tulare and Fresno

Counties. This process ensured sustainability of the Williamson Act program and preservation of the livestock industry and open space in the two counties.

Funding Source: Hatch, Smith-Lever, and State

Scope of Impact: State Specific

Theme: 4.14 Natural Resources Management

Title: TEN YEARS OF WATERSHED RESTORATION IN THE GOOSE LAKE BASIN

Description: When Goose Lake went dry in 1992, threatening fish habitat in the Goose Lake Basin of California and Oregon, a unique bi-state working group was formed to protect and reestablish native fishes in the Basin. The Goose Lake Fishes Workgroup included local ranchers, landowners, interest groups and representatives of state, local, and federal agencies. Members of the Workgroup developed a memorandum of understanding emphasizing the need for a conservation strategy plan which would consider social, economic, and environmental issues. The MOU and plan provided an opportunity for local residents to take part in setting recovery priorities and developing restoration projects. The Modoc County Cooperative Extension Director assisted with formation of the initial working group, insuring that a broad spectrum of interested citizens could provide input into the Goose Lake Fishes Conservation Strategy. He has served as the group facilitator for the past ten years, guiding the development of the Conservation Strategy. In collaboration with a UC Davis rangeland watershed specialist; a Lassen County farm advisor; and an Oregon State University Extension agent, he initiated a water quality/stream temperature monitoring research project which was the first of its kind in California. He coordinated stream habitat and fish population/distribution surveys with private landowners and federal land management agencies, and implemented innovative grazing management practices. The Cooperative Extension team coordinated in-stream restoration projects and conducted workshops and field days on riparian grazing and stream monitoring and restoration.

Impact: In March of 2000 the US Fish and Wildlife Service determined that Great Basin Redband Trout did not need the protection of the Endangered Species Act, due in part to the excellent cooperative partnerships which balanced economic and environmental concerns in addressing the needs of sensitive species. The Goose Lake Fishes Workgroup was credited with "developing a conservation strategy which was to conserve all native fishes in Goose Lake by reducing threats, stabilizing population numbers and maintaining the ecosystem."

Funding Source: Smith-Lever and State

Scope of Impact: CA, OR

Theme: 4.15 Nutrient Management

Title: EFFICIENT PHOSPHORUS MANAGEMENT IN COASTAL VEGETABLE PRODUCTION

Description: This project proposes to evaluate the relationships among various analytical techniques to estimate soil P bioavailability, prediction of P fertilizer need for cool-season vegetable production, and potential for P loss in runoff from vegetable fields. The goals of this research will be to aid vegetable growers in a) improving P fertilizer efficiency and reducing production costs, and b) identifying fields that pose the greatest risk for off-site movement of P so that remediation efforts can be efficiently targeted. Specific objectives are: 1.Document the relationship between soil characteristics, soil test P levels, and potential loss of P through runoff for soils in long-term vegetable rotations.2.Refine P fertilizer guidelines for vegetable production. Soils from 30 representative fields in long-term vegetable rotations in the coastal valleys of central California were collected. These soils ranged from 15-177 mg P kg-1 bicarbonate extractable P, averaging 75 mg kg-1; these elevated P levels document the effects of decades of heavy P fertilization in these production areas. These soils are currently being evaluated for P bioavailability (anion resin technique), P saturation index, and soluble P concentration in runoff from a simulated rainfall event; the intent is to determine how closely correlated bicarbonate extractable P concentration (the standard agronomic soil test procedure) is to these other measures of soil P behavior. A total of 12 field trials were conducted in the Salinas Valley evaluating the effect of current grower P fertilization practices on lettuce production. These trials were conducted in commercial fields with bicarbonate extractable P levels ranging from 53-171 mg kg-1, with planting dates representing the full production season. In each field, replicated plots of the growers' preplant fertilization treatment were compared to matching plots in which no preplant P was applied. P application resulted in a statistically significant yield increase in only one of these trials in a field with 54 mg kg-1 extractable P. Averaged across all trials lettuce productivity with and without P was equivalent, with only minor treatment differences in biomass P, or tissue P concentration.

Impact: These results reinforce at showed that fertilizing high-P fields confers no agronomic benefit, and documents that grower P fertilization practices in coastal production areas can be made more efficient without sacrificing productivity. This work will result in reduced P fertilizer applications, thus protecting water quality while reducing production costs.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.15 Nutrient Management

Title: FACTORS CONTROLLING THE DISTRIBUTION OF TRACE ELEMENTS IN THE SOLID-PHASE OF TERRESTRIAL ECOSYSTEMS

Description: Accumulations of potentially toxic trace elements (TE) in soils and wetland sediments is a major environmental concern for sustainable agricultural production. The interaction of TE between the solid phase and pore water is a key controlling factor for predicting the condition in which TE will accumulate on the solid phase or be released from it. These interactions may take place within distances of a few micro- or millimeters in the soil or sediment matrix. The objectives of this research are: 1) to determine the principal solid-phase components in soil and sediment matrices at a micro- and milliscale distance that control the retention of such selected TE as selenium, arsenic, or boron; 2) to determine molecular level

associations of the selected TE with other elements in the soil or sediment matrix; and 3) to relate these results to their potential solubility, bioavailability, and mobility through soils. Slow releases of boron from soils in semiarid and arid regions continue to limit land use for irrigated agriculture. Magnesium from mineral weathering has been implicated in boron retention. Here they report on the sorption and desorption of boron from model soil minerals containing magnesium. They found that the following minerals sorbed significant amounts of boron: actinolite, enstatite, forsterite, dolomite, magnesite, brucite, magadiite (a non-magnesium mineral), sepiolite and reagent grade magnesium hydroxide. The maximum sorption pH ranged from 8.3 to 11.3. Sorption was directly related to magnesium content of the minerals. Maximum boron sorption was approximately 2 micromoles per square meter. They would expect only soils in the more alkaline range to sorb boron as a result of the presence of magnesium containing minerals. Spectral studies using an attenuated total reflectance, Fourier transform infrared spectrometer revealed that both tetrahedral and trigonal boron forms were sorbed to magnesium hydroxide. X-ray diffraction spectroscopy failed to identify a separate boron mineral species or significant changes in host mineral structure after boron treatment. These results do not eliminate the possibility of small amounts of solid phase boron compounds precipitating but it is more likely a surface controlled process. A decrease or increase of pH as little as 0.3 units dramatically increases boron release. The release may be the result of either desorption or dissolution. Thus, in managing boron rich soils decreasing the pH by a small amount may improve the efficiency of boron removal and improve growing conditions.

Impact: The research has shown that magnesium minerals can play a role in boron retention only under alkaline conditions. This has led to a much more efficient use of irrigation water for leaching removal of boron by inducing a small decrease in soil pH.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.15 Nutrient Management

Title: MESOSCALE HABITAT CONTROL OF MICROBIAL COMMUNITY COMPOSITION: EFFECTS ON SOIL CARBON AND NITROGEN TRANSFORMATIONS

Description: Objectives are: 1. The rhizosphere: To determine if specific microbial populations respond to plant roots and if the metabolic characteristics of these populations impact plant nitrogen availability. 2. The aggregate: To determine if diffusion-limited domains in soil aggregates create habitats for growth and activity of bacteria capable of anaerobic respiration and fermentation. 3. The EPS matrix: To determine if the extracellular polysaccharide matrix produced by microbes provides a microhabitat in soil that indigenous bacteria control in critical physical and chemical characteristics. 4. The vertical profile: To determine if fluctuations in soil water content in high-rainfall tropical forest soils allow redox stratification in the soil profile that facilitates metabolic coupling of microbial physiologies "normally" relegated to very high and very low redox environments. To determine if changes in microbial community composition and metabolic capacity alter decomposition patterns of young and old soil carbon pools, the UC researchers incubated soils under conditions of varying temperature, N-availability, and water content. They used a soil from a pineapple plantation (CAM; 13C litter = -14.1 percent) that had

previously been under tropical forest (C3; 13C soil carbon = -26.5 percent). Forest derived carbon represented 'old' carbon and plantation inputs represented 'new' carbon. In order to differentiate utilization of young (less than 14yr) and old (greater than 14yr) soil carbon, they measured the 13C of respired CO2 and microbial phospholipid fatty acids (PLFAs) during a 103 day laboratory incubation. They determined community composition (PLFA and bacterial Intergenic Transcribed Spacer (ITS) analysis) in addition to carbon degrading and nutrient releasing enzyme activities. They observed that greater quantities of older carbon were respired at higher temperatures (20 and 35 degrees C) compared to the lower temperature (5 degrees C). This effect could be explained by changes in microbial community composition and accompanying changes in enzyme activities that affect C degradation. Nitrogen addition stimulated the utilization of older soil carbon, possibly due to greater peroxidase activity, but microbial community composition was unaffected by this treatment. Increasing soil moisture had no effect on the utilization of older SOM (soil organic matter), but enzyme activity typically declined. Increased oxidative enzyme activities in response to elevated temperature and nitrogen additions point to a plausible mechanism for alterations in C resource utilization patterns.

Impact: This project demonstrates that changing climatic conditions may result in altered temperature and water regimes; atmospheric N-deposition may result in increasing N-availability. It is critical that they understand how changing environmental controllers will alter soil organic matter dynamics. Soil microbial communities and their metabolic capacities mediate carbon storage in soil. Dissection of soil microbial communities and their enzymatic capacities may then elucidate mechanisms by which organic matter dynamics will change. This information will be utilized by resource managers in evaluating management strategies, improving management decisions.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.17 Pesticide Application

Title: STUDY MANUAL SERIES FOR COMMERCIAL AND PRIVATE PESTICIDE APPLICATORS

Description: Since pesticide and pest control regulations are very complex, anyone who uses or supervises the use of restricted materials must be certified. Commercial applicators must pass at least two qualifying examinations administered by the California Department of Pesticide Regulation. Private applicators are certified by passing an examination given by county agricultural commissioners. Until UC experts stepped in, however, all those studying for the exams struggled to glean the information they needed from various sources. In 1988, the director of the UC IPM Pesticide Safety Education Program, launched the well-received Pesticide Application Compendium, composed of comprehensive study manuals for people preparing to take the commercial applicator examinations. These carefully researched publications contain all of the needed information in a single, concise reference for each examination. The core manual, The Safe and Effective Use of Pesticides (ANR Pub. #3324), covers laws, regulations and general principles. The other Compendium volumes cover individual examination categories.

Impact: Both commercial and private pesticide applicators in California are now able to study for each particular examination by using a single comprehensive manual. Examinees have found these study manuals extremely helpful. In addition, they have been excellent resources for ongoing in-field reference regarding the safe and effective use of pesticides. Safer and more effective pesticide use results in fewer pesticide applications, which are more consistent with label instructions, thus reducing environmental contamination and impacts on human health.

Funding Source: Smith-Lever, Hatch, and State

Scope of Impact: State Specific

Theme: 4.19 Riparian Management

Title: ANALYSIS AND MODELING OF LANDSCAPE PATTERNS AND PROCESSES OF ALLUVIAL RIVERS FOR CONSERVATION AND RESTORATION STRATEGY DEVELOPMENT

Description: Objectives are to: 1. Create sets of time-series GIS map databases of current and historical land cover and low-flow channels in selected reaches. 2. Map historical floodplain inundation (high-flows) and model current floodplain inundation through compilation of a historical flow database at all gages on the main channel and compilation of current and historical topographic and bathymetric maps in the form of digital elevation models. 3. Develop and implement an integrated set of models of riparian landscape change (e.g., fluvial geomorphic modeling linked to vegetation succession modeling) by measuring floodplain position and modeling floodplain age of various riparian vegetation species and by integration of the vegetation model with a meander migration model. 4. Develop and apply geographic habitat suitability index models for indicator species. 5. Create GIS visualization tools to depict dynamic landscape processes on the river. 6. Create current and historical spatial distribution GIS maps and databases of exotic vegetation species (e.g. on the middle Sacramento River, lower Cache Creek and lower Putah Creek, and San Joaquin Valley rivers) and measure trends of spatial distribution and rates of spread. Progress was made on developing several of the spatial data sets and computer models needed to achieve the objectives of the project (Greco 2003). Computer geographic information systems (GIS) and remote sensing were utilized extensively. OBJ. 1: A journal article was published summarizing findings of a temporal mapping project in a 23-river mile reach on the Sacramento River (Greco and Plant 2003). A time series of land cover data layers revealed numerous trends of land type conversions. For example, riparian forest (area) was found to decrease from 1938 to 1978 and then increase from 1978 to 1997. The increase was, in part, attributed to river dynamics that cut-off meander loops and created oxbow lakes. The mean rate of riparian forest regeneration within the oxbow lakes was 1.2 HA/yr. Another significant finding was that agricultural lands underwent a dramatic conversion from annual crops to perennial orchards. A spatial time series of low-flow channels of a 100 river-mile reach of the Sacramento River was completed using GIS and documented in a report (Greco and Alford 2003a,b). In addition, a historical aerial photography collection was procured, cataloged and documented in a report (Greco et al. 2003). These photographs were used as the basis for the channel mapping. A thesis by Fremier (2003) also examined an intensive time series of a 4 river-mile reach. This work will be discussed further in Obj. #3 (below). OBJ. 2: Flood flows on the Sacramento River were mapped in a GIS using aerial photography from the collection (described

above). These flooded channel data sets will be used to validate flood event modeling. A topographic map of the river channel's bathymetry and floodplain has been completed from raw data provided from a contractor to the U.S. Army Corps. A flow analysis report was completed by Lowney and Greco (203). OBJ. 3: The integrated riparian landscape spatial model has made progress. Two key predictive spatial variables, floodplain age (report in prep.) and relative elevation (report in prep.), were completed and combined to define sample units for vegetation sampling from Colusa to Vina (river miles 144-218). Comprehensive vegetation sampling occurred in the summer of 2002 and 2003. Masters thesis competed by Vaghti (2003) described 14 vegetation communities and a master's thesis by Williams is in preparation. A master's thesis completed by Fremier (2003) examined an intensive spatial time series of a single site to determine vegetation successional trajectories (Fremier and Greco 2003). These studies will be combined in a doctoral thesis by Fremier to form the basis of a predictive vegetation model to be linked to a channel migration model. OBJ. 4: Two predictive indicator species models are in development for the Sacramento River system. One is for a state endangered bird, the western yellow-billed cuckoo (Girvetz and Greco 2003), and the other is for the bank swallow (a state-threatened bird). Models are being developed in a doctoral thesis by Girvetz. OBJ. 5: A set of landscape animations was created using the temporal GIS data described in Obj.#1 (report in prep.). OBJ. 6: Extramural funds were not secured.

Impact: The project assists public and private agency land managers devise plans to restore the Sacramento River and to model impacts of land and water management. Endangered species in the river system depend on the dynamic forces of land and water to maintain their habitats over time. The project data sets and models are valuable tools for managers and researchers studying the river (Golet et al. 2003).

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.19 Riparian Management

Title: HYDROGEOMORPHIC RESTORATION OF RIPARIAN AGRICULTURAL LAND

Description: This study aims to determine the geomorphic and hydrologic potential of northern California's riparian agricultural lands to revert back to healthy ecosystems that reduce financial losses from floods. The geomorphic potential is defined as the elevational, stratigraphic, and sedimentary conditions necessary for riparian habitats to exist at all. The hydrologic potential interacts with the geomorphic conditions and is defined as the flow magnitude, duration, frequency, timing, and flashiness, which together drive many ecological processes and functions in riparian systems. Specific objectives with respect to a northern California riparian agricultural system include the quantification of the relative proportion of vertical accretion due to alluvial influx of inorganic sediment versus in situ biomass accumulation, the characterization of the spatio-temporal distributions of habitats, the determination of the amount and direction of energy driving changes in sediment patterns, the assessment of historical and pre-historical physical stability, and the simulation of the natural flow regime resulting in a hydrogeomorphically viable restoration. A 3-year project on the environmental history of the ag McCormack-Williamson Tract (MWT) in the Delta to get a strong base of understanding and check assumptions used in

riparian restoration planning, analysis, and modeling was completed this year. A 4-chapter, 175-p report is available for free at http://watershed.ucdavis.edu/crg/projects.html. In addition, one peer-reviewed paper was accepted for publication, a 2nd went to review, and 2 more were prepared for review. The significance of the findings for restoration in the Delta is that regardless of careful design of a tidal gradient as has been done in past Delta projects, a restored upper Delta will face an unpredictable flood regime that will result in a spatially complex assemblage of geomorphic units that will defy conventional criteria for success in restoration. That is not inherently bad in that it is the natural condition of the system. However, the assumption of a well-ordered tidal geomorphic process as exists in other coastal wetlands is not appropriate for MWT. In addition, extremely high [Hg] in both Delta Meadows (DM) and MWT create significant uncertainty in the biogeochemical fate of wetland restoration of MWT, though the opportunity exists for experts to study the biogeochemistry of DM and establish how it functions in the face of the existing pollution. A 3-year project on the environmental history of the ag riparian lands around Navarro River to understand the effects of land use on aquatic habitat relative to natural processes was completed. This study of ag in the North Coast provides a basis for regional comparison across CA. A final report was submitted to CALTRANS, a peer-reviewed paper was published, and a 2nd paper is currently in review. The researchers found that overbank deposition rates increased over 400% within years of logging events and that the higher rates persisted for less than 4 years. After logging-induced deposition peaked, overbank deposition decreased over 60% relative to the pre-logging background values. The decreased deposition rates persisted for over 40 years. They attributed the dualistic effects of logging to the mass wasting of hollows, the products of which are sediment pulses that travel rapidly through the watershed, and to a reduction in the volume of sediment available for transport. The reduction in the volume of available sediment led to a reduction in overbank deposition rates until subsequent logging disturbances destabilized and emptied other hollows. Floodplain studies have continued despite persistent dry conditions that hurt the planned research, but some things have been learned. Methods for monitoring a spatially diverse floodplain were refined leading to a high quality dataset for 2003. A study using optimization for our monitoring was done, existing data were analyzed, and a peer reviewed conference paper was accepted for publication. They considered placement of beacons and loggers in the Cosumnes River Preserve. Currently, there are many sensors deployed. Our goal was to determine the min number and placement of beacons and data loggers for maximal wireless sensors deployed in the preserve. They solved an optimization problem with a Integer Linear Program.

Impact: Riparian agricultural lands in California face the dual problem of high exposure to flood risk and low availability of natural habitats to sustain a healthy ecosystem. In this project the pre-historic, historic, and on-going environmental conditions present at a representative area are being studied. Information from this project is being used for water resource planning and sustainable land-use that both restores nature and protects land from flood damages.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.21 Soil Quality

Title: EFFECT OF PLANT GROWTH ZONES ON SOIL QUALITY IN THE RHIZOSPHERE

Description: To test a recently formulated convection-diffusion model for the pH field around growth zones, the pH will be measured in the rhizospheres of tips of roots grown in different substrates. Effects of bulk soil pH, water stress, and temperature on pH of the root surface and the rhizosphere will be characterized. Species with differing capacity for rhizosphere acidification will be tested for improved uptake of mineral nutrients, particularly phosphate. The ability of the root to change the pH (acidity) of the nearby soil affects the uptake of both beneficial and toxic nutrients and thus regulates the rate of introduction of mineral elements into the food chain. This year experiments were conducted to determine copper uptake as a function of sulfur availability in monkey flower plants collected from an abandoned copper mine. High sulfur was found to inhibit copper uptake and promote growth. In another study, relationships among pH and copper content of stream water, soil, and plant tissue were analyzed in a watershed affected by acid mine drainage. Strong seasonal patterns were found in copper and zinc uptake. Metals in the stream water, but not in soils or plant tissue, were strongly correlated to pH of the water. Steep concentration gradients in metal abundance were found next to the stream. Time lapse records of primary root growth were produced and analyzed to determine the extent to which nutrients in one stratum would be carried to deeper soil layers. Two masters theses were written and accepted.

Impact: Knowledge of the ability of different plant varieties to modify the pH of the soil surrounding the root is enabling growers and horticulturalists to select plants to increase calcium and iron content, and possibly phosphorus uptake. There is also the potential to enhance uptake of toxic ions such as copper and zinc if soil purification by plants (phytoremediation) is desired, or to exclude toxic ions if the plants are to be used as food.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.21 Soil Quality

Title: ENHANCING THE BENEFITS OF PLANT-ASSOCIATED BACTERIA

Description: Objectives are to: 1) define how root-colonizing bacteria increase carbon availability from roots, naturally and under predation by nematodes; and 2) define how bacterial-feeding nematodes enhance growth of both the plant and root-colonizing bacteria. Work during this period focused on clarifying amino acid exudation by plant roots and on learning how soil food web organisms associated with the root can influence that process. Using new, highly sensitive fluorescent methods for detecting amino acids, amino acid uptake and efflux was quantified at physiologically relevant concentrations in roots of four plant species. Performing these experiments in the absence of culturable microorganisms, either outside or inside the root, the researchers found the influx rates of 16 amino acids exceed efflux rates by 5 to 545 percent in roots of alfalfa, Medicago truncatula, maize and wheat. Several microbial products, which are produced by common soil microorganisms such as Pseudomonas bacteria and Fusarium fungi, significantly enhanced the net efflux (i.e. exudation) of amino acids from roots of these four plant species. Current ecological thinking emphasizes how microorganisms compete with plants for taking up amino acids near roots. The new data show that both bacteria and fungi can play a more active role by actually enhancing the net efflux of these compounds. In other experiments,

they determined that natural degradation products of wide-spread quorum-sensing signals produced by root-colonizing bacteria can increase transpiration in plants when they are applied to roots in nanomolar concentrations. Work continued on attempts to identify plant compounds that attract or repel nematodes.

Impact: Natural plant and microbial signal compounds identified on this project are contributing to the development efforts of commercial organizations to supply agriculture with new bacteria or chemicals that optimize the efficient use of mineral resources, for example by increasing root growth. Outreach and educational activities associated with this project are improving societal understanding that plant growth depends to a large extent on having beneficial microorganisms in the root zone. Identifying how useful organisms function in the root zone will clarify sustainable technologies for minimizing damage from plant pathogens and pests. For example natural products that control soil nematodes may reduce the use of synthetic compounds currently used for this purpose.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.21 Soil Quality

Title: FORMATION AND REDISTRIBUTION OF NANOCRYSTALLINE PRODUCTS OF BIOMINERALIZATION AND CHEMICAL WEATHERING DURING SOIL FORMATION

Description: Microorganisms and geochemical processes lead to generation of the smallest soil particles. This project will examine the form, distribution, and abundance of nanoparticles, and the extent to which the transport of these particles leads to mobility of elements and impacts the chemistry of weathered rock. The UC researchers predict that both chemical weathering and microbial activity (biomineralization, often incidental to the main metabolic activity of the cells) generate particles that are < 10 nm in diameter. Substantial transport of insoluble, nanocrystalline solids should occur once the porosity and permeability of the weathered rock increase due to dissolution. This may lead to patterns of element distribution in the weathering profile and soil that are not anticipated if "insoluble" is equated with "immobile". Understanding of physical transport of "immobile" elements (such as titanium and zirconium) is critical to development of models for soil formation and landscape development that often assume that certain elements are immobile. They have completed geochemical analyses of a soil and weathered granodiorite (saprolite) across a hill slope at a joint field site in order to document patterns of element loss as a function of soil thickness and transport distance. Results indicate significant mobility of most constituents (including aluminum and titanium) in the soil and complex patterns of redistribution of lanthanide ions normally sequestered into highly insoluble secondary phosphate minerals. In laboratory experiments they have discovered that the presence or absence of certain soil organic molecules can dramatically influence metal ion distribution patterns. These organic molecules undergo complex reactions with cerianite surfaces. The organic molecules catalyze a redox transformation and organic-mineralinteractions induce significant decarboxylation and some humification of the organic molecules. They have incorporated landscape lowering rates determined previously (Heimsath et al. 1999) into a soil age model to constrain the relative rates of loss of elements via solution or nanoparticle transport compared to via conventional physical

erosion underpinned by soil creep. The approach has yielded spatially-resolved fluxes of ions from both the soil and saprolite.

Impact: Information about the processes that lead to the redistribution of metals and organic compounds in soils is critical to understanding of factors that determine soil fertility. The results constrain processes involved in soil production and landscape evolution. The findings are being utilized to improve soil management and environmental remediation.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.21 Soil Quality

Title: MICROBIAL TECHNOLOGY REMOVES SELENIUM

Description: Selenium levels at Kesterson Reservoir in 1985 were 300 times higher than maximum levels allowed by the federal government as a result of years of agricultural drainage in the area. Hundreds of dead adult birds and deformed bird embryos could be found on the San Joaquin Valley reservoir, which served as a breeding and stopping point for migratory birds. The cleanup plan involved digging up the tainted sediment and dumping it into a landfill lined with protective barriers. However, the solution was not ideal. UC researchers believed that the barriers would leak eventually, a landfill would take away the value the area had as a wildlife refuge, and farmers' needs for agricultural drainage would be ignored. A UC Riverside Soil Microbiologist and his research colleagues had an alternative, a permanent and environmentally safe method to rid the soil of selenium. During two years of lab research, they had identified five species of soil fungi commonly found in California that convert selenium to a harmless gas, dimethylselenide. tHEY referred to this conversion process as "volatilization." They also had discovered through field tests a way to accelerate the natural volatilization process by as much as 200 percent by using carbon-containing amendments such as pectin, proteins, and cattle manure and by ensuring that the soil was well-aerated. The team began tests of their process at Kesterson in 1987.

Impact: After two years of field trials, 62 percent of the selenium had been removed from the soil using the new microbial technology, which received a patent in 1989. Estimates of the cost of using the technology were $1,000 an acre, compared to landfill costs of about $200,000 an acre. Although government officials decided to proceed with the landfill at Kesterson, bioremediation became a widely accepted alternative for toxic cleanup due in large part to the UC team’s pioneering efforts, which received national press and Congressional attention. This early success of the UC research program has launched further work on bioremediation of other toxins, including arsenic and perchlorate.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.21 Soil Quality

Title: NEMATODE POPULATION BIOLOGY

Description: Objectives are to: 1. Develop, verify and validate predictive and explanatory population models of nematodes functioning at various trophic levels in food webs. 2. Develop and calibrate bioindicator systems for soil faunae and soil health. 3 Relate function to structure in soil food webs. UC researchers used the nematode fauna as an indicator of the structure and function of the soil food web. They documented the development of connectance and structure in the soil food web of agricultural soils during 12 years of low-input and organic production practices. They demonstrated that the structure was destroyed in one year of disruptive conventional management. They are studying the impact of elevated CO2 on the soil food web and whether increase in biomass and metabolic activity of soil organisms is enhanced by additional C flow into soil. Preliminary indicators are that the increase in biomass of soil organisms is not commensurate with the amount of C channeled into the soil. They surmise that C not accounted for in biomass is lost through respiration of a selected community with higher metabolic rates. In parallel with these studies, they are screening chemicals of plant origin as attractants and repellents of plant-feeding nematodes, with the objective of developing baited traps and confusant signals. In studies on the interaction of bacterivore nematodes and their prey, they demonstrated that at low nematode:bacteria ratios, bacterial growth rate is enhanced because the nematodes move the bacteria to new resources. However, at higher nematode:bacteria ratios, consumption by the nematodes outstrips the benefit of the farming effect and bacterial biomass declines. They continued evaluation of isothiocyanates, produced through hydrolysis of glucosinolates in the Brassicaceae, for efficacy against plant-feeding nematodes. They tested the use of brassicaceous residues for nematode management under field conditions and found that in most cases the amount of material required was prohibitive. They demonstrated that the various isothiocyanate products of glucosinolates were differentially effective against nematodes and that management system could be optimized by selecting brassicas with glucosinolates effective against the target nematodes. They continue development of grape rootstocks with broad and durable resistance to nematodes. They are determining the heat stability of resistance to four species of nematodes in our advanced rootstock selections. Field evaluation is underway.

Impact: The researchers continued to identify soil management practices that are beneficial to maintaining and improving soil health and those that are not. They are developing the protocols and rationale for reducing reliance on soil tillage, mineral fertilizers and synthetic pesticides. Their work on organic amendments is designed to improve the likelihood of success with those approaches in nematode management. Their studies on nematode behavior in relation to plant molecules, and on interaction of nematodes and bacteria, are leading to a mechanistic understanding of the interaction of organisms in the rhizosphere. New grape rootstocks with broad and durable nematode resistance will provide important options for nematode management in the grape industry.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.21 Soil Quality

Title: NUTRIENT RELEASE AND ORGANIC DECOMPOSITION IN FOREST SOILS

Description: Objectives are: 1. To characterize phosphorus (and other nutrients) and carbon forms, and the linkages between them, in forest litter and soils from two different climates under different forest tree species. 2. To determine what controls the anticipated differences in the decomposition dynamics of phosphorus (and other nutrients) and carbon forms at the contrasting study sites. In particular, is the controlling factor climate, tree species, or something else? After two years (in a paired-litter bag study) Douglas fir litter type material had changed nutrient concentrations that resembled those of destination sites. In contrast, for the cedar litter type material, the concentrations of nutrients remained unchanged after two years, and resembled those of the source material more than the destination material, both for California-to-Washington and Washington-to-California transplants.

Impact: Results indicate that nutrient cycling through litter decomposition is largely controlled by the litter microenvironment of the Douglas fir litter type, but much more controlled by 'litter quality' in the case of the cedar litter types. This better understanding of nutrient cycling will contribute to improved forest management.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.21 Soil Quality

Title: USING GENETIC ENGINEERING TO ENHANCE PHYTOREMEDIATION OF TOXIC TRACE ELEMENTS

Description: Objectives are: 1: To improve the efficiency of phytoremediation by elucidating and genetically manipulating mechanisms of transport, sequestration, or volatilization of toxic trace elements in plants. Objective 2: To identify key genes responsible for microbial tolerance to high levels of trace element contaminants and to construct a library of novel genes for overexpression in plants. Objective 3: To evaluate the potential of newly-developed transgenic plants for the phytoremediation of toxic trace elements under field conditions. A UC laboratory uses a multi-disciplinary approach to develop more efficient bioremediation technology for the clean up of selenium (Se) and other trace elements from agricultural and industrial wastewater. Recent developments in ecology, plant physiology, and molecular biology are summarized below. Ecology research: Clean water is currently the most important factor limiting agriculture in the western United States. However, agricultural irrigation water leaches salts and trace element contaminants, such as Se, from the soil, and quickly becomes unusable for irrigation of many crops. The integrated on-farm drainage management system, or IFDM, is an innovative solution to this problem being used at the Red Rock Ranch, CA. Clean water is used to irrigate non-salt tolerant crops. The drainage water from these fields are then used to irrigate successively more salt-tolerant crops, until only a small amount is deposited into a solar evaporation pond. Before this approach can be applied on a more widespread scale, it must first be determined if the IFDM system poses an ecotoxic risk to wildlife with respect to Se. The UC researchers have earlier found high concentrations of Se in plant tissue and soil from the halophyte fields of the IFDM system. Determination of Se ecotoxicity requires not only the quantification of total Se present but also a thorough and complete speciation of Se, particularly organic Se, in different compartments of the ecosystem. This is because Se toxicity and

bioavailability are strongly dependent on Se chemical form. In 2002, they have conducted three sampling trips at the IFDM system in Red Rock Ranch, collecting plant roots, shoots, seeds, soil, and insects from areas of different salinity. They have used X-ray absorption spectroscopy during two trips at the Stanford Synchrotron Radiation Laboratory to speciate inorganic Se forms. Additionally, they have developed HPLC methods to identify and quantitate selenoamino acids from plant tissue and are now analyzing samples. Plant Biochemistry, Molecular Biology, and Physiology: They have developed double homozygous Indian mustard plants overexpressing both ATP sulfurylase (APS), from Arabidopsis thaliana, and selenocysteine methyltransferase (SMT), from the Se-hyperaccumulator, Astragalus bisulcatus and Indian mustard expressing both gamma-glutamyl cysteine synthetase (ECS) and glutathione synthetase (GS). They expect that the double transgenic plants will combine the traits of their single transgenic parents and, therefore, have even further increased phytoremediation potential. They have completed the molecular characterization of the APSXSMT plants and have begun their physiological characterization. In seedling tolerance experiments, they have shown that the APSXSMT seedlings tolerate selenate and selenite better than wildtype and single transgenic plants. They expect that the double transgenics overexpressing GS and ECS will have increased tolerance to heavy metals because they overproduce phytochelatins, which act as metal detoxifiers.

Impact: This research provides a fundamental understanding of the assimilation of selenium and other trace elements by plants and microbes. The results of this bioremediation research are being used to efficiently and economically clean up trace element-contaminated environments.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.22 Sustainable Agriculture

Title: BREEDING, GENETIC, AND AGRONOMIC STUDIES OF BARLEY IN CALIFORNIA

Description: Objectives are to: 1) Development of disease resistant forage barley combining the hooded character with low gramini content in a high yielding background, 2) development of disease resistant malting barley for the Central Valley of California, and 3) improve six-rowed spring feed barley. UC 1047 over four years averaged 6,523 lbs./ac. compared to 6,186 lbs./ac. for UC 933 and 5,666 lbs./ac. for UC 937 in the Sacramento Valley. In the San Joaquin Valley UC 1047 averaged 6,358 lba./ca. compared to 5,763 for UC 933 and 5,778 for UC 937. UC 1047 had no yield advantage in low yielding, dryland tests. Seed of UC 1047 are being multiplied for commercialization in Nov. 04. New entries were placed into regional grain yield trials for the 2003-04 crop season including three hulless entries, one of which was a two-rowed selection from the ICARDA/CIMMYT barley improvement program. The two six-rowed hulless selections were derived from UCD populations. For the Klamath Basin advanced lines from four populations are being evaluated in the northern intermountain grain yield trials and IREC observation plots. These lines are from the crosses: Stander X UC 960, Brigham X UC 960, Statehood X UC 960, and Millennium X UC 960.

Impact: UC 1047 should replace the other two semidwarfs UC 933 and UC 937 over time in the Central Valley and surrounding foothills. Commercial quantities of the semi-dwarf, stripe rust

resistant spring barley varieties (UC 933, UC 937 and UC 960) are still available to growers in the Central Valley and Klamath/Tulelake Basin. An early maturing spring barley, UC 969, also has been released and should replace UC 603.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.22 Sustainable Agriculture

Title: EVALUATION AND DESIGN OF SUSTAINABLE AGRICULTURAL SYSTEMS

Description: Objectives are to: 1) Develop criteria on which sustainability can be evaluated and methods to quantitatively compare alternative agricultural systems, 2) evaluate sustainability of current agricultural systems in California, 3) develop methods of evaluating neighborhood farms in terms of natural resource consumption, opportunities in water and wastes re-cycling, environmental impact by production practices so that the sustainability of all farms in a county can be enhanced. Evaluation and design of sustainable agricultural systems is a broad area of research in agricultural sciences and an important ongoing research project for this UC researcher. The scientific task of evaluating an agricultural system is extremely difficult due the complex nature of field environment where crops are grown and the convoluted and multifaceted interactions that constantly occur in the field. In addition, objectives of sustainable agriculture are multidimensional and often counteracting. For instance, profitability and productivity of a production system have to be balanced with its environmental impact and resource conservation in order to be sustainable. The UC researcher has taken a combination of field observational and computer modeling approaches to evaluate the system. An intelligent recommendation can only be derived after a comprehensive analysis of the models that are based on inputs of field observations. Example would be in a field study where they evaluated the impact of pocket gophers on alfalfa yields. The objectives were to minimize the input of chemicals and enhance the sustainability of the production system. Pocket gophers affect alfalfa production, as well as the disposition of multiple legally rare species that either prey on gophers or use their burrows as habitat. The researchers analyzed attributes of the landscape, alfalfa fields, and farming practices that might influence gopher density in 35 alfalfa stands scattered throughout the Yolo County. They found that gopher density in alfalfa increased with increasing age of the stand (time since planting), habitat area as a percentage of the landscape within a 500 m buffer around the field, percentage of sand within the top soil layer, and season of the year progressing from winter through autumn. Gopher density in alfalfa decreased with increasing frequency of irrigation and field size. Using these variables, they were able to explain 73 percent of the variation in the 134 estimates of gopher density among the 35 alfalfa stands. The landscape and field attributes improved our predictions of gopher density, and can therefore improve our predictions of how the conservation of legally rare species can be improved by enhancing gopher habitat on non-production lands intervening alfalfa fields. The researcher also used a model, SIMETO, to simulate the weather patterns and extreme conditions. This information would allow us to assess the impact of global climate change on sustainability of a cropping system in a region. Example of this work is shown in the paper A sustainable agro-ecological solution to water shortage in north China Plain (Huabei). They are applying the same approach to evaluate the sustainability

of water use in California cropping systems. Because the focus will be on water, they will transform this project to a new project with a shifted emphasis on water resources.

Impact: Through this project the researchers developed a modeling approach to evaluate the sustainability of cropping systems. Results of their research have also been utilized to improve sustainability of alfalfa production systems in California and corn-wheat intercropping systems in north China.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.22 Sustainable Agriculture

Title: IMPROVING POTENTIAL FOR NITROGEN INPUTS FROM BIOLOGICAL NITROGEN FIXATION

Description: Objectives are to: 1. Determine the pattern of nitrogen assimilation in root nodules of DATISCA GLOMERATA and investigate the composition and function of cell wall components in root nodules; 2. Further elucidate the molecular basis of nitrogen fixation regulation in FRANKIA; 3. Quantify patterns of nitrogen cycling from legume and actinorhizal plant sources in biosystems dominated by woody perennials. Research projects on biological nitrogen fixation have been focused in 3 areas: 1) Effects of legume cover-crops as nitrogen sources in a winegrape vineyard. Nitrogen was traced from isotopically-enriched legume cover-crop hay into grapevines in field experiments. Cover-crop derived nitrogen was rapidly detected in the vines, but vine N uptake was much lower in the field than in lysimeter experiments. 2) Role of plant cell wall components in nodule establishment and function. Arabinogalactan proteins were localized at sites of early infection in root nodules of ALNUS, indicating a role for these extracellular glycoproteins at the symbiotic interface. 3) Continued characterization of hopanoid lipid genes and gene products from the nitrogen-fixing microsymbiont, FRANKIA. Evidence for an interaction between phenylpropanoid metabolism in the root nodule and biosynthesis of nitrogen-fixation specific hopanoids in FRANKIA was uncovered.

Impact: Organic matter derived from N-fixing plants has value for soil-building and agroecological applications. Nitrogen-fixing trees contribute to sustainable productivity and biodiversity in disturbed or depleted soils, often in extreme environments.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.22 Sustainable Agriculture

Title: INTEGRATED CANOPY MANAGEMENT IN CALIFORNIA NUT CROPS

Description: Objectives: 1) Work to maintain productivity in dense plantings. 2) Assess possibilities of using regulated deficit irrigation and/or nitrogen manipulation to attempt to control vegetative growth. 3) Investigate the role of role of irrigation and canopy management in

disease and insect resistance. Objective 1- The technique of making selective thinning cuts high in the canopy has again been shown to have no significant effects on midday canopy light interception on any individual day during the season in 2003. However, when the average seasonal canopy light interception was calculated, there was a small but significant increase for the high limb pruning treatment in 2002 and in 2003. Shoot growth data suggests that when large thinning cuts were made high in the canopy, energy was reallocated into shoot growth on the sides of the canopy. In general, yields appeared to be directly related to the midday canopy light interception with increased light interception resulting in increased yields. The third year data again showed no significant impact of the pruning treatment on yield and a slight but significant increase in seasonal average canopy light interception in the Tulare trees on Northern California Black rootstock. The results suggest that use of selective pruning cuts high in the canopy can be effectively used to maintain high density Tulare walnut plantings at a reduced height without significant impacts on yield. Objective 2- This project was initiated to investigate the dynamics of spur renewal, fruitfulness and longevity and to determine how these are influenced by nitrogen and irrigation. Monitoring will be carried out for 6 years to quantify the impacts of treatments on spur longevity. In 2003, all three deficit treatments had significantly lower midday canopy light interception than the control throughout the season. Once again, midday stem water potentials were maintained near target levels throughout the 2003 season. All three deficit treatments led to significantly lower yields in the third year of treatment imposition, but this is partially due to decreased canopy area since treatments were imposed before trees had filled in their allotted space. Incidence of kernel mold has been less in deficit irrigated trees. Significant changes in leaf specific area (a measure of spur quality), particularly in inner canopy positions in the deficit treatments, may lead to improved spur longevity and shifts in canopy nut production patterns in the coming season. Objective 3- As the key insect pest of walnut, codling moth requires extensive intervention to prevent unacceptable levels of nut damage by harvest. This work was initiated to look at the relationship between tree water status and nut susceptibility to provide growers with an opportunity to maximize the natural resistance of nuts to codling moth damage through irrigation management. Results of this work suggest that codling moth susceptibility in walnut is directly related to water status with trees receiving the most water being the most susceptible to codling moth attack. This work suggests that some level of deficit irrigation may help to relive codling moth pressure in walnut.

Impact: Deficit water management combined with selective pruning has been shown to have applicability in managing dense plantings, if trees have filled in allotted space when deficits are imposed. In addition to providing canopy management benefits, deficit irrigation management may make the orchards less susceptible to insect and/or fungal pests. By minimizing irrigation events, pruning tower use and spraying operations, reliance on fossil fuels can be decreased while minimizing pesticide usage. Employing these techniques would provide direct benefits to growers by decreasing costs of production and reducing potential for worker and environmental pesticide exposure while producing products with the lower pesticide residues consumers desire.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.22 Sustainable Agriculture

Title: LONG TERM RESEARCH ON AGRICULTURAL SYSTEMS

Description: Objectives are to: 1) Compare long-term trends in yield of cropping systems differing in external inputs. 2) Monitor changes over time in soil properties and effects of these changes on resource use efficiency. 3) Determine how differences among the systems affect movement of nitrate or pesticides below the root zone. 4) Identify and analyze processes and mechanisms responsible for these differences in system performance. 5) Serve as a resource for education and outreach. The former director of the 100-year Long-Term Research on Agricultural Systems (LTRAS) project in 2003, remains involved in some project aspects, especially analyzing results and writing papers. He has also been working with the project databases, correcting a few errors and holding a training session for potential users. Scientific results from this multi-investigator project, including some not yet published, have been diverse. There have been dramatic shifts in weed species differing between cropping systems. Organic systems produce more dust. Low-input and alternative systems have generally had lower yields, but this was not true of tomato, the most valuable crop. Improvements in yield-limiting aspects of soil quality from organic methods (particularly the use of winter legume cover crops) were apparent only a few months into the organic transition, in contrast to the widely held view that such benefits develop only over years. Residual soil N made a substantial contribution to yields of unfertilized controls even after 9 years. This shows that short-term soil fertility experiments can be very misleading a crop dependent only on a green manure or low fertilizer rate might actually be using significant amounts of soil N and underscores the importance of a long-term approach. LTRAS has also hosted UCD classes and many visitors from around the world each year. The recent move of the SAFS team to the LTRAS site creates exciting new opportunities for collaborative research, making LTRAS arguably the most ambitious sustainable agriculture experiment in the world.

Impact: LTRAS provides a credible source of field data to answer important questions about the sustainability, profitability, resource use, and environmental impact of conventional and alternative field crop production practices.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.22 Sustainable Agriculture

Title: MANAGING PLANT-MICROBE INTERACTIONS IN SOIL TO PROMOTE SUSTAINABLE AGRICULTURE

Description: Objectives: To identify and characterize new biological agents, naturally suppressive soils, cultural practices, and organic amendments that provide control of diseases caused by soil borne plant pathogens. Destruction of infected crop residue is a management strategy commonly recommended for the control of many plant diseases. Based upon knowledge of the biology of the root-infecting fungus Monosporascus cannonballus, this strategy is a likely candidate for use in the management of vine decline of melons caused by this pathogen. Specifically, ascospores, the primary survival structure and inoculum for root infection, are

produced on infected melon roots primarily after crop termination. Thus, destruction of infected roots prior to reproduction would be a very practical method of preventing inoculum buildup in soil. Results of this study demonstrated that two practices employed by some growers to kill living plants at crop termination (i.e., foliar application of an herbicide or the mechanical destruction of vines) could be counterproductive with respect to disease management. Specifically, relative to their respective nontreated controls, significant ($P < 0.05$) increases in the percentage of roots per plant with perithecia were observed in all mechanical vine destruction experiments and in all herbicide experiments applied at crop termination in both the spring and fall cropping seasons.

Impact: In addition to the above interactions at the end of the growing season, the use of glyphosate to kill volunteer melon plants in non-host rotation crops (such as Roundup-ready cotton) could result in an unanticipated increase in the soil populations of M. cannonballus and a concomitant increase in disease incidence or severity in the next melon crop. The latter scenario is highly probable because our previous studies showed that root infection of melon seedlings can occur within 9 days after emergence and that the pathogen will reproduce on the roots of infected seedlings upon their death. Although the size of the root system of an infected seedling would be small in comparison to an adult melon plant, that difference would be offset by the far greater numbers of volunteer melon seedlings per hectare than the normal planting density of a melon crop.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AK, AZ, CA, ID, IL, MT, NM, NY, OR, WA

Theme: 4.22 Sustainable Agriculture

Title: MANAGING PLANT-MICROBE INTERACTIONS IN SOILS TO PROMOTE SUSTAINABLE AGRICULTURE

Description: Objectives: 1. To identify and characterize new biological agents, naturally suppressive soils, cultural practices, and organic amendments that provide control of diseases caused by soil borne plant pathogens. 2. To understand how microbial populations and their gene expression are regulated by the biological (plants and microbes) and physical environment and how they influence disease. 3. To develop and implement biological control in agriculture. UC researchers have identified three sources of soil suppressive toward Phytphthora cinnamomi: 1) Suppressive soils from Southern California, 2) Soils that have experienced an avocado root rot epidemic, and 3) Soils from the region where P. cinnamomi originated, namely Papua New Guinea. Some of these sources are 10-fold more suppressive than the same soils which are fumigated to remove the biocontrol microbes. In some of the soils the microbes and the suppressiveness are transferable to other soils. They are regularly generating new, strong biocontrol candidates such as Rosella sp., Pseudomonas constantinii and Lytobacter mycophilus which are vicious predators of P. cinnamomi in the laboratory. They have created soils with varying level of suppressiveness by heating the Somas CA soil to 21, 45, 60, 75, and 90 degrees. A greenhouse trial was set up with this microbially suppressive soil in which the soil was subjected to this same range of temperatures in order to determine at what point the suppressive effect disappeared. After takedown, the results showed a gradual decline in the percentage of

healthy roots with increasing temperature, which indicated that the suppressiveness was declining with increased temperature. Samples of each soil treatment were taken to the lab, and P. cinnamomi hyphal mats were buried in the soil for one week. One ml of mat suspension was then plated onto various media to check for the predominant fungi and bacteria, which attacked Phytophthora at each temperature. Galactomyces was most common at the lower temperatures, Verticillium and Trichoderma at the higher temperatures and Fusarium was present throughout all temperature treatments. Verticillium, Fusarium and Trichoderma are all known antagonists of Phytophthora but their presence could not be correlated with suppressiveness. According to these results Galactomyces populations correlated well with suppressiveness. Bacterial identification of culture-based organisms and molecular identification of fungal and bacterial organisms were also done. Molecular examinations of the microbial communities confirmed Galactomyces as a major component of the suppressive soil. Molecular examinations led to the discovery of several other organisms whose populations correlate with suppressiveness. These organisms are related to Chaetomium, Monographella, Fusarium, Tritirachium, Galactomyces, Cryptococcus, Chytridium polysiphoniae and beta-Proteobacteria. Chytridium and Tritirachium are known to parasitize fungi and Chaetomium, Fusarium and Mongraphella are known to suppress Phytophthora. Using new and novel microbial techniques they have identified, isolated and tested our first microbes from suppressive soil. They are now poised to initiate an assembly-line procedure to isolate and test new biocontrol organisms for use against Phytophthora cinnamomi. There probably are several types of soil suppressiveness toward P. cinnamomi and not all of them appear to be of microbial origin. Pseudomonas putida has been rigorously tested and has proven to be a fair biocontrol agent of Pseudomonas putida.

Impact: Biocontrol may provide an effective, long-term, non-chemical, environmentally acceptable method of controlling Phytophthora root rot of avocado through a combination of cultural methods and application of selected microorganisms. The researchers have provided evidence that excellent control of Phytophtora cinnamomi can be found in suppressive soils and that this suppressiveness can be transferred to other soils. They have developed a method to identify the microorganisms in the soil responsible for the suppressiveness. Several excellent candidates for biocontrol of Phytophtora cinnamomi have been identified.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AK, AZ, CA, ID, IL, MT, NM, NY, OR, WA

Theme: 4.22 Sustainable Agriculture

Title: POLLINATION BY INSECTS

Description: Objectives are to: Investigate methods for improving pollination efficiency of honey bees in almond; determine potential of native and non-indigenous bees for almond pollination; determine roles of bee pollination in conservation of plants in the vernal pool habitat; investigate ecological relationships between flowering plants and their oligolectic bees; determine impact of honey bees on fauna and flora of selected ecosystems; and investigate systematics and ecology of selected pollinating insects, especially bees.

Impact: The researchers continue to expand their knowledge of diversity and resource use by native bees on sustainable ag farms, adjacent wildlands, and urban gardens. Newly established

gardens attract bees as soon as bloom is available. Reduced pollination and increased seed predation may effectively reduce reproduction of some weeds.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.23 Water Quality

Title: ASSESSING NITROGEN MINERALIZATION AND OTHER DIAGNOSTIC CRITERIA TO REFINE NITROGEN RATES FOR CROPS AND MINIMIZE LOSSES

Description: Objectives are to: 1. Develop and evaluate rapid tests for soil N mineralization capacity across the various soils and climatic regimes of the region and determine the feasibility and most appropriate conditions for use of these tests. 2. Conduct fundamental work to enhance current understanding of the role of active C and N pools in cropping systems and to predict net N mineralization as influenced by C sequestration management. 3. Develop a guidance document for agricultural professional focusing on N best management practices and optimum rate determinations for the region. The development and implementation of methods to prescribe N fertilizer recommendation has proven difficult because no one method can accurately determine soil N mineralization and availability across changes in soil type and agronomic management practice. Excessive N application rates and or timing have been cited as reasons for the occurrence of high groundwater nitrate content across the US. The excess application of N and its export from agricultural fields may produce secondary affects associated with nutrient and dissolved oxygen depletion in sensitive aquatic food webs. Nitrates and salts are of concern in surface waters because they can contribute to increased algal productivity and cause secondary production of dissolved organic C, a drinking water constituent of concern. Soil tests for nitrate combined with matching N application rates and timing to actual crop uptake have been commonly used practices in the past to ensure adequate available crop N. However, the testing for residual fertilizers and available soil N has proven to be marginal in predicting crop N requirements. Establishing sites across a range of soils, climate and cropping systems is critical to developing accurate fertilizer recommendation rates that are cropping system specific. Field studies to measure crop production responses to various N application rates at diverse sites representing soils and cropping systems throughout the United States are in progress. The amount of excess N applied at rates above the observed production or economic optimum will be used to evaluate the relationships between excess N and potential losses nitrate and other drinking water constituents of concern. This will allow estimation of the consequences of reducing N inputs on the potential for impacting water quality and crop productivity. In addition, soil organic matter fractions are being examined to further develop an understanding of the factors controlling the N mineralization potential of soils. To overcome the limitations researchers currently experience in predicting soil N mineralization, the development of rapid tests for soil N mineralization capacity across the various soils and climatic regimes of the region are required. The tests require modification in order to be adopted by commercial soil test laboratories. The product of this research should enable soil test labs to provide accurate information to growers as to the responsiveness of N fertilizer application and determine better the rate of application. This will result in improved fertilizer use efficiency and reduce offsite transport of fertilizer. The efficient management of N in cropping systems has many ancillary

benefits other than improving fertilizer use efficiency. Coupling N processes to soil C processes provides a holistic approach that addresses soil C sequestration, enhances the quality of the soil resource and helps farmers reduce input costs with sustainable fertilizer practices.

Impact: The accurate determination of soil N mineralization is recognized as a requirement for prescribing accurate fertilizer N recommendations and to avoid excessive application rates that leads to offsite transport or groundwater contamination. This project develops methods for commercial soil test labs to accurately estimate soil N availability and reduce non-point fertilizer losses from agriculture.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AK, CA, FL, IL, IN, IA, KS, MN, MO, NE, NY, OH, SD, WI

Theme: 4.23 Water Quality

Title: BENEFICIAL USE OF BIOSOLIDS

Description: California communities treat billions of gallons of municipal wastewater each year. The impurities that are removed during treatment are collected into a stabilized residue, called "biosolids," which must be disposed safely. Land filling or incineration of biosolids has proven difficult and costly. Application to land is less expensive and, since they are rich in the nutrients needed by plants, biosolids are also effective fertilizers. Because wastewater treatment collects dissolved and suspended heavy metal in the biosolids, research was needed to determine the metal concentrations land-applied without affecting human health. Two ANR professors have researched the fate of metals applied to California soils for many years. The professors considered how applied metals react with soil particles over time as well as how they are taken up by plants. They were centrally involved with the EPA as it developed legal quality standards for land application and have published recommendations for the World Health Organization. They also have published background metal concentrations naturally present in California soils. In 1993 a Cooperative Extension Specialist began to share their research, as well as that of other waste management scientists, to the community through workshops, a conference, and a notebook.

Impact: Wastewater treatment plants have reduced the concentrations in biosolids dramatically by regulating the discharge of metals into sewage systems. Land application (including composting) has increased from approximately 25 percent of generated biosolids to over 75 percent today, savings millions of dollars in disposal fees, conserving landfill space, and providing valuable nutrients to California farmlands, recreational areas, and urban landscapes. Extension advisors have worked with county governments around the state to develop regulations appropriate for local conditions and concerns.

Funding Source: Smith-Lever, Hatch, and State

Scope of Impact: State Specific

Theme: 4.23 Water Quality

Title: COSTS AND BENEFITS FOR CENTRAL COAST WATER QUALITY CONSERVATION PRACTICES

Description: Water quality protection and maintenance have garnered considerable attention recently in counties neighboring the Monterey Bay National Marine Sanctuary. In particular, Central Coast farmers are facing more scrutiny and regulatory pressure about land management and agricultural runoff. Economic analyses of water quality conservation practices have been identified as "high priority" needs by the Water Quality Protection Program of the Sanctuary, a coalition of 29 public and private coastal organizations and businesses. UC Cooperative Extension in Santa Cruz County recently completed nine economic analyses that can help farmers estimate costs and potential benefits of water quality conservation practices on their farms. Supported by a grant from the USDA Natural Resources Conservation Service (NRCS), the research was done in collaboration with NRCS and with coastal farmers, ranchers and landowners as well as other researchers, agencies and industry representatives. Each of the nine studies describes a particular conservation practice and provides a budget table estimating costs (operations and reduced returns) and potential benefits (additional returns and reduced costs) for its installation, operation and maintenance. Costs include such items as equipment use and labor, planting of ground cover or yield losses because of flood damage. Benefits include less equipment use and labor for storm repairs, and improved returns by minimizing yield losses from flood damage. Estimated costs and potential benefits are shown for low, representative and high cost scenarios. More detailed information on labor and material inputs for the representative scenario is contained in additional tables. The information has been presented and incorporated into ongoing UC-NRCS sponsored Farm Water Quality Short Courses, and more recently in more informal field "tailgate" meetings.

Impact: These first-of-a-kind economic analyses provide coastal farmers, ranchers and landowners with information to help them make important water quality planning and management decisions. In addition, NRCS technical field staff use the studies when working directly with local farmers to help implement conservation practices. The studies are also used in calculating cost sharing for farmers through the NRCS Environmental Quality Incentives Program (EQIP). Staff from the area's Regional Water Quality Control Board also have used the information to help identify regulatory impacts on the agricultural community. In sum, these UCCE research results fill a critical information and education gap in the economics of conservation practices.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 4.23 Water Quality

Title: DEVELOPMENT AND APPLICATION OF CROP MODELS FOR CUT-FLOWER ROSES

Description: Objectives are to: 1. Develop models for various aspects of plant development and growth for cut-flower roses focusing on biomass growth, water relations, and plant nutrition.

2. Incorporate these models into crop management tools that can be used directly by growers for making decisions regarding irrigation, fertilization and run-off. 3. Develop a rose crop simulation model that will allow simulation of crop productivity under a wide range of horticultural conditions. Production of greenhouse flowering crops has traditionally been a large industry, especially in California. Growers are facing significant challenges that threaten to drive them out of business. In this project tools are being built to help growers manage the greenhouse environment more efficiently while controlling run-off from excessive fertigation. In previous years a computer simulation model was build for rose stem growth and development. Currently the model is being further developed to include the effect of the various root-zone variables especially moisture, nutrient concentration and oxygen concentration. During the reporting period a simple simulation model for nitrogen dynamics was expanded and incorporated into the simulation model. Current work is progressing on quantifying the effect of dissolved oxygen and nutrient availability on rose plant and shoot growth. The researchers work with dissolved oxygen resulted in information that suggests that significant productivity gains can be made in hydroponic production by optimizing oxygen in the root-zone. In the future they will use the model resulting from this research in this optimization process. They are also in the process of refining a rose crop scheduling tool that growers can use for managing the greenhouse environment of rose crops.

Impact: Greenhouse growers of ornamental crops (flowers and potted plants) are always seeking ways to be more productive and efficient. In their competition with foreign producers, U. S. growers must be as efficient as possible. Development of improved horticultural techniques will allow growers to be more competitive while at the same time improving their sustainability and to make their greenhouse operations more environmentally friendly. One portion of this project has yielded a software tool that growers can use to help them with making decisions for timing rose crops for holiday markets.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.23 Water Quality

Title: ECOLOGICAL AND PHYSIOLOGICAL ASPECTS OF NUTRIENT USE EFFICIENCY OF CROP PLANTS

Description: Silicon plays important roles in agronomic plants. It often minimizes lodging, enhances resistance to diseases and pests, affords protection against Al and heavy metal toxicities, promotes orientation of leaves toward the sun in such a way as to maximize light interception and hence, photosynthesis, affects the quality of plant fibers, influences the absorption and transport of several mineral elements, and performs many other functions in the life of plants. Although the research described in this report represents a different direction compared to the previous report, it still addresses the overall objectives expressed in the project title. The UC researchers are using wheat, Triticum aestivum, Yecora rojo, to investigate the role of Si. The reasons for this choice are (a) it is known to be a Si accumulating plant (b) much less is known about its Si nutrition than is the case for rice, rice indeed being the only species for which a substantial body of information in regard to Si is available(c) they already have

experience in experimentation with wheat, an advantage in a project which is of short duration. Initially they will investigate the transport and distribution of Si to provide basic information on its nutrition. The response of acala (Gossypium hirsutum) and Pima cotton (G. barbdense) to a range of applied nitrogen was investigated in a multi-year, multi-site experiment in the San Joaquin Valley of California. A better understanding of plant N management practices may assist in the design of N management strategies that optimize N utilization and lint yields while reducing environmental impacts. Both Acala and Pima (Gossypium barbadense) tissue N concentrations were strongly affected by plant developmental stage and N treatment. Leaf N concentration as an in-season indicator of N status and estimates of seasonal soil mineralization potential may be useful in optimizing N management in cotton. The chemical speciation of Si in xylem exudates from wheat (Triticum aestivum) was examined by 29Si NMR spectroscopy. There was no evidence that organosilicate complexes in xylem exudates, however, the efficiency by which wheat concentrates aqueous Si indicates active mechanisms of Si transport across root cell membranes.

Impact: The information in this report will provide the bases for reevaluation of the rate of fertilizer used in the production of cotton in the San Joaquin Valley

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.23 Water Quality

Title: ENGINEERING SYSTEMS FOR AQUACULTURE

Description: The general objective is to improve the scientific and engineering basis for aquaculture practices. Specific objectives include: 1) To develop bioengineering data on aquatic species suitable for culture. 2) To develop improved processes and equipment for unit operations carried out in aquaculture. 3) To develop technologies for improving the efficiency of water use in aquaculture systems and minimizing the negative environmental impacts from aquaculture. 4) To develop instrumentation suitable for field use in aquaculture. A computational fluid dynamics (CFD) model of aquaculture raceways has been developed. The model has been used to characterize the solids settling in the quiescent zone (QZ) of existing trout raceways and also to investigate potential raceway modifications designed to improve the settling of solids in the QZ. Improvements in settling will result in smaller solids discharges to receiving waters from trout rearing operations. According to the simulations, alternatives investigated could result in reductions in solids releases of over 10 percent of total solids produced in a raceway. The UC researchers are the first group to study the presence and treatment of off-flavor compounds in recirculation aquaculture systems. Currently, aquaculture producers use depuration techniques to deal with off-flavor in recirculation systems. They are collaborating with a researcher in Mississippi to determine the concentrations of off-flavor compounds in recirculation systems and to develop water treatment techniques that are compatible with recirculation system technologies used in industry. They are working with a nutritionist in the Animal Science Department to develop recirculation and general culture and nutrition information for a native California seawater species (California halibut) that has not been cultured in the past. They were successful in transporting eggs and newly hatched larvae from a hatchery in Southern California. They

developed a recirculation system for the early rearing of the fish. They have determined bio-engineering design criteria for the fish, and have evaluated a number of water treatment operations suitable for their culture. They have constructed a pilot commercial-scale unit at the Bodega Marine Lab that is currently being evaluated. One of the primary characteristics of the system they have developed is its low energy requirement primarily due to a new type of biofilter they are using.

Impact: The CFD model help develop more efficient processes for controlling solids in raceway effluents and reducing their environmental impact. The off-flavor work should reduce production costs and risks for aquaculturists using recirculation systems. The recirculation technology and diets being developed for California halibut will help with the establishment of an industry for halibut culture.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.23 Water Quality

Title: INSECTICIDE CHOICE FOR ALFALFA MAY PROTECT WATER QUALITY

Description: Some insecticides used for controlling Egyptian alfalfa weevil have been detected in California's surface waters. Many are of concern due to their impact on water quality and toxicity to some aquatic life. UCCE farm advisors and specialists teamed up to determine how organophosphate insecticides move offsite from alfalfa fields, and to find alternative pesticides that do not impair water quality in irrigation runoff. In a three-year project, they demonstrated that using pyrethroid pesticides rather than the more common organophosphates is more effective for controlling Egyptian alfalfa weevil and also reduces the amount of pesticide that could run off the field into natural waterways. This project involved working directly with 30 farmers in the northern Sacramento Valley. UCCE's link with farmers helped this project succeed because they worked together for a solution on water quality problems.

Impact: As a result of this project, annual use of the organophosphate chlorpyrifos in alfalfa decreased by 50% in Yolo County (14,000 lbs to 7,000 lbs) and by 75% in Solano County (12,000 lbs to 3,000 lbs). Reduced organophosphate use in alfalfa will help improve water quality in areas where there is irrigation runoff from alfalfa fields and organophosphates are found in surface waters.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 4.23 Water Quality

Title: INTEGRATED PESTICIDE TRANSPORT MODELING

Description: Objectives are: To quantify pesticide migration through variably-saturated soils, aquifers, and surface streams by taking into account pertinent physical, chemical, and biological

processes; to develop an integrated, three-phase, pesticide transport model to characterize the vulnerability of both surface and subsurface environments to pesticide contamination; to develop a hybrid solution approach that is suitable for multiple-scale solute transport modeling; to evaluate the potential threat of pesticides and their breakdown products to subsurface and surface water systems; and to apply the model to basins in the Sacramento-San Joaquin River and identify comprehensive management schemes. The fate of nonpoint-source pesticides in subsurface and surface environments was investigated by developing a systematic procedure and practical analytical tools for evaluation of the leaching potential of pesticide residues to ground water and the potential threat of pesticide emissions to adjacent rivers/streams.

Impact: Cost-effective assessment tools have been developed which can be employed to regulate the use of agricultural chemicals, identify areas that are potentially vulnerable to nonpoint-source pollution, and support ecosystem restoration goals by improving a regions water quality.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.23 Water Quality

Title: MECHANISMS AND MITIGATION OF AGROCHEMICAL IMPACTS ON HUMAN AND ENVIRONMENTAL HEALTH.

Description: Objectives are to: 1. Identify, develop, and/or validate trace residue analytical methods, immunological procedures and biomarkers. 3. Determine adverse impacts from agrochemical exposure to cells, organisms and ecosystems. A project of UC researchers is characterizing orchard dormant sprays to minimize runoff that may harm aquatic life. This year's studies did not fully verify previous findings that early spraying reduces runoff later after heavy rains. Round robin studies of state mandated cholinesterase monitoring by clinical laboratories led the Department of Pesticide Regulation to withdraw permission to monitor from 11 or 20 clinical laboratories until their findings are consistent with ours. A Department of Defense cholinesterase harmonization project is directly comparing their slower method with our faster colorimetric assay.

Impact: The research is helping reduce pesticides runoff in California and plays a major role in standardizing blood cholinesterase assays to detect exposure to pesticides and related chemical warfare agents.

Funding Source: Hatch Multistate Research and State

Scope of Impact: CA, FL, HI, IN, KS, NM, NV, NY, OR, UT, WA

Theme: 4.23 Water Quality

Title: MICROIRRIGATION TECHNOLOGIES FOR PROTECTION OF NATURAL RESOURCES AND OPTIMUM PRODUCTION

Description: Objectives are: 1. To evaluate and refine microirrigation management strategies to promote natural resource protection and optimal crop production. 2. To improve, modify, and evaluate microirrigation system design and components for natural resources protection and optimal crop production. 3. To assess and develop decision criteria for adoption of microirrigation technologies. 4. To promote appropriate microirrigation technologies through formal and informal educational activities. The irrigation industry is facing increasing pressures to improve the efficiency of irrigation water use and to reduce environmental impacts such as rising groundwater, salinization, and groundwater pollution. Specifically, nitrate leaching to the groundwater from irrigated fields is a major problem in many areas of California, and worldwide. This leaching appears to be caused by a combination of excessive nitrate and water applications. Micro-irrigation systems can be designed and operated so that water and solute (nutrients and agrochemicals) are applied at a rate, duration and frequency, so as to maximize crop water and nutrient uptake, while minimizing leaching of nutrients and chemicals from the root zone of agricultural fields. Ongoing research has an educational focus, using two-dimensional modeling and illustration of results with colorful output graphics. Specifically, the UC researchers model and present soil water and nitrate patterns for different fertigation practices and microirrigation systems using simulation models Guidelines will be developed for appropriate fertigation strategies.

Impact: A modeling study on various micro-irrigation systems concluded that nitrate leaching can be reduced in coarse-textured soils if fertigation is conducted early on during the irrigation. The study also clearly demonstrated that surface runoff can be minimized by adjusting water application rates to soil type. This information is being utilized in development of irrigations systems and management practices that reduce nitrate leaching and surface runoff, improving water quality.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AZ, CA, CO, FL, IA, ID, KS, LA, NM, NY, OH, OR, PR, TX, UT, VI

Theme: 4.23 Water Quality

Title: MICROIRRIGATION: MANAGEMENT PRACTICES TO SUSTAIN WATER QUALITY AND AGRICULTURAL PRODUCTIVITY

Description: The objective is to improve, modify, and evaluate microirrigation system design and components for natural resource protection and optimal crop production. Current design procedures for microirrigation systems are based on uniformity of water application. However, it is generally known that plant water requirements are non-uniform within an agricultural unit, and, therefore, uniform application of water may not be efficient. A simple design procedure was developed for laterals with unequal emitter discharge rates to match variable plant water requirements, and unequal emitter spacings to match the need for unequal plant spacings. In phase one, a step-by-step (SBS) model was built to simulate the effects of study variables on lateral hydraulics. In phase two, field experiments were conducted to verify the SBS model. The percentage difference between theoretical and experimental results was satisfactory and ranged between plus/minus 6.0 percent. In the third phase, the segment-based analysis (SBA) technique was developed to simplify the procedure of calculating head loss in non-uniform laterals. The

SBA technique transformed the lateral into a virtual lateral divided into a number of equal-length segments and replaced existing emitters by a virtual emitter positioned at the center of each segment. Accuracy levels of plus/minus 5.0 percent were attained by using five segments. A graphical lateral design tool was developed for readily designing site specific laterals.

Impact: Site-specific procedures were developed in this project for treating each plant differently with respect to irrigation input, thus optimizing natural resources and minimizing environmental concerns. Considerable water savings could be realized .

Funding Source: Hatch Multistate Research and State

Scope of Impact: AZ, CA, CO, FL, IA, ID, KS, LA, NM, NY, OH, OR, PR, TX, UT, VI

Theme: 4.23 Water Quality

Title: MITIGATION OF CONTAMINANTS IN SURFACE RUNOFF FROM NURSERIES

Description: In the late 1980s, contamination of San Diego Creek and Newport Bay in Orange County resulted in the development of Total Maximum Daily Loads (TMDLs) for sediment, nutrients, pathogens, and several toxics. Since then, surface runoff from three nurseries operating in the San Diego Creek watershed has been regulated by the Santa Ana Regional Water Quality Board by issuing Waste Discharge Requirements (WDRs) permits. The permits have been updated regularly to reflect changes in water quality and to coincide with TMDL allocations. However, pollutant allocations have been expected to be reduced substantially in revised permits, thereby putting the nurseries at risk of consistently exceeding their daily load allocation. UCCE Orange County Advisors developed and implemented a series of mitigation practices at one of the three permitted nurseries. The goal was to evaluate several low-cost practices for reducing pollutant loads in surface runoff. Extension Specialists assisted the UCCE advisors and nursery personnel in measuring the effectiveness of the various mitigation efforts by analyzing pollutants, especially pesticides. The project also involved several agencies, including the California Department of Pesticide Regulation, the Santa Ana Regional Water Quality Control Board and the California Department of Food and Agriculture. Surface runoff was treated with a series of mitigation practices, starting with the addition of polyacrylamides to flocculate soil particles, then settling these particles in sediment traps and a pond, and finally passing the runoff through a vegetative filter.

Impact: The result was a significant decrease in pollutant loading. During two years, water samples taken upstream and downstream of the mitigation practices showed reductions in nitrogen and phosphorus loads of 58% and 54%, respectively. Suspended solids were reduced 97-99%, while pesticides used to control Red Imported Fire Ant (bifenthrin and permethrin) were consistently reduced by more than 90%. The vegetative filter alone showed a 44% decrease in bifenthrin. Without these improvements in water quality, the nursery would potentially face serious fines and/or a cease and desist order. The pollutant reductions resulting from this project provided the nursery with a comfortable buffer.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 4.23 Water Quality

Title: NORTH COAST RANGELAND OWNERS BENEFIT FROM WATER QUALITY PLANNING COURSES & APPLIED RESEARCH

Description: Improving North Coast water quality requires accelerated efforts to create phased-TMDL's (total maximum daily loads) for more than 18 watersheds. Most of these watersheds are listed as impaired for the beneficial use of habitat for Coho salmon and steelhead trout. Causes of the impairment are sediment, temperature or both. During the past seven years a concentrated effort was made to assist rangeland owners to understand and deal with water quality issues on their property. Water quality planning short courses provided 22 hours of instruction on clean water laws, sources of non-point pollution, management to mitigate problems, fish habitat improvement and monitoring programs for both sediment and temperature. In completing the short course, landowners prepared individual plans that identified and prioritized water quality problems on their property. In addition, watershed groups were formed to work collectively on water quality problems. Local applied research by UC specialists and UCCE advisors assessed sediment, temperature and riparian health. A long term study of eight paired watersheds was established at the Hopland Research and Extension Center to test grazing and fire as management practices to improve water quality. A cattle grazing behavior study at the Sierra Foothill Research and Extension Center will help develop new management practices to protect riparian areas without costly fencing.

Impact: In Mendocino County more than 150 landowners have prepared plans, inventoried sediment sources and begun mitigation. Management practices include exclusionary fencing, revegetation of riparian corridors and repair or modification of range and forest roads. Twenty landowners in the county now routinely monitor temperature in the Eel and Russian River watersheds. Watershed groups have been formed in the Garcia, Russian, Eel, Noyo, Navarro, Albion, Gualala, Big River, Little River, and 10-Mile watersheds. Most of the chairs or co-chairs of these watershed groups have taken the UC short course at least twice. The North Coast Regional Water Quality Control Board adopted two resolutions: (1) that UCCE rangeland water quality plans developed during the short course meet the TMDL requirement of a site-specific sediment reduction plan and (2) that the UCCE sediment inventory method, developed to help landowners quickly and cost- effectively identify and prioritize natural and man-caused sediment sources, is an acceptable method for meeting TMDL requirements. A survey of ranches in Mendocino County using this UCCE sediment inventory method determined that ranch roads are a significant contributor of sediment.

Funding Source: Hatch, Smith-Lever, and State

Scope of Impact: State Specific

Theme: 4.23 Water Quality

Title: PISTACHIOS PROVE AS SALT TOLERANT AS COTTON

Description: Managing salinity and brackish drainwater on the Westside soils of the San Joaquin Valley remains a challenge. Environmental/economic concerns and legislation have

closed many tile drains and forced growers with drains still operating to deal with the effluent on their own land. In some cases this water can be recycled (possibly blended with fresh water) on salt-tolerant crops. Cotton and sudangrass hay traditionally filled this role, but are often unprofitable. Pistachios, a profitable crop on the Westside, are known to grow in saline soils in Iran. The salt tolerance threshold for California pistachios was previously unknown. Nine years of UCCE research completed in 2002 revealed that pistachios can be irrigated with drainwater as saline as that tolerated by cotton. The replicated study was set up by UC specialists and advisors in a 40 acre pistachio orchard planted on clay loam soil south of Kettleman City. Saline irrigation treatments used three levels of salinity and a sodium-calcium ratio typical of Westside drain water. California Aqueduct water was used as the control comparison. All treatments were applied to four different rootstocks. During the trial, no significant difference in yields was evident up to the middle level of salinity (8 dS/m). This confirmed findings from Iran and from a Riverside USDA Salinity Lab study of salt tolerance in one-year-old pistachios.

Impact: The high degree of salt tolerance shown by pistachios in this trial, similar to cotton, allows some Westside growers a possible permanent crop for diversification and may result in the reuse of 3,000 to 8,000 acre-feet of drain water yearly in Lost Hills Water District alone. These results as well as production experience elsewhere on the Westside have expanded pistachio plantings across 4,000 acres previously deemed suitable for only cotton/grain rotations. This benefits statewide water conservation and helps growers maintain sustainable farming operations by recycling drainage water.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 4.23 Water Quality

Title: PREDICTING IMPACTS OF NON-POINT SOURCE POLLUTION ON GROUND-WATER QUALITY

Description: The ultimate objective is to develop improved conceptual and quantitative models of migration on non-point source contaminants in complex alluvial aquifer systems so that ultimate consequences of past and future land management strategies can be ascertained. Specific objectives are as follows: #Use our new geostatistical modeling tools to create more accurate characterizations of alluvial aquifer systems. Advance the state of the art In geologic conceptualization and modeling. # Investigate the role of matrix diffusion in regional, subsurface solute transport. #Investigate long-term responses of water quality in a ground-water system to (a) typical levels of non-point source pollution and (b) reductions in those levels as a result of changes in land management practice. Produce recommendations for land and water management options that will reduce groundwater contamination. #Investigate long-term response of water quality in a groundwater system to irrigation and salinization. Assess sustainability of irrigated agriculture with respect to groundwater quality. A UC research group has shown that, as a general rule, groundwater ages in typical, heterogeneous geologic systems tend to be widely variable, even within single water samples collected from small volumes of the subsurface. This in turn indicates that groundwater quality in basins undergoing persistent, non-point source pollution may undergo a decades- to centuries-long decline and that the worst

effects have not yet occurred. Their detailed modeling experiments have further indicated that field tests involving transient monitoring of the age of groundwater discharged from a pumping well can be used to investigate and possibly quantify not only the dispersion of groundwater ages in a system, but the specific hydrogeologic characteristics (e.g., degree of heterogeneity) giving rise to the age dispersion phenomenon. With NSF funding in 2003 they conducted such a field test by pumping and intensively sampling a well constantly for 30 days. The wells were sampled for several environmental tracers typically used to estimate mean groundwater age (CFCs, SF-6, 14C, 3H-He). Preliminary results are generally confirming the hypotheses drawn from the modeling experiments that systematic changes in mean age occur with long-term pumping and that such changes can be used to estimate mixing of groundwaters of different ages within individual sampling wells. Furthermore, they continue to move their developed modeling tools out into the public and private sectors. TProGS, their geostatistical software for modeling heterogeneous subsurface systems has been adopted by the popular groundwater modeling software package, GMS. Further, our random walk computer code (RWHET) for accurately modeling transport of non-point source and point source pollution is being adopted by the US Geological Survey. Work on incorporating RWHET into the USGS MODFLOW-2000 family of codes is ongoing.

Impact: This work is providing more efficient, scientifically-based means of characterizing and modeling contaminant problems in groundwater, especially for nonpoint sources. The information produced is resulting in more effective, cost-effective protection and cleanup of groundwater resources as well as reduction in the probability of human exposure to harmful substances. This work points toward land-management strategies that will preserve rather than damage groundwater quality.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.23 Water Quality

Title: RANCH WATER QUALITY TRAINING

Description: All major rivers in Humboldt County are listed as impaired by the Environmental Protection Agency (EPA) because of sediment and, in some cases, temperature. Under regulations required by the Clean Water Act, Total Daily Maximum Load (TMDL) management plans must be developed to correct the deficiencies. Because TMDLs will affect the management of riparian areas and upslope erosion, land owners need to become involved in the TMDL process. Ranchers have requested help from UCCE in coping with the new regulations. A UC Cooperative Extension Livestock & Natural Resource Advisor worked with a UCCE Range Specialist to organize and conduct Ranch Water Quality Shortcourses that addressed producers' concerns about water quality regulations. The objectives were to:

--create awareness of the regulations,

--recognize good stewardship practices that land owners are already undertaking, and

--provide education and assistance in developing ranch water quality plans.

To reach as many ranchers as possible, five Ranch Water Quality Shortcourses were offered by UCCE throughout Humboldt County.

Impact: More than 100 ranchers have participated in the shortcourses and developed ranch water quality management plans for their operations. Implementation of these plans is resulting in the maintenance and improvement of water quality on more than 148,000 acres of rangeland in Humboldt County.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 4.23 Water Quality

Title: RANCHERS PROTECT WATER QUALITY ON THE CENTRAL COAST

Description: Over 3,500,000 acres of rangeland in San Luis Obispo and Monterey Counties serve as watersheds to capture, store and release water for downstream uses. These rangelands provide forage for livestock grazing and their diverse plant communities serve as habitat for many species of wildlife. However, proper management of rangeland is needed to prevent surface water pollution. Thirteen UCCE Ranch Water Quality Short Courses, which provide for self-determined development and implementation of water quality plans by rangeland owners, have been taught in Monterey and San Luis Obispo counties.

Impact: During these short courses, 226 attendees from 160 ranches learned about nonpoint source pollution associated with ranching. Seventy-two of the ranches (45%) completed water quality plans covering 275,363 acres. Each plan included ranch goals, ranch management practices, water quality status, nonpoint source self-assessment, planned management practices and monitoring procedures. The Central Coast Regional Water Quality Board, Region 3, identified the Short Course as its primary outreach method to the ranching community for working with non-point source pollution from rangelands. In addition, the RWQCB identified the short course as its primary reason for not issuing formal requirements to responsible parties for the Morro Bay Pathogen TMDL Implementation Plan that went into effect November 19, 2003. The Farm Bureau in the Central Coast is creating watershed working groups for joint efforts on planning, implementing practices and monitoring water quality. The Farm Bureau relies on UCCE's Ranch Water Quality Short Course (as well as the Farm Water Quality Short Course, which deals with irrigated farmlands) as its chief method of teaching water quality issues to watershed groups. As a result of the short courses, 20 participants have entered into NRCS Environmental Quality Incentives Program (EQIP) contracts and have implemented large water quality protection practices on rangelands. Over 90% of participants who responded to a survey after taking the Ranch Water Quality Short Course have changed management practices, leading to improved water quality.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 4.23 Water Quality

Title: SALINITY AND ENVIRONMENTAL STRESS RESISTANCE IN TURFGRASS AND LANDSCAPE PLANTS FOR RECYCLED WATER IRRIGATION AND PHYTOREMEDIATION

Description: Objectives are to: 1. Further improvement of buffalograss environmental stress characteristics for low maintenance turfgrass. 2. Research on California native grass species and landscape plant species for recycled water irrigation management. 3. Study mechanisms of bioremediation using plants for soil and water quality improvement. Four selenium (Se) nonaccumulator plant species, tall fescue, alfalfa, rush, and saltgrass, were grown in soil having elevated Se and sulfur (S). Above ground tissues were harvested five times and examined for Se and S accumulation. Both tissue Se and S concentrations were significantly different between harvest, species, and species x harvest interactions. Soil S concentration was several hundred times higher than the soil Se concentration, but Se accumulation by the plants and soil Se dissipation were not impaired. Five California native grass species, California hairgrass, California melic, needlegrass, deergrass, and alkali scaton, were sprinkler irrigated with low salt (500 ppm) and high salt waters (1500 ppm). All five species were found to be suitable for sprinkler irrigation with saline water up to 500 ppm NaCl. Above that level, California hairgrass and California melic showed significant increase in leaf chlorosis and produced significantly less dry weight mainly due to sensitivity to saline ion toxicity. Deergrass and alkali sacaton were better able to maintain healthy levels of K+ and Ca2+ in the shoots and were not susceptible to the saline water.

Impact: For a natural grassland habitat restoration such as at the Kesterson Wildlife Refugee in the Central Valley of California or for restoration of large-scale Se contaminated agricultural land Se nonaccumulator plants are favorable candidates, because any possible Se toxicity to the food chain can be minimized. The information on California native grass species tolerance to salt spray is useful for landscape management using recycled water irrigation.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.23 Water Quality

Title: THE ROLE OF PLANTS IN WETLAND ECOSYSTEMS: APPLICATIONS FOR WASTEWATER TREATMENT AND BIOREMEDIATION

Description: Objectives are to determine 1) Carbon budget for emergent macrophytes growing in natural vs. constructed wetlands. 2) Mechanisms by which different wetland species cope with increased levels of salinity. 3) Role of wetland macrophytes in biochemical transformations of selenium and other pollutants. This project focused on elucidating functions of macrophytes in wetland ecosystems. They studied species growth and decomposition, nutrient uptake and resorption, and tolerance of selected species to increased levels of salinity. Ecosystem processes were explained in terms of life history strategies. Species Selection The species selection concentrated on the emergent macrophytes, tules, cattails and rushes, for the following reasons: 1) These species have previously been suggested as suitable for wastewater treatment. 2) They

are robust, highly productive, herbaceous perennials with a strong tendency to dominate wetland systems. 3) All the species are known to deal well with anoxic conditions in the sediments. In addition, these species differ in their nutrient resorption efficiency and proficiency. Wastewater Treatment The growth and decomposition were studied for Scirpus acutus, S. californicus, and Typha spp. at the South Sacramento Wastewater Treatment Experimental wetland in Sacramento. Based on the results of this competition study, the procedure for replacement of a less desirable Typha spp. with Scirpus spp. has been suggested and implemented. Tahoe Basin Wetlands Distribution and response of wetland plant communities in Tahoe Basin to drought was evaluated. Communities dominated by matrix species (Carex, Juncus) were resistant to drought, while those dominated by Nuphar and Scirpus were replaced by terrestrial ruderals. Information on nutrient uptake and nutrient resorption efficiency resulted in delineation of several simple indicators of current and (recent) past conditions of sediments in particular marshes. This then provided information on N and P input from the watersheds draining into these wetlands, and potential output of nutrients into the lake. Salinity and Nutrient Addition Responses The response of several species to increasing salinity was studied in the field and in a greenhouse experiment. The amount of salts taken up by plants and allocated to different plant parts was measured and the production of organic solutes evaluated. A fertilization experiment studying the effect of phosphorus addition on the nutrient-poor Eleocharis cellulosa community was conducted. The experiment was simulating the effect of agricultural runoff on freshwater marshes. An additional component to the study on nutrient cycling in these marshes was the assessment of nitrogen fixation by cyanobacterial mats. Life History Strategies of Wetland Species from the Central Valley Comprehensive information and functional assessment of representative native and exotic wetland plants from inland wetlands of northern California was obtained. Information on biomass of mature plants together with data on tissue nutrient concentration, species cover, species richness, and soil properties was collected for a set of 22 species throughout twelve Central Valley wetlands. This information is available for managers of Wildlife refuges and any potential wetland restoration projects. Succession of wetland vegetation was monitored as a part of the Cache Slough Ecosystem program. The results of this monitoring were utilized by the US Army Corps of Engineers.

Impact: Knowledge created of the functional role of wetland macrophytes is critical for understanding their role in both natural and man-made wetland ecosystems. The response of wetland macrophytes to nutrient enrichment and changes in salinity provides the necessary information for the use of these plants in wastewater treatment and wetland restoration projects. Results generated by this project have been utilized by various agencies, such as US Army Corps of Engineers, in developing their successful wetland mitigation projects. This project also developed information for Wildlife Refugees managers on proper selection of wetland species for the waterfowl habitats.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.23 Water Quality

Title: WATER QUALITY IN SOUTHERN CALIFORNIA SURFACE WATER

Description: The overall objective of this project is to quantify the processes governing contaminant fate in lakes and reservoirs, with particular emphases on (a) the loading and cycling of nutrients in lakes and reservoirs, (2) sources, fate and persistence of microbial contaminants in surface waters, and (3) hydrodynamics and modeling of shallow polymictic and deeper monomictic lakes. The research will include lakes and reservoirs used as source drinking water supplies, fisheries and wildlife habitat, and for recreation. The studies will provide information pertinent to the management of regionally important water bodies as well as basic process-level information extensible to surface waters in other regions. Research quantifying the internal loading of nutrients to Big Bear Lake and ammonium adsorption within its sediments was completed and summarized in a M.S. thesis of a UC graduate student. Internal nutrient loading rates were found to vary strongly along a longitudinal transect in the lake, with deep water sediments on the western edge of the lake releasing large amounts of ammonium-N and soluble-reactive phosphorus, with lesser amounts released from sediments located in shallower water. Strong seasonal effects were also present, with maximal release in the warm summer months and very little release present during the winter. Sediment and water column properties were also quantified. In addition to being released from the sediments through organic matter decomposition reactions, ammonium was also found to be adsorbed by clay particles derived from the weathering of mica. Related research was conducted at Canyon Lake by Heemadri I. Oza as part of her thesis research. Canyon Lake was found to be nitrogen-limited, rather than phosphorus-limited, and was thermally stratified from May-November. As a result of this stratification, the lower portion of the water column (the hypolimnion) was anoxic, with elevated levels of dissolved nutrients, as well as dissolved iron and manganese. Nutrient release from the sediments was rapid in the shallow, warm waters but lower in the cooler, deeper (anoxic) waters during the summer. Internal loading rates were broadly comparable across all sites during the winter. Nutrient release rates reflected the N-limitation, with a lower N:P release ratio compared with other (P-limited) lakes in the region. Separately, phytoplankton identification and enumeration in downstream Lake Elsinore documented the presence of a cyanophyte-based community that was dominated by Oscillatoria spp. Lake Elsinore was also characterized by a low biological diversity, with high nutrient levels, low dissolved oxygen concentrations near the sediments and overall poor water quality. The partitioning of hydrophobic organic compounds and their fate in surface waters was also investigated through laboratory experiments. These studies demonstrated that bifenthrin and permethrin, common pyrethroid pesticides, adsorbed significantly to dissolved organic matter. As a result, adsorption experiments yielded significant underestimation of distribution coefficients (Kd). Solid phase microextraction techniques yielded more accurate estimates of true dissolved concentrations and thus also provided better estimates of Kd. These improved estimates of Kd are important for accurate predictions of transport and persistence of strongly hydrophobic chemicals in the environment.

Impact: These studies improve our understanding of surface water quality in Southern California. Information developed is being used to identify appropriate management strategies for Southern California water bodies.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.24 Weather and Climate

Title: STUDIES OF SHORT-TERM CLIMATE VARIABILITY

Description: Objectives are: 1) To provide a better understanding of the feedback mechanisms that control regional and global climate variability on intra- and inter-annual time scales, with emphasis on California and the Northern Hemisphere middle latitudes. 2) To determine to what extent human-caused perturbations (e.g., enhanced greenhouse gases) and natural-caused perturbations (e.g., 11-year solar cycle) to the ozone layer alter the atmospheric circulation from regional to global scales. 3) To better understand the connection between solar cycle-induced climate variability and anomalous weather events (e.g., drought, frost, flooding, etc.), particularly in California. UC researchers have shown that solitary Rossby waves (SRWs) in midlatitude flow provide a clearer picture of the dynamics of atmospheric circulation patterns having time scales beyond thirty days (Nathan and Hodyss 2003). In particular, they have shown that depending on the jet stream structure, three different types of SRW behavior can emerge: transmission, reflection, and production. For the zonally varying jet flow that they considered, the solution behaviors go from transmission to reflection to production as the local jet strength uniformly increases. They have also shown that coupled wave ozone interactions in the tropics must be accounted for when examining the effects of anthropogenic and natural perturbations in stratospheric ozone on climate (Nathan and Cordero 2003). In particular, they present analytical results showing that the local spatial modulation of equatorial Kelvin and Rossby-gravity waves is intimately connected to the ratio of photochemical to dynamical time scales, which vary strongly with altitude in the stratosphere. These studies provide new understanding of how atmospheric wave motions affect regional and global climate variability.

Impact: Weather and climate affect many important aspects of the California economy, including agricultural production, power generation by public utilities, air quality, and the recreational industry. Their research has increased our understanding of the processes that affect short-term climate variability, improving long-range weather forecasts, thus benefiting California's economy and the quality of life of its citizens.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.26 Wildfire Science and Management

Title: STRUCTURE, COMPOSITION AND SUCCESSION OF VEGETATION IN THE URBAN-WILDLAND FRINGE

Description: The objective of this research is to characterize the change in the structure and composition of vegetation in the urban-wildland fringe of central California that has resulted from plant succession due to urbanization. These changes in land management result in successional changes that have important consequences for fire hazard and wildlife habitats. An understanding of these changes is needed to effectively manage the urban-wildland fringe. Research on the structure, composition, and succession of vegetation in the urban-wildland fringe demonstrated an increase in fire hazards associated with the succession of Bay Area grasslands to brushlands and an increase in wind throw potential in certain forest plantation types

as they mature. In the six open space areas studied, grasslands coverage declined dramatically while shrub cover increased from the 1930s to the 1990s. Associated with this change was an increase in fire hazard as measured by fire-line intensity and average flame length. Investigations of older forest plantations in the urban-wildland fringe showed a high correlation between historic wind throw and soil shear strength, tree species, age of plantation, and topographic position. The feasibility of mapping areas of high windthrow potential based on these factors was demonstrated. These findings suggest proactive management of succession from grasslands to brushlands can be effective in reducing fire hazard. Shorter rotation ages and avoiding the replanting of Monterey pine on exposed ridges with soils of low shear strength can be used to avoid future problems of wind throw associated currently with older stands.

Impact: Several land management agencies in the San Francisco Bay Area are now developing and applying management strategies to halt the successional change from grassland to brushland in order to reduce fire hazard. Projects are also underway to convert brushland areas to grassland. Wind throw hazard maps, based on this research, are being used at the Presidio of San Francisco and at The Sea Ranch in Sonoma County, to plan the long-term management of forest cover in the urban-wildland fringe.

Funding Source: McIntire Stennis and State

Scope of Impact: State specific

Theme: 4.27 Wildlife Management

Title: BIRD AND SMALL MAMMAL STUDIES

Description: Objectives are: to investigate use of nest box barriers for protection of insectivorous bird nests from predators; to investigate the fitness consequences of cooperative breeding in an avian insectivorous species, the pygmy nuthatch (Sittidae: SITTA PYGMAEA); and to determine the effects on vertebrates of riparian woodland management for control of Pierce's disease. UC researchers concluded their study monitoring nesting activity of cavity nesting birds in 8 plots with 8 nest boxes per plot in Napa and Sonoma County riparian areas; Nesting activity in 2003 was down from 2002 (45 vs. 65 nests with eggs). Predominant bird species were oak titmouse (39% of nests), tree swallow (24%), and violet-green swallow (22%). Other species present were western bluebird, white-breasted nuthatch, and chestnut-backed chickadee. Also in Napa Co. they completed the second year of monitoring nest boxes in a vineyard near Rutherford with boxes placed in areas with different management activities. Swallow species and oak titmice and were the most common bird species nesting in these areas during 2003. Tilden (Coast Range, Contra Costa County) nest box plots showed a decrease in numbers (23 in 2003 vs. 26 in 2002) of nests by cavity nesting birds in 2003 compared to 2002. Chestnut-backed chickadees (occupying 36% of boxes) declined from 25 to 19 in the current year, reversing the recent trend of higher numbers of chickadee nests. Predation by weasels on nests was heavy, with 11 of the 19 chickadee nests nest being attacked. Most weasel attacks were on consecutive nest boxes, which indicate that a weasel may be learning to locate nests by presence of nest boxes. Five of the weasel attacks occurred during the egg incubation stage, and it appeared that many adult birds were killed during the attacks. The 11 nests attacked compares to 16 attacks in 2002 and zero attacks in these nest boxes during the 1996-2001 seasons (1994-

1995 also had heavy weasel attacks). Predator bands on the trees were ineffective in preventing weasel attacks or takeovers by mice. In the Mt. Pinos (Kern Co.) area, occupancy of nests in 2003 was about the same as in 2002 (84%) compared to 2001 (74%) and 2000 (63%). Pygmy nuthatch nests increased to 37% compared to 34% in 2001. Mountain chickadee nests decreased to 26% compared to 30% in 2001. White-breasted nuthatch, oak titmouse, and violet-green swallow were the other bird species present. They are studying the impacts of habitat loss due to 'sudden oak death' on cavity nesting birds and other vertebrates. The goal of this study is to assess the impact of the loss of oaks on the population and behavioral ecology of chestnut-backed chickadees and oak titmice. Plots established in the fall of 2001 and spring of 2002 in heavily affected and unaffected oak woodlands were monitored in 2003. Results from foraging studies indicate that both of these species utilize coast live oaks more heavily than other tree species. On plots in which many oaks have succumbed to sudden oak death, these birds appear to compensate by utilizing less preferred tree species. Insect populations, especially Lepidoptera larvae, were much lower on bay trees than on coast live oaks. Birds in heavily affected areas seem to spend longer foraging for food for nestlings than in less affected areas. They initiated a study and established plots to determine the effect on birds and other vertebrates of biological control for tamarisk. Preliminary results should be available in 2004 from another investigator.

Impact: It is well known that habitat alteration by disease or human activities can influence the populations of vertebrates, including cavity-nesting birds, which are primary predators of many forest insects. Their studies determine how populations of birds and small mammals are influenced by habitat change, and what impact birds have on insect populations. This information is informing management decisions of wildlife and other natural resource managers.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.27 Wildlife Management

Title: DEMOGRAPHY OF THREATENED AND EXPLOITED BIRDS

Description: A five-year study is proposed to combine field and modeling approaches to examine the demography of contrasting case studies of threatened and exploited birds. One species, the Marbled Murrelet, is extremely difficult to study but is threatened and thought to be declining rapidly. The other species, the Green-rumped Parrotlet, is easily studied, which makes it ideal for investigating population processes that are postulated to be common but difficult to document. The first objective is to determine why the central California Marbled Murrelet population is in decline. UC researchers will conduct mark-recapture and radio-telemetry studies to determine whether murrelets are declining because of high rates of nest failure or because many individuals fail to nest. The second objective is to continue long-term studies of the Green-rumped Parrotlet in Venezuela to link social system, dispersal and demography to source-sink population dynamics. Work will be conducted on two populations of a small box-nesting parrot, which will act as a model for other parrots that are less easily studied and are heavily exploited for the international trade. Work continued on demography and population trends of Marbled Murrelets (Brachyramphus marmoratus) that they have been conducting in central California since 1995 to understand the factors that threaten this population. They captured 72 individuals

to bring the total number of individuals marked to 333 since 1997. Mark-recapture analyses in progress suggest adult survival is equivalent or exceeds what would be expected for a seabird of this size. At-sea surveys indicate that 500-600 birds are in this population but no clear trend can be discerned. Likewise, applications of mark-recapture models suggest population size changed little. Yet direct estimates of reproduction from telemetry studies and estimates based on the ratio of juveniles-to-after hatch year birds indicate very little successful reproduction. They hypothesize that the central California population may be sustained by immigration from populations further north and may be a demographic sink. They completed the 16th year of continuous studies of the demography and behavior of Green-rumped Parrotlets (Forpus passerinus) in Venezuela, conducting field work from June through December. After several dry years that coincided with population declines, 2003 was rainy and over 500 nestlings fledged from the nest boxes. Data analyses are concentrating on evaluating behavioral, spatial and temporal factors driving rates population change. They continued studies of Black Rails (Laterallus jamaicensis) in the foothills of the Sierra Nevada Mountains primarily in Yuba and Nevada Counties. These secretive birds occur in small, isolated wetlands ranging in size from 0.1-10 ha in our study area in a metapopulation structure. They conducted systematic surveys (broadcasting rail calls) to determine the presence or absence of rails from wetland patches at visited 106 sites, as well as 25 others, and found high rates of turnover. Patches that were occupied in 2002 (n=68) had a probability of extinction of 0.25, while unoccupied patches (n=35) had a probability of colonization of 0.083. Apparently occupied patches can quickly became unoccupied if heavy grazed or dried out by reduced water flow, and unoccupied sites can be colonized shortly after livestock are excluded or water is returned. Studies of the threatened Song Sparrow subspecies (Melospiza melodia) in San Francisco Bay examined the role of the introduced and invasive Spartina alternifora, which is taking over the wetlands and vastly changing the habitat. Sparrows used this habitat but had very low nesting success. It also favored Marsh Wrens, which appeared to exclude sparrows from their territories and punctures sparrow eggs. Work in progress examined territorial overlap and interactions.

Impact: Results from the murrelet studies are guiding the application of effective forest restoration management strategies in old growth forests in California. Parrotlet work provides baseline data for evaluation of the impact of international bird trade. Sparrow and rail studies are yielding important information for successful wetland management.

Funding Source: McIntire Stennis and State

Scope of Impact: State specific

Theme: 4.27 Wildlife Management

Title: ECOLOGY AND CONSERVATION OF INLAND FISHES OF CALIFORNIA

Description: Objective is to develop conservation strategies for freshwater fish (especially native fishes and salmonid fishes) and aquatic ecosystems in California by examining the interactions of land use, water projects and natural processes with fish distribution and abundance and to apply knowledge of the biology of freshwater fish to environmental decision-making. (1) The study of the Cosumnes River watershed and floodplain was completed last year so this year UC researchers are producing publications. A key finding was that much of the

watershed had been invaded by alien redeye bass, a little-known fish, and it has replaced most native fishes. Stable isotope analyses, which are continuing, indicate changing structure of foodwebs both in response to elevation and alien invasions. The results of studies of splittail have been incorporated into a review paper on this endemic species which is currently under review. (2) The study of Putah Creek, a regulated stream, continued, demonstrating the positive effects of enhanced flows on native fishes, including anadromous lampreys and salmon. (3) The a study of steelhead in the Navarro River estuary has revealed the importance of estuaries to anadromous fishes in coastal streams. (4) Year 24 of monthly fish sampling in Suisun Marsh was completed, with showing a surprising increase in abundance. They are currently documenting the impacts of a new invasive shrimp and of problems in water quality caused by duck club management. (5) Studies on brook trout invasions on Sierra Nevada waters continued, focusing on finding alternatives to poisoning to remove them from alpine lakes (where they eliminate native amphibians). (6) Two more papers in a series of papers analyzing patterns of fish invasions in California were submitted for publication, with one more accepted for publication. (7) A study on the population dynamics of longfin smelt in the San Francisco Estuary still underway and producing results that suggest the standard agency data analysis system is flawed. (8) A major study on the history and use of floodplains in the Central Valley was started. (9) Two major studies, funded by CALFED, one on the biology of Sacramento perch and one on Suisun Marsh as a refuge for native invertebrates were also started.

Impact: The information obtained from the Suisun Marsh and Cosumnes River studies are helping CALFED set priorities for research and restoration activities and the researcher is on the CALFED Independent Science Board of the Ecosystem Restoration Program as a consequence. The studies on native fish status are being used as the historical basis for restoration programs. The work on splittail has led to their being removed from the federal list of threatened species. The studies on invasions of California fishes are being used for understanding patterns of fish invasions worldwide to assess current situations and develop management strategies.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.27 Wildlife Management

Title: POPULATION GENETICS AND PHYLOGEOGRAPHY OF DECLINING AMPHIBIANS AND REPTILES IN CALIFORNIA

Description: Objectives are: 1. To collect mitochondrial DNA (mtDNA) sequence data for three species of native California amphibians and one reptile to measure population differentiation. 2. To use these mtDNA data, in conjunction with field information of population declines, to determine Evolutionarily Significant Units (ESUs) and Management Units (MUs) for all four species. 3. To collect nuclear DNA data from 10-15 rapidly-evolving microsatellite loci for two species to determine levels of migration and gene flow over a fine-grained spatial scale. 4. To make recommendations to the US Fish and Wildlife Service and the California Department of Fish and Game on management directions for all four of these species, particularly in landscapes that have been severely affected by California agriculture. The researcher's work in California examines the influence of agriculture and urban land use on native amphibians and

reptiles, particularly in the Great Central Valley. During the review period, they completed several projects, and made substantial progress on others. Major completed projects now include: 1) a spatial ecology project on upland habitat use in the endangered California tiger salamander, 2) completion of a systematic study of the endangered California red-legged frogs, 3) completion of a second study examining the detailed genetic interactions of native and introduced tiger salamanders in the Salinas Valley, and 4) discovery of a new nuclear gene that is useful in molecular analyses of our target turtle species. They have continued to collect material for genetic analyses of four species of threatened amphibians and reptiles in the Central Valley, including the foothill yellow-legged frog, California tiger salamander (CTS), western Spadefoot and western pond turtle. Relevant publications that were accepted, submitted, or published during this review period are listed below. Several talks at major universities were also given.

Impact: The work on population genetics continues to define Distinct Population Segments (DPS) of several sensitive species of amphibians. The researchers provided critical data on DPS of the endangered California Tiger Salamander (CTS) which is guiding management by the US Fish and Wildlife Service. Our spatial ecology work has provided critical data on management and regulation of CTS, and our work on hybrids is providing important information on threats to the specie.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.27 Wildlife Management

Title: POPULATION MODELS FOR IMPROVING MANAGEMENT OF GROUND SQUIRRELS IN CALIFORNIA

Description: Objective is to develop mathematical models for squirrel populations, for determining the effectiveness of current and potential management strategies. Populations of California ground squirrels were indexed again at sites where control was conducted in 2001. Additional monitoring of populations was also undertaken in Madera County where a variety of methods (baiting using anticoagulant bait, followed by an acute bait; a burrow exploding device; and burrow fumigation) were incorporated to demonstrate the effectiveness of an integrated management approach. Using information from the field studies, and information from the literature, the researcher developed a mathematical model of ground squirrel populations under different control scenarios. Efforts have also been focused on developing improved indexing techniques for ground squirrels and other field rodent pests.

Impact: Results have been provided to the California Department of Food and Agriculture in support of re-registration of ground squirrel rodenticides and for modifications of labels to recommend baiting strategies that reduce the frequency of bait applications. Reduced frequency of application, and reduce use of rodenticides, reduces risk of environmental impacts.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.27 Wildlife Management

Title: TEMPORAL AND SPATIAL DYNAMICS OF SQUIRREL POPULATIONS

Description: Objective is to measure temporal and spatial variation in populations of squirrels native to California in order to design ecologically based, integrated approaches for managing pest damage. During 2003, 66 golden-mantled ground squirrels were trapped, ear-tagged, and dye-marked for individual recognition, then tracked through intensive behavioral observations to determine spatial and temporal dynamics. Densities increased dramatically this year, caused primarily by high survival of females overwinter and a very high rate of reproduction by females. This sudden demographic change probably had multiple causes. High reproduction may have resulted from a lag effect, with several females failing to breed the preceding year because of drought. Additionally, a female immigrated into the study area mid-summer and brought her litter with her; the researcher had never observed this phenomenon before (immigrants always come alone, after reproduction, then first breed the following year). The cause of a high overwinter survival is unclear at this time.

Impact: Many species of ground squirrels are considered pests and are threats to agriculture and public health. The results on temporal and spatial dynamics of ground squirrels enhances our knowledge of how pest species respond to environmental factors. This has provided managers with the information necessary to design control programs that are more effective at reducing damage by squirrels than earlier programs.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.27 Wildlife Management

Title: WATERFOWL PRODUCTION AND CONSERVATION IN THE AGRICULTURAL LANDSCAPE

Description: Objectives are to: (1) Examine the effect of waterfowl foraging activity on rice straw degradation and nutrient incorporation in winter-flooded rice fields; (2) Evaluate survival, dispersal and reproduction of wood ducks in relation to agricultural land use patterns; (3) Examine the population genetic structure of wintering and breeding waterfowl in California and the Pacific Flyway to guide effective management practices; (4) Evaluate habitat needs for waterfowl and wetland-dependent wildlife in the Central Valley (5) Develop and evaluate moist soil management practices to maximize food production for waterbirds. (1) The UC researchers have completed the final phase of a study to examine the impact of waterfowl activity in winter-flooded rice fields. Their work demonstrated the strong effect of waterfowl foraging on straw decomposition and weed seed abundance. (2) They have completed our study of feeding ecology by waterfowl in the Suisun Marsh. They found that previous research over-emphasized waterfowl use of some food plants, while new food plants have become more important. These results have important implications for habitat management and tidal restoration initiatives in this key area of the state. (3) They are continuing a collaborative project with Central Valley Habitat Joint Venture (CVHJV) partners to examine winter habitat needs for waterfowl. Specifically, they are undertaking research to: (a) determine the amount of food available in moist-soil

habitats and agricultural fields when waterfowl arrive in fall, (b) determine the rate at which this food is depleted throughout the winter, (c) determine the minimum food-density threshold below which waterfowl will abandon or avoid agricultural fields and moist-soil habitats and (d) determine the rate at which moist-soil seeds decompose and thus lose their energetic value for waterfowl. They are measuring moist-soil and rice seed abundance over the season in a range of habitat types, climatic conditions, juxtaposition to sanctuary, and management regimes. Data from this study will be incorporated into the planning model used to establish habitat goals for the Central Valley. Their finding that many wetland restoration projects are not providing high quality foraging habitat has attracted attention and they are working to develop management techniques to improve food production for wildlife. (4) They are continuing our research on the effect of land use and agricultural practices on dispersal and recruitment of wood ducks to determine habitat management needs and to assess the value of riparian strips on agricultural lands to wildlife. They are focusing on several local populations of wood ducks to track inter-annual changes in key demographic variables. Because of their dependency on riparian habitat, wood ducks represent an excellent indicator species for the health of riparian ecosystems in California. Their studies will provide a long-term monitoring tool to assess the productivity of this key natural resource. (5) They are continuing our studies using molecular genetic techniques to evaluate the population structure of waterfowl in the Pacific Flyway. These studies will evaluate the appropriate units for the management of these species based on their ecology and evolutionary histories, rather than geographical boundaries. (6) They have completed several studies to determine the factors limiting production of mallards in California. They will extend this work in the coming year to follow breeding females using radio-telemetry to assess habitat selection and breeding survival. This work will provide essential data needed to guide habitat restoration efforts for breeding waterfowl in California.

Impact: This project provides key information to guide waterfowl conservation and wetland restoration efforts while promoting sustainable agriculture in California. The studies on the agronomic benefits of attracting waterfowl to rice fields demonstrated the compatibility of agricultural practices and wildlife habitat objectives. The research has provided the information necessary to establish realistic acreage goals for wetland conservation efforts, including key winter and breeding habitats. The researchers are developing new management techniques to maximize the quality and productivity of existing wetland habitats.

Funding Source: Hatch and State

Scope of Impact: State Specific

NATIONAL GOAL 5

Enhanced economic opportunity and quality of life for Americans. Empower people and communities, through research-based information and education, to address economic and social challenges facing our youth, families, and communities.

The changing economic, political and social environments in California continue to have major impacts on the use of human resources and to contribute to unique challenges for California youth and families. Consumer credit indebtedness and bankruptcies are rampant while the personal savings rate is lower than in any other industrialized nation. Surveys indicate that both youth and adults lack the financial knowledge necessary to achieve long-term financial security. Few have adequately prepared to achieve financial goals to fund higher education, retirement, and long-term health care. The 12th annual Retirement Confidence Survey (RCS) reveals that the majority of Americans are not prepared for retirement.

The human resource issues in California cross demographic and socioeconomic lines, affecting all ages, from children to the elderly to diverse cultural groups. Many California communities are experiencing real and pressing needs for research-based information on how to remain viable and provide the necessary services for their residents. For the past year, the human resources program identified a number of pressing issues for emphasis in programming. These included: fostering civic engagement, enrichment programs for youth, exploring the relationships between farm jobs, immigration, and poverty, supporting elders, out-of-school programming, healthy child development, and reaching diverse audiences.

Work during this past year has resulted in the knowledge that the use of smaller wine grape picking tubs results in a five-fold reduction in workers' post-season MSD pain and symptom scores; the development of models to explain the changed demography caused by the arrival of immigrants to fill farm and farm-related jobs and to assess the relationships between farm jobs, immigration, and poverty; knowledge that exploring the ideological underpinning of 19th century parks will lead to a better understanding of the public park as a cultural institution today; knowledge that the development of learning and cognitive processing in children is greatly impacted by parenting styles; information on how stress and coping processes change across the lifespan and affect adult adaptation styles; knowledge of how a viable model of Alzheimer's disease cognition must take semantic memory functioning into account; the proposition that migrant civic engagement in Mexico is not incompatible with engagement in state and local politics in the U.S.; knowledge of how the internet provides unprecedented opportunities for networking farm operations and households to enter economic and social milieus far beyond the confines or rural localities; information of how young children, when encountering a novel problem-solving situation, will often retrieve relevant prior experience such as procedural strategies and attempt to apply familiar approaches to solve novel problems; knowledge about major influences of the family of origin on the social and economic development of the second generation of adults and their families; information of how attractive alternatives to unstructured leisure time, in safe, accessible and nurturing environments can improve self-concept, homework completion, attitudes towards school and feelings of safety; knowledge of how 4-H School Enrichment Programs help keep students in class and excited about learning; information on how participation in California's Focus increased knowledge about the state and its government;

knowledge of how UCCE collaborative projects can provide the means to create networks and on-going dialogue between the Latino community and previously unconnected organizations and agencies; knowledge of how enrichment programs can increase participant interest in and appreciation for science, increase their reading skills, and improve their social skills and ability to bond with a group; information on how professional development workshops with after-school staff have improved knowledge and skills in working with children; and knowledge of how an experiential learning program can provide youth with the opportunity to gain knowledge about the environmental concepts presented through the program with those who are repeating the program scoring significantly higher on pre-tests than those who are new to the program, indicating a high retention rate for what was learning in past years.

CE advisors delivered 174 local extension programs in this area. In addition, 17 statewide collaborative workgroups composed of both AES and CE academics planned and conducted research and extension projects. In addition, UC ANR has one Statewide Special Program that brings together AES and CE resources and personnel that addressed critical issues in the state that are included within National Goal 5. California academics published 66 peer-reviewed articles and 2 extension publications to address Goal 5 last year. Four patents were issued that addressed this goal.

UC-DANR's Human Resources Programs Covering:

- Human and Community Development
- Economically Viable Families and Communities

HUMAN AND COMMUNITY DEVELOPMENT

UC-DANR focused its research and extension resources on the need to create supportive environments in which culturally diverse youth and adults can reach their fullest potential and to strengthen the capacities of families and individuals for self-sufficiency and well-being by 14 statewide workgroups composed of both AES and CE academics.

Research and Extension Performance Goals

- Improve the capacity of targeted communities to provide integrated approaches to support healthy youth development that involve youth, families, and community members, and provide training and technical assistance to family, youth, and community professionals.
- Develop and implement programs that teach and demonstrate collaboration building.
- Improve understanding of multicultural and diversity issues by providing youth and family service agencies with training and technical assistance in issues of diversity and promoting tolerance. Research the parenting practices of California's minority populations to develop and disseminate more culturally appropriate parent education materials.
- Developing and extending curricula on youth career decision making, workforce preparation and entrepreneurship experience to youth agencies in order to prepare youth

for an employable future. Generate new knowledge about workforce preparation strategies by conducting comparative studies.

ECONOMICALLY VIABLE FAMILIES AND COMMUNITIES

UC-DANR focused its research and extension resources on the need to improve the capacity of consumers to efficiently use economic and personal resources and strengthen the capacity of communities, families and individuals to create and maintain sustainable economic growth. Programs were delivered by individuals and collaborative groups including 8 statewide workgroups composed of both AES and CE academics.

Research and Extension Performance Goals

- Develop, test and institute effective educational programs on topics related to economic health: consumer choices, personal and family resources management, employment readiness and training, transition from welfare to work, etc.
- Develop, test, and institute effective economic education outreach models for building community coalitions with emphasis on economic self-sufficiency of individuals and economic development for communities.
- Conduct community level research on the effects of economic changes and decisions on communities and households.
- Perform evaluation research on economic programs that demonstrate effective results for potential creation of economic development models. Develop a "best practices" approach for replication of models that work.

FY 2003-2004 Allocated Resources

Extension Federal Funds (Smith Lever 3 b&c)	Extension State Match	Research Federal Funds (Hatch)	Research State Match
$1,142,648	$4,174,124 [47.44 FTE]	$229,811	$3,358,897 [13.31 FTE]

Theme: 5.01 Aging

Title: CAREGIVER TRAINING PROGRAM

Description: The population is growing older. In California, the elderly population is expected to grow more than twice as fast as the total population. The demand for in-home caregivers continues to increase as the population grows older. The Sacramento County In-Home Supportive Services Public Authority (IHSS) is mandated to provide education to caregivers on their registry. However, the Authority lacks the staff to conduct the mandated education programs. Thus developed a partnership with the University of California Cooperative

Extension (UCCE). The UCCE Sacramento County's Caregiver Training Program is designed to meet the needs of the IHSS caregiver workforce. The training enhances the caregivers' knowledge and skills in activities of daily living and job skills. This is the second year UCCE Sacramento County has provided caregiver training. The training sessions were conducted in a two-hour time frame. A combination of instructional methods (i.e. lecture, small group discussion, handouts and visual aids) were used to enhance the learning process. Small group activities allowed participants to share issues and concerns for providing care to their in-home residents. The following training topics were covered during the sessions: skin care, bowel and bladder care, diabetes, infection control, dementia/memory loss, preventing falls, self-neglect, and job skills. Participation evaluations were completed after each session.

Impact: An overall total of 482 participated in the training program. Eighty-two of the participants received certificates of Activities of Daily Living and 78 received certificates in Job Skills. Male caregivers were 16% of those attending the program while 84% were female. The caregiver workforce represented a diverse group: white (38%), African American (16%), American Indian (1%), Hispanic (22%) and Asian (23%). Participants consistently rated the sessions as relevant, well organized and having improved their knowledge, skill, attitude, and interest. When asked if they would advise others to attend the training, 100% responded "Yes".

The results of the program include:

* IHSS Public Authority meets educational mandate with caregiver program.

* Participant evaluations document a statistically significant positive change in knowledge, skill/ability, attitude, interest and confidence in using the information from the caregiver program.

* UCCE addresses emerging need of the aging population by preparing caregivers to more adequately assist the aging.

* UCCE establishes outreach to a new clientele group.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 5.01 Aging

Title: DAVIS LONGITUDINAL STUDY

Description: There are a number of objectives for this proposal, most of which center around factors which influence the positive adaptation to stress. (1) Childhood Experiences and Adult Health. By re-administering the Childhood Experiences Scale, UC researchers will be able to investigate the reliability of retrospective reporting of this sort, as well as the factors that correlate with reliability. They will also include better health measures, which will allow them to explore childhood stressors impact on physical health, especially in mid-life. (2) Childhood Experiences and Physiological Reactions to Stress. They anticipate a substudy which will involve contrasting salivary cortisol responses to stress in individuals with traumatic childhoods vs. those with less stressful childhoods, to see if childhood stress creates greater vulnerability or resilience to adulthood stress. (3) Childhood Social Class and Adaptation. Aldwin, Crumpler, &

Levenson (1995) found that participation in social organizations in childhood such as 4-H had unexpected negative associations for working class children in later adulthood in terms of lower levels of mastery for men and higher levels of depression for women. However, the number of working class children in the current cohorts of the DLS was too small to publish this finding. Given the greater diversity of the current cohorts, it is anticipated that including the class of `99 will allow them to more reliably test this finding. (4) Stress and the Development of Coping Resources. By including an additional time wave, they will be to examine whether coping with major stressful events has a cumulative influence and affects future adaptation to stress. (5) Anticipatory Coping. They are working on a new model of coping which examines the ability of individuals to prevent or mitigate stress, called anticipatory coping. They feel that this may better characterize the development of coping resources in adulthood, and will develop and test a new scale. (6) Cohort Sequential Studies of Personality and Values. Finally, by adding a new cohort, they will continue our tradition of studying cohort and age-related changes in personality and values. They continue to present findings from our analyses from the DLS data set at national conferences. Kelly, Boeninger, Shiraishi, and Aldwin (2003) found that childhood stress, as well as abuse, were weak predictors of both acute (minor) and chronic illnesses in adulthood, examining both their frequency of occurrence as well as their severity, controlling for age. Interestingly, emotional abuse was more likely to have significant impact than physical abuse. Although significant, the overall amount of variance accounted for was small, typically less than 5%. Thus, the results suggest that negative childhood experiences modestly influences subsequent health status in early and middle adulthood. They also are exploring a new construct of anticipatory coping using the DLS sample, anticipatory coping, which they presented at the American Psychological Association (Kelly, Shiraishi, & Aldwin, 2003). The ability to predict and avoid problems may be more protective of mental health than coping with a problem once it occurs. They had predicted linear increases with age in this ability. However, they found both non-linear patterns and sex differences in developmental patterns, depending upon the problem domain. These patterns appear to relate to gender differences in the timing and acquisition of work and family roles.

Impact: The goal of this project is to understand how stress and coping processes change across the lifespan and affect adult adaptational styles. This will assist psychiatrists, psychologists, and social workers in understanding that types of stressors in particular need to be focused on in therapy. Understanding the natural history of coping strategies will also be of use in assisting therapists in understanding the efficacy and problems associated with different kinds of coping strategies.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 5.01 Aging

Title: SEMANTIC MEMORY IN ALZHEIMER'S DISEASE: LIMITS ON LOSS

Description: a. The UC researchers will complete a series of 40 semantic memory organization experiments (5 tasks are crossed with 8 semantic domains, which yields 40 total experiments); they refer to this series as SMORG-40. AD, elderly normal (EN), and young normal (YN)

participants (25 in each group) will be tested. The Pathfinder Networks (that provides information about linkages between items within a given semantic domain) to be derived from SMORG-40, and particularly the differences in these networks for AD versus EN and for EN versus YN groups, will be assessed across both tasks and semantic domains. Their strong prediction is that virtually all of the variation in networks will be due to tasks (which vary in the degree to which attention, strategy, etc. are involved) and domains (which vary in their degree of internal structure, including the degree to which items within the domain are highly associated with one another, are typical versus atypical members of the domain, etc.) with very little variation coming from subject group. There are additional, secondary analyses that they will conduct on the SMORG-40 data set. These analyses, based on specific characteristics of the stimulus items and of the domains to which these items belong, will increase their understanding of semantic memory organization in normal adults, as well as their understanding of how this organization may or may not differ as a function of AD. b. An experiment using a lexical-decision semantic priming paradigm will be set up and run with AD, EN, and YN subjects (25 in each group), using the same basic stimuli as are being used in the SMORG-40 series. Semantic priming paradigms are very commonly used to test for the intactness of associations among related concepts in semantic memory and for the intactness of the spreading activation process in semantic memory. To date, however, they do not know whether reaction-time data derived from semantic priming paradigms can be used to obtain reliable, interpretable, Pathfinder networks for normal or AD subjects. They will determine the usefulness of semantic priming tasks in deriving semantic networks and the degree to which such networks are similar to, or different from, those derived from the five semantic memory tasks used in the SMORG-40 series. c. Structural, magnetic resonance imaging (MRI) brain scans will be obtained on 20 AD patients who will also have participated in the SMORG-40 series and in the lexical-decision, semantic priming experiment. Via this type of neuroimaging, they will obtain data on brain tissue density in selected regions within the frontal and temporal lobes (these regions were selected on the basis of key findings in the cognitive neuroscience literature regarding brain areas involved in semantic memory, e.g., Gabrieli et al., 1996; Hodges & Patterson, 1996; Martin et al., 1996; Thompson-Schill et al., 1999; Wagner et al., 1997). They predict that the brain tissue density in these selected regions will be significantly and positively correlated with the degree to which the AD patients' performance on the semantic memory tasks is similar to that of EN participants. The prevailing methods of assessing semantic memory (world knowledge) in Alzheimer's disease (AD) have involved tasks which require attentional skills, strategy implementation, and/or word retrieval, in addition to semantic memory knowledge. Their hypothesis has been that AD patients will show little or no abnormality in semantic memory when tasks are used that focus specifically on semantic memory structures and processes, rather than depending, in part, on non-semantic-memory abilities. They have recently completed a large study of semantic memory in AD compared to normal aging. In this study, five different experimental tasks (which vary in the degree to which attention- and/or strategy-based skills are required) and eight different semantic domains (e.g., animals, tools) were utilized. They have data on all 40 combinations of task and domain for 21 AD, 30 elderly control, and 30 young control subjects. They also have partial data for an additional 30 AD subjects. Pathfinder network and multi-dimensional scaling analyses were employed on the data, as were more traditional univariate and multivariate methods of analysis. Their initial findings show that the degree to which AD individuals show normal versus abnormal semantic memory organization is affected both by type of task and semantic domain (relatively more structured domains are less affected by AD). The

general finding is that semantic memory organization is far more preserved in AD than previously believed. They are in the process of conducting more fine-grained analyses of the data, including item analyses, which will enhance our ability to interpret the findings from this large set of experiments. Several publications with theoretical as well as clinical relevance will be generated from this large data set on semantic memory in AD and normal aging.

Impact: All cognitive abilities are dependent upon the access and utilization of world knowledge (semantic memory). Thus, a viable model of AD cognition must take semantic memory functioning into account. These findings are highly relevant to the assessment, treatment, and management of AD (which affects approximately 8% of all individuals over 65 years of age).

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 5.05 Children, Youth, and Families at Risk

Title: A MICRO PROCESS STUDY: SIBLINGS AND ANTISOCIAL BEHAVIOR

Description: Objectives are to: A. Investigate patterns of sibling interactions hypothesized to mediate or moderate risk for antisocial or delinquent behavior. B. Investigate the influence of sibling approval (positive reinforcement) of deviant, antisocial talk or behaviors that may function as contributing factors for the initiation, maintenance, or escalation of such behaviors. C. Examine which social processes between siblings appear to be salient for the development of antisocial, delinquent behaviors at different developmental periods (early to later adolescence) and test if these salient social processes differ systematically according to gender composition of the sibling dyad. D. Evaluate the degree to which parenting practices affect social processes in the sibling relationship that either increase or decrease risk for adolescent antisocial behavior, as well as the extent to which sibling influence is independent of parenting behaviors E. Identify the family processes, between parents and adolescents and between siblings, which affect risk for delinquency and which could be modified via social and behavioral interventions. The availability of longitudinal data will allow the investigators to examine how the influence of these social processes may change over time. F. Disseminate information about research results to university-based as well as local and state programs for their use in the creation of more efficacious prevention and intervention programs for troubled teens and their parents. The overall purpose of this study is to investigate patterns of sibling interactions hypothesized to mediate or moderate individual risk for antisocial or delinquent behavior. Specifically, the study will investigate the influence of sibling approval (positive reinforcement) of deviant, antisocial talk or behaviors that may function as contributing factors for the initiation, maintenance, or escalation of such behaviors. There were three key objectives for the first full year of this study. First, complete micro-social coding on all available videotaped sibling interactions (about 2000) from two longitudinal studies of family and sibling processes and adolescent adjustment: the Iowa Youth and Families Project and the Single Parent Project. This included conducting reliability analyses of 18 % of all coded interactions to establish inter-observer reliability. Second, conduct analyses of associated questionnaire data in relation to the observed patterns of behavior between siblings to determine the association between sibling interaction patterns and their participation in delinquent behaviors. Systematically coding and analyzing these patterns of

interactions associated with problem behaviors will allow the researchers to identify those points within the interactions that contribute to risk for serious delinquency and other antisocial behaviors. Third, begin the dissemination of research results to university-based as well as local and state programs for their use in the creation of more efficacious prevention and intervention programs for troubled teens and their parents. This will be accomplished through publications in academic journals and presentations at research conferences, research workshops, ANR work groups, and community forums.

Impact: Antisocial and delinquent behaviors are a continuing concern for families, schools, and communities. Social processes between peers have been studied a great deal but processes between siblings have not. This study will allow the investigative team to examine which social processes between siblings appear to be salient for the development of antisocial, delinquent behaviors at different developmental periods (early to later adolescence, i.e., 12 to 20 years of age). Furthermore, this study will provide data to test if these salient social processes differ systematically according to the gender composition of the sibling dyad that is an understudied area in research on delinquent behaviors. In addition, the inclusion of information on parenting practices will assist the researchers in identifying the family processes, between parents and adolescents and between siblings, which affect risk for delinquency and which could be modified via social and behavioral interventions. The availability of longitudinal data will allow the investigators to examine how the influence of these social processes may change over time. This is crucial information that is lacking in current research on family processes and adolescent problem behavior. Thus, this study is positioned to inform the development of effective intervention and prevention programs designed to ameliorate the risk of developing problem behaviors by rural and urban youth in California.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 5.05 Children, Youth, and Families at Risk

Title: CRITICAL TRANSITIONS IN RURAL FAMILIES AT RISK

Description: Objectives are to: a. Determine the degree to which economic hardship in the family of origin predicts hardship in the emerging families of the cohort of young adults in the study. b. Determine the degree to which disruptions in parenting, as they relate to hardship in the family of origin, predict deficits in social and emotional functioning in the cohort of young adults in the study and the degree to which these deficits account for intergenerational continuities in hardship. c. Examine the degree to which economic stress in the emerging families of the cohort of young adults has a similar influence on couple relationships and child development as occurred in the families of origin; this objective constitutes an intergenerational replication of the findings in the earlier years of the study. d. Identify social processes and personal characteristics that generate resilience to the adverse consequences of economic hardship in both the families of origin and the emerging families of the young adults in the study. e. Consider the implications of the findings for children and families of different cultural backgrounds and generate a plan for replication studies involving Mexican American children and families in California. There were two crucial objectives for the study during the past year. First, preliminary analyses were

conducted with the goal of confirming the existence of the intergenerational transmission of family characteristics in general from one generation to the next. Second, efforts were made to identify pathways from economic adversity in one generation of families to adversity in the next generation of young adults. The findings were supportive of study hypotheses. With regard to the first goal, two articles were published that demonstrated that parenting style is transmitted from one generation to the next (Conger et al., 2003; Scaramella et al., 2003). The results suggested that angry, hostile parenting in the first generation is emulated by the second generation parent, and that a difficult temperament by the third generation child exacerbates the transmission of this parenting style. The second goal was addressed in a paper presented at the annual meetings of the American Sociological Association (Wickrama, Abraham, & Conger, 2003). The analyses showed that economic adversity in the first generation leads to economic adversity in the second generation by impairing the physical and mental health of the second generation during the transition from adolescence to adulthood.

Impact: The findings generated from the first year of this project are among the first to demonstrate the major influences of the family of origin on the social and economic development of the second generation of adults and their families. Earlier research in this vein has relied almost exclusively on retrospective reports given by adults recounting the experiences of their childhood. These reports are known to be highly distorted by memory failures and biases created by current emotional state. The results from the current prospective, longitudinal research project overcome these biases and provide much firmer support for hypotheses about the intergenerational transmission of socioeconomic influences. They will play a major role in promoting programs that can overcome the negative consequences of socioeconomic adversity in the family of origin.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 5.05 Children, Youth, and Families at Risk

Title: DEVELOPMENTAL PRECURSORS OF WELL-BEING AT WORK AND AT HOME

Description: The general objective of this research program is to provide an integrated, comprehensive assessment of experiences in one's family and in experiences in one's relationships outside the family during middle childhood that predict vocational identity development, job satisfaction, and marital satisfaction in young adulthood. The specific objectives are to: a) Identify specific kinds and domains of family resources and social support which children use during middle childhood and determine how they are related to vocational identity, job satisfaction, and marital satisfaction in young adulthood. b) Examine how parental availability (availability of both mothers and fathers), parental practices concerning discipline, parental support during childhood stress experiences, and shared activities are related to clear vocational identity in adulthood and well-being. c) Investigate ways peer relations, involvement in activities outside of the family, and mobilization of social support outside the family during middle childhood and early adolescence are related to vocational identity and well-being during adulthood. d) Examine the relationships among vocational identity, actual vocation, job satisfaction, and marital satisfaction. e) Test hypotheses regarding the manner in which early

experiences with family and extrafamilial resources interact with gender to promote clear vocational and family well-being in young adulthood. Examined work and well-being among youth. Found that working more than 15-20 hours weekly during the school year is more than most young persons can tolerate without work taking an undesirable toll on their psychological well-being. Increase in drug (marijuana and alcohol) use is associated with exposure to work stress, which characterizes most teen jobs, and this is a very sturdy finding since every published study of this issue has found the link between teen employment and drug use. Transitioning into paid work during adolescence too often takes a toll on physical well-being as well. In addition to danger on the job, youth who work long hours also sleep less, exercise less often, and eat breakfast less regularly than their peers not working long hours. Thus, working long hours at a young age may be promoting a lifestyle that promotes health risks. Prepared for longitudinal followup data collection: Identified three kinds of websites to locate participants first studied 20 years ago: vital records; commercial records; and phone directories. All subjects were located, including 10 of the original 168 who have died.

Impact: Guidelines, forms, and homework assignments were developed to help child therapists more effectively work with families as they make decisions about their teens employment. A procedure developed will help monitor the benefits and costs to mental health and school functioning of their teens employment. Particular attention is paid to drug use that has been linked to teen employment.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 5.05 Children, Youth, and Families at Risk

Title: FACTOR ANALYSIS SOCIAL SCIENCES: TESTING MODEL & APPLICATION INVOLVING ENVIRONMENTAL ATTITUDES

Description: This two pronged study involves empirical evaluations of the appropriateness of factor analysis in the social sciences. (1) The model is tested against known set of physical data underlying the Periodic Table of Elements. The objective is to convince skeptical social scientists (and chemists) the usefulness of using factor analysis to detect underlying structure among variables. If factor analysis arrives at the same model as Mendeleev then this same technique should be equally valid in such social sciences as psychology. (2) Factor analytic techniques are used to define variables in a new area of psychology: human attitudes towards fauna and flora in the environment. The objective is to demonstrate usefulness of factor analysis in a domain which is so new that underlying variables are still vaguely defined. The topic of human impact on environmental ecology is currently receiving attention in areas where the environment is threatened by humans. There a need to define what they are measuring when studying a complex system. There is no lack in instruments that purport to measure X, Y and Z in this area but validity data is lacking. One of the objectives is to provide such validity data. Both structural (or conceptual validity) from a factor analytic approach and for predictive validates by using the variables defined by factor analytic means in multiple regression models to assess their usefulness.

Impact: Since the researchers have shown that the factor analytic model can do an excellent job of modeling physical reality then they feel justified in hoping that it will have the impact of convincing more psychologists of its usefulness in psychological research.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 5.05 Children, Youth, and Families at Risk

Title: LEARNING AND PROBLEM SOLVING IN YOUNG CHILDREN

Description: Studies of early cognitive functioning suggest that infants are capable of inventing strategies to solve novel problems and generalizing the strategies to unfamiliar problems. However, virtually nothing is known about how they accomplish these feats. To address these issues, a UC researcher planned to obtain trial-by-trial assessments of infants' and toddlers' problem-solving strategies and examine how their strategies change with experience. A series of experiments, each involving multiple phases (exploration, training, and transfer), is proposed. The specific issues on which he will focus include: (1) identifying the strategies that infants/toddlers use to solve problems; (2) examining strategy changes with experience; (3) examining the transfer of strategies to novel problems; (4) documenting developmental differences in infants' and toddlers' learning and transfer; and (5) identifying individual differences in infants' and toddlers' learning. Exploring these important but neglected issues of young children's problem solving should yield theoretically significant information about the nature and characteristics of early representations and about the path, rate, breadth, variability and sources of early cognitive change. Thus, the studies could promote the development of more general theories of cognitive development. Studying young children's strategy discovery and generalization and cognitive processes involved in strategy use also has significant educational implications; findings from this research will provide a foundation for improving early education in preschool, daycare and home settings. Examining young children's learning processes will help link research on cognitive development during infancy and during later childhood. The proposed research examines toddlers' ability to use strategies and the processes involved in infants and toddlers acquisition and generalization of problem solving strategies. The general goal of the experiments is to 1) identify the strategies that infants and toddlers use to solve problems, 2) to examine the changes in those strategies that result from experience, 3) to examine the transfer of strategies to novel problems, and 4) to document the developmental differences in infants and toddlers learning and transfer of strategies. The first four experiments conducted over the last few year focused on toddlers' discovery and generalization of strategies. Preliminary analyses revealed that toddlers demonstrated the ability to learn strategies involved in tool use from a video. However, younger children's performance in problem solving remained low, suggesting that their difficulty in transferring a learned strategy might have been due to the difficulty in accessing relevant information from the video when solving problems. The two follow-up studies conducted over the past year focused the issue of reminding of the relations between the solution illustrated in the video and the problems toddlers encountered. It was hypothesized that one obstacle of young children's strategy generalization was due to the absence of hints concerning the relations between the video and the problems. Thus, providing a hint that reminds children the relations between the video and the problems was predicted to

improve their application of the strategy learned from the video. Fifty-two toddlers aged 22 to 44 months participated in the studies. Three analogous problems were presented to children. Each problem set differed in superficial characteristics but shared an underlying problem structure and solution strategy. Children were first presented with the tools and encouraged to obtain the target toy. They then watched a video in which an adult dressed in a Panda Bear costume utilized a tool to obtain an out of reach apple on the table. When first presented with the video, they were instructed to watch the video very carefully because it may help you with the games you will play today. After viewing the video, children were given three 60-second trials at each of two problem sets to obtain an out of reach toy. The instruction was repeated when the video was shown again after they attempted to solve the two problems and before the third problem set was presented. The researchers hypothesize that toddlers strategy learning and generalization are facilitated when hints are provided to remind them the analogous relations between the video and the problems. They have finished analyzing the data for two experiments, and are currently analyzing other data, and designing further experiments to pinpoint the learning processes involved in discovery of tool-use strategies.

Impact: Every day, even young children face the challenge of various problems that need solutions. When encountering a novel problem-solving situation, young children, in addition to using trial and error, often retrieve relevant prior experience such as procedural strategies and attempt to apply familiar approaches to solve novel problems. Findings from this research will provide a foundation for improving early education in preschool, daycare, and home settings.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 5.05 Children, Youth, and Families at Risk

Title: RURAL LOW-INCOME FAMILIES: TRACKING THEIR WELL-BEING AND FUNCTION IN AN ERA OF WELFARE REFORM

Description: Objectives: To assess across time the relative effects of economic opportunity, and personal attributes and actions, on employment and self-sufficiency among the rural low income families participating in the study, and to collect additional data in year 3 of the study to track the functioning of the participating families related to changing policies and economic conditions. The main objective of this study is to track over time, individual and family circumstances, functioning, and well-being of rural low-income families with children in the context of welfare reform. California is one of fifteen states that collected data as part of this three-year longitudinal study to investigate rural low-income mothers. The same sample was followed for three years beginning in 2000. To be included in the sample in Year 1, the mothers had to be TANF, Food Stamp, or WIC eligible; have a child under 12 in the household, and have income of 200 percent of below the national poverty line as of 2000. Quantitative and qualitative data were collected. Analysis during this period examined data collected during Year 1 (N-414; California N=40) and Year 2 (N=313; California N=35). The California sample is predominantly Hispanic (88 percent). Analysis of the data is ongoing. Current efforts have been directed at examining the enrollment of rural, low-income families in assistance programs such as the food stamp program, and the potential impact of enrollment or non-enrollment on the well-being of limited resource,

rural minority children (Hispanic, African American, and Caucasian). Minority children living in rural areas are at high risk for poverty and its associated problems. Poverty rates are higher among rural families than for those living in urban areas. Additionally, more rural minority families live in poverty than either urban or rural white families. This suggests that children living in rural minority families are at a higher risk for poverty and the associated negative outcomes, including behavioral, health, learning, and emotional difficulties. Only data from families who participated in both waves 1 and 2 of data collection were used in the present analyses. First and second-year findings from the study suggest that rural low-income families in general may not be taking advantage of supports and assistance programs that are known to improve the financial situation of their family and increase the well-being of their children. Additionally, ethnic differences revealed that the well-being of children in minority groups may be particularly in question, i.e. use of food stamps, WIC, TANF, the Earned Income Tax Credit (EITC), Medicaid, and housing assistance. However, in some cases, white usage was lower or the same as that of minorities, i.e. use of school lunch programs and dental and medical care. Differential patterns were also found between waves. The qualitative data indicate that reasons for this behavior may include: transportation difficulties, lack of information, poor/inaccurate information, limited local resources, negative experiences, suspicion of the system, and discrimination. Under-utilization of all assistance programs was a notable trend for the participants in the study. From Wave 1 to Wave 2, information was provided to participants regarding availability of assistance programs. Analysis of Wave 2 data indicate that usage did increase for many of the assistance programs such as the Earned Income Tax Credit.

Impact: These analyses suggested that providing information on assistance programs will help, but probably needs to be part of the larger issue of improving overall access to public benefits for limited resource families, especially minorities. The challenge is to utilize our many networks to reach minority families in rural areas.

Funding Source: Hatch Multistate Research and State

Scope of Impact: CA, IA, IN, KY, LA, MA, MD, MI, MN, NE, NH, NY, OH, OR, SD

Theme: 5.05 Children, Youth, and Families at Risk

Title: SAND TRAY PROJECT

Description: The major reason for this project is that although Sand Tray procedures/therapy have been extensively used in the past and are used widely today, especially in clinical areas of Psychological practice, there is relatively little research on objective (versus subjective) interpretation of the content matter of completed Sand Trays. It is the opinion of the author that it is unfortunate that any particular interpretation of a tray relies so much at present on the theoretical background of the clinician making the judgment. This is not to say that such interpretations are invalid but rather that it might be also useful to look for more objective measures that are independent of any clinical theory. If it is possible to show that such objective measures can be generated and that they have both reliability and validities, then maybe, these measures could be used by clinicians and researchers in conjunction with traditional measures. The cross-validation study submitted to the journal Multivariate Experimental Clinical Research has been returned asking for modifications before publication.....an edited and modified

manuscript has been prepared and is almost ready for evaluation. A major sticking point has been that one of the journal editors was misled into thinking that the 16 factors they extracted were in some way supposed to reflect the 16 Personality factors of Raymond Cattells system.....It has taken some time to sort out this confusion. The next phase of the project involves gathering more data.....this time of a longitudinal nature. As a start the UC researcher is collecting data on his own daughter....twice a month for 2 yrs plus. A P-technique factor analysis on this data will allow me to investigate whether or not there is a consistent structure within subjects. Thus between and within structures can be compared.

Impact: Now that the cross validation analyses have been shown to be highly reliable then what this means in a practical way is that clinicians, educators or researchers who use sand tray methods need not have identical sets of toy objects: it will suffice if the toys reasonably are similar to the salient ones in the factor analytic studies. This is important because without it no generalization could be made across different sets of toys. It would be like demanding that each researcher or clinician use an identical set of toys much like in a standardized intelligence test. The most "impact" of our work will be evident in the next phase of the study i.e. the demonstration of predictive validity i.e. do the factors or dimensions that we find really help us understand child behaviors in the "real world", pathological or non-pathological. The addition of within subject structure adds impact to the work, in that it allows generalization to be made not only across subject but also to changes within individuals.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 5.07 Community Development

Title: ART, VISION AND REALITY: THE LANDSCAPE OF PUBLIC PARKS

Description: The objective is to build an archive of visual representations of the Central Valley rural landscape, 1850 to the present. Make these images available to the public. Analyze cultural meanings conveyed by these images. During the past year a UC researcher continued writing a book on urban, public parks. He also compiled a digital catalogue of illustrations to be included in the book. The book is a social and cultural history of the nineteenth-century parks movement in Europe and the Americas. Urban public parks proliferated internationally in the nineteenth century. They were part of a wave of civic improvements that altered cities around the world in this period, transforming ancient capitals and colonial settlements alike into modern, industrial cities. Like other civic amenities, such as sewers, sanitary water delivery systems, opera houses and tree-lined boulevards, public parks were important signifiers of modernity. Paradoxically, urban parks celebrated an idealized and vanishing rural landscape in a period of rapid urban expansion. They were promoted as beneficial to public health, both physical and spiritual, and as anecdotes to a range of urban problems, from over-crowded tenements to rising crime. Politicians around the world found parks to be effective symbols of official concern for the public welfare. By the end of the century, every modernizing city had to have at least one large park to symbolize progress and urbanity. As community leaders in San Francisco put it, in a petition calling for such a park in that city in 1865: "the great cities of our own country, as well as of Europe, have found it necessary at some period of their growth, to provide large parks, or

pleasure grounds for the amusement and entertainment of the people . . . . Until some provision is made to meet this need, however successful and impressive the business growth of San Francisco may be, it will not be an attractive and impressive place for families and homes." This book includes case studies of specific parks in London, Paris, New York, San Francisco, Mexico City and Santiago, Chile. Each of these parks is unique, in terms of social, political, cultural and ecological context, yet strong themes and significant similarities emerge through comparison of parks in these different settings. Together these case studies support the thesis that urban parks were an important mark of distinction for an emerging, international, bourgeois culture in the nineteenth century.

Impact: Nineteenth-century urban public parks simulated an idealized rural landscape. Today they perpetuate this landscape as an aesthetic norm against which both the modern, urban landscape and the rapidly changing rural landscape are measured. Exploring the ideological underpinning of these parks will lead to better understanding of the public park as a cultural institution today, and to better understanding of the contemporary rural/urban dichotomy.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 5.07 Community Development

Title: CAPACITY-BUILDING IN THE SOUTH LAKE TAHOE LATINO COMMUNITY

Description: South Lake Tahoe (SLT) is a California community well known for its natural beauty, recreational opportunities and proximity to Nevada's gambling economy. Less known is SLT's growing reliance on and the increasing size and importance of the immigrant Latino community. From 1970 to 2000, population nearly doubled from 13,000 to 24,000, while the Latino population increased six times from under 1,000 to nearly 6,500. Today, Latinos constitute 30-35 percent of the population. Despite this growth, the Latino community and associated issues have been largely unacknowledged. In 2001, SLT officials created the Latino Affairs Commission (LAC) to identify and address issues related to housing, education, employment, health and safety. In 2002, UC Cooperative Extension (UCCE) officials met with LAC members in El Dorado County. This connection and the resulting outcomes and products have been beneficial for both entities and the Latino community. SLT was isolated from county central services; significant connections did not exist with UCCE and its 4H programs. A new connection was established as the result of assessing, documenting and reporting the needs and assets of the local Latino community. The project involved the conceptualization, design and implementation of a SLT Latino community assessment by personnel from the LAC Commission, El Dorado County Cooperative Extension and UC Davis faculty. The assessment team used existing census and other secondary data, a series of key informant interviews of Latino and other residents, and systematic observations. Updates were provided to LAC members, local newspapers, radio outlets and the community. A bilingual report, now in production, will be shared with the larger community.

Impact: Awareness of the issues and the role of the Latino Affairs Commission is increasing. CE's role in the community has been enhanced, and the UCCE office is engaged directly with a new community. UCCE is developing collaborative research with new partners and has

undertaken new strategies for building local capacity. This project provides the means to create networks and on-going dialogue between the Latino community and previously unconnected organizations and agencies. As the result of this project, the El Dorado Community Foundation is addressing Latino issues in the county and in its program planning, expanding the assessment process to a county-wide level, and committing resources to the effort. This project demonstrates the power and utility of meaningful linkages among county-based Extension staff, campus Extension personnel and graduate students. Such linkages benefit the university and local Extension systems while focusing greater attention on local issues and the mobilization of community resources.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 5.07 Community Development

Title: GATEWAY TO A BETTER LIFE

Description: The stagnant Imperial county economy has negatively impacted the economic and social welfare of a large portion of Imperial County residents. Unemployment and poverty are notably higher in Imperial County than in other California counties. According to the US Census 2000, 22% of Imperial County residents were living below the poverty level, compared to the California average of 14%. Unemployment in Imperial County has ranged from 23% to 35% during the past ten years. Through collaboration with the Imperial County Housing Authority and the Regional Occupation Program, over 500 low-income individuals have been reached in the past two years with segments of the Gateway to a Better Life curriculum. Ninety-eight of the participants were also enrolled in the Housing Authority's Self-Sufficiency Program. The Gateway curriculum helps prepare welfare recipients to enter the workforce with greater success, providing them with the information they need to get a job and balance the demands of work and home. The easy-to-understand lessons were developed in English and Spanish, and were used in small group settings. The field-tested lessons help welfare-to-work recipients find jobs and stay employed through the development of life skills.

Impact: In the last two years the Imperial County Housing Authority has enrolled over 98 participants in its Self-Sufficiency Program, which features segments of the Gateway to a Better Life curriculum. Lessons were presented on establishing goals, decision making, paying bills on time, stretching your dollars and banking. The Food Stamp Nutrition Education Program was also presented. Twenty-four participants completed the Self-Sufficiency Program and half of them were able to purchase their first home and leave public-assisted housing.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 5.07 Community Development

Title: NEW IMMIGRANT POLITICAL INCORPORATION PATTERNS AND TRANSNATIONAL PRACTICES OF MEXICAN MIGRANTS IN CALIFORNIA

Description: The three main objectives of this study are: (a) To investigate the character of the trans-local ties forged by transnational Mexican migrants in Napa and Santa Rosa and their relationship to the transnational practices of political elites and policy-makers in their states of origin. b) To investigate the consequences of these trans-local and transnational connections and practices for local processes of Mexican immigrant incorporation in the two selected California communities in California's Wine Country, particularly with respect to acquisition of citizenship, rates of local civic and political participation; rates of electoral participation; and participation in local issue-oriented coalitions and state and local ethnic politics in California. (c) To develop analytical and policy criteria for evaluating the character and effectiveness of national, state and local public policies designed to promote citizenship, immigrant incorporation, and affiliation within a multicultural public sphere in the U.S. in the face of the ongoing pressures of transnational identity formation promoted by the nationalist projects of sending states. Leaders of a Zacatecan federation of migrant home town associations in Los Angeles promoting economic development in communities of origin; leaders of a civic association allowing Zacatecan migrants to act as an interest group within California; and a tomato grower from Winters, who was elected mayor of Jerez but had to step down because of lack of residence, were interviewed. Passive and participant observation was done at meetings of the federation. A research grant from UC-Mexus was won to obtain additional support for the research. An article on transnational electoral politics was published.

Impact: The research reveals the dynamics of new modes of cross-border community economic development and transnational citizenship. It enables immigration researchers and policymakers to observe the consequences on both sides of the U.S-Mexican border of emerging practices of dual citizenship. Findings thus far support the proposition that migrant civic engagement n Mexico is not incompatible with engagement in state and local politics in the US. The study informs the immigration policy-making debate.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 5.09 Consumer Management

Title: MAKING USE OF POST-CONSUMER TEXTILES AND CLOTHING

Description: Each month, more than 350 garbage bags of clothing and textiles from thrift shops in Siskiyou County were being disposed of in the local landfill. Other sources added to the problem. Thrift store managers in Yreka verified that this was common practice, but few options were available. In spring and summer of 2001, interviews were conducted in Siskiyou County with managers of thrift shops, operators of yard sales and customers of both types of outlets. Questions focused on the amount and type of clothing and textile waste the managers and operators had each month or after each sale, and also how they disposed of the waste. Customers were asked how often they shopped at thrift shops and/or yard sales for clothing and textiles, what items they sought and what determined whether they would buy. They were also asked if they purchased items for other than the original purpose and whether they would use an alteration service if available. While conducting this research, the advisor also worked with a group of volunteers to develop products from the waste textiles and clothing from one non-profit

thrift store. Group members have made home decorating products such as pillows and rugs, have woven rugs on floor looms and frame looms from denim and wool skirts, and have crocheted rugs from jeans and sheets. They have also made pillows from T-shirts, flannel shirts and sheets and have painted on denim to increase its saleability. These items have been sold at craft fairs and more recently from their own shop, bringing over $10,000 to one non-profit group in less than two years. The advisor developed three slide programs, a poster presentation, two displays and a 15-minute video to report findings of this research and recommendations for community involvement.

Impact: To date, members of the group have recycled and kept from the landfill an estimated 700 pairs of jeans, 300 flannel shirts, 500 wool garments and many boxes of fabric and notions. They have demonstrated that a garbage bag of waste denim jeans can be reduced to only a grocery bag of waistbands that needs disposal. Publicity and education have increased the number of volunteers from five to 38. Continuing education about alternatives for re-use of clothing and textiles can bring additional income to the non-profits operating the thrift shops and extend the life of the landfills. This research project has been selected for presentation at several national consumer science and other events. It was the 2002 Western Regional winner in the Environmental Education category of the National Extension Association of Family Consumer Science.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 5.09 Consumer Management

Title: UC TRAINS TRAINERS TO TEACH MONEY MANAGEMENT TO LOW INCOME FAMILIES

Description: Consumer debt is an important factor in the financial stability of families. Low-income families are even more vulnerable as they access credit in the form of payday loans and rent-to-own, which charge very high interest rates. Low-income families, with much less disposable income, often lack the skills necessary to set goals, make good choices and manage their resources. A UC advisor began this project of training trainers in money management in 1991. She has conducted 16 "Training for Trainer" sessions which have graduated 161 agency personnel representing over 40 agencies in eight Kern County communities, as well as community volunteers. Agency personnel who work with low-income families attend a minimum of 15 hours of money management training consisting of goal setting/choices, savings/checking, credit, food-buying, car-buying/insurance, and housing. In order to graduate from the class, participants must set personal goals, access their credit reports, and prepare and follow a personal budget. In 1999, she conducted six, four-hour trainings for Americorp volunteers, reaching 210 ethnically diverse members who are assigned to work with low-income families and children at school sites throughout the county. She also conducted workshops for the Department of Human Services Welfare to Work conference held for CalWORKs participants. Since 2000, she has given six presentations annually to the Teen Dads and Teen Moms programs of the Kern County Probation Department.

Impact: An evaluation of the Money Management "Training for Trainers" program in 2000 showed that 95% of the trainers are using the information in their personal lives. Money Management graduates share the information with an additional 23 to 38 individuals. Agency personnel, volunteers and the advisor are continuing to disseminate Money Management information throughout the county to audiences with the greatest need, including immigrants, teen parents, low-income families and Hispanic families.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 5.14 Home Safety

Title: BIOMECHANICAL STUDY OF WALKING COMFORT ON CARPETED FLOOR

Description: Carpets are widely used in workplaces to reduce human's fatigue or even pain. However, according to the American Pediatric Association in 1983, discomfort, pain or orthopedic deformities in foot or lower leg still occurred in 83% of the American workplace. These effects are especially common in supermarket checkout personnel, health care workers such as surgeons and nurses, etc. The objective of this project is to develop biomechanical and experimental models of human physiological and psychological perception of fatigue in relation to tufted carpet properties. The results from this study will improve understanding of the nature of human fatigue due to interactions with carpeted floor, and to establish ergonomically sound criteria for better carpet design. UC researchers have applied a fractional Brownian motion to investigate the dynamic characteristics of the center-of-pressure (COP) profiles collected in quiet standing on five flooring conditions including four widely used yet different carpets as well as the surface of a force platform (the hard floor). Seven healthy young subjects stood barefoot under upright stance on each flooring condition under both eyes-open and eyes-closed conditions. The COP profiles collected by a force platform were analyzed through a fractional Brownian motion along both anteroposterior and mediolateral directions.

Impact: The results revealed that a more compliant flooring condition in general provides a shorter transition time to transfer posture from a persistent feature to anti-persistent feature. Meanwhile, along the anteroposterior direction, a more compliant flooring condition provides a higher level of anti-persistent postural sway over a long-term region under eyes-open condition, whereas yields a lower level of anti-persistent sway under eyes-closed condition. The findings should be helpful in enhancing our understanding of postural sway on varied flooring conditions. Furthermore, the findings provide guidance to apply appropriate floors in many living places such as senior nursing homes to reduce physical problems and potential falls.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 5.16 Impact of Change on Rural Communities

Title: ANALYSIS OF AGRICULTURAL AND TRADE POLICY AND MIGRATION IMPACTS IN RURAL COMMUNITIES

Description: This project will employ agricultural household and micro economy-wide modeling techniques to explore the economic impacts of agricultural and trade policy reforms on production, incomes and resource allocations in rural areas, and the interactions between these impacts and migration out of (e.g., Mexico) and into (e.g., California) rural communities. The models used in this research will integrate micro-economic, household-farm modeling into local general-equilibrium frameworks, making it possible to capture both direct and indirect impacts of policy changes on rural economies. Many of the applications will be in developing countries with important trade and migration relationships with United States. Nevertheless, the modeling techniques potentially are equally applicable to rural areas in California, as well, and a major component of the research carried out under this project will focus on rural California. This research will involve extensive analysis of household-farm data, econometric estimation of model parameters, programming techniques, and policy analysis. The first applications will use micro economy-wide modeling to explore the implications of NAFTA and Mexican agricultural policy reforms on incomes, production, and migration in major migrant-sending areas of Mexico and impacts of migration on rural California communities.

Impact: This project examines impacts of trade and agricultural policy reforms and migration-development interactions in rural communities in the United States and abroad. Research using field survey data uncovered new interactions between migration and development, including negative lost-labor and positive remittance effects on agricultural productivity and the transition to non-farm activities in rural areas. Research in the United States indicates that there is a positive interaction between farm employment and immigration that increases rural poverty and welfare demands. It also produced evidence that certain types of public transfers "crowd in" remittances from U.S. immigrant households to households abroad. As rural economies increasingly become integrated with world markets through trade liberalization, understanding the ramifications for rural production, employment, poverty and migration is a priority for both the United States and less developed countries, including Mexico. Findings from this project are providing new insights into these ramifications and their implications for designing trade and rural development policies.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 5.16 Impact of Change on Rural Communities

Title: COMPUTERS AND VISUAL COMMUNICATION FOR RURAL NON-PROFIT ORGANIZATIONS

Description: Objectives are: To assess and evaluate the status of computer usage and visual communication in the rural non-profit sector; to provide direct services to a select subset of rural non-profit organizations, including the design of new print graphics and a Web site prototype; to develop a model program for self-assessment and training for utilization of computer-based visual communication by rural non-profit organizations; to publish and disseminate the results of these assessments and model programs in a manual and in Design and non-profit journals for the benefit of rural non-profit organizations. The UC researcher's project focuses on examining the computer and visual communication needs of non-profit organizations. The emphasis that this

project has taken is in the communication of health issues. The initial focus was on finding an appropriate forms and visual strategies that could increase people's awareness of the seriousness of these disorders (anorexia nervosa has the highest mortality rate of any mental disorder). In 2001 she has worked with art, mental health groups, women's centers, and college campuses to develop ways to promote public awareness on issues such as eating disorders. The imagery created has been shown in seven solo galleries exhibitions and in a large awareness-building campaign at Boston College. Exhibitions in 2001 included a large exhibition at Parsons School of design in New York with an accompanying public art campaign showing in twenty subway stations throughout Manhattan, Queens and Brooklyn. Another large exhibition was held in the fall at UC Riverside. There the exhibition was the focus for student writing assignments from such varied classes as aerobics to Biology 2. The final project was a performance in response to the exhibition. Future exhibitions will return the project to the Boston College campus in February for a long exhibition. The show will also travel back to New York to Columbia University in the winter of 2003 and to Humboldt State University. She has begun work with the Center for Weight and Health at UC Berkeley. There the researcher is working with an extension specialist on developing visual compelling material for two projects: encouraging healthy food choices for Vietnamese immigrant women; helping communities develop strategies to reduce childhood obesity. The posters, logos and other visual materials were finished in the summer of 2001 . The design center described in my original proposal is moving forward. She has a second grant this year for $27,000 to develop visual materials for diabetes education. This project is part of a DANR work group with people from the Nutrition Department on the Davis campus. The visual materials will be finished in the spring of 2002.

Impact: There continues to be a strong response from ordinary people who come to the exhibitions, see the public art and visit the web site. The repeated, unqualified embrace of and engagement with the project informed me that in a visual culture, visual communication may be critical to enhance individuals' and communities' ability to access information or confront an issue, even if it is something that is already central to their lives.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 5.16 Impact of Change on Rural Communities

Title: IMMIGRATION AND THE CHANGING FACE OF RURAL AMERICA

Description: Objectives are to: Examine the impacts of immigrant farm workers on (1) the competitiveness of the farm commodities in which they are employed, (2) the communities in which they live, and (3) prospects for upward mobility for immigrant farm workers and their children. This project asks a fundamental question: is the U.S. re-creating a rural underclass through the immigration of farm workers? About 2.5 million people work for wages on U.S. farms sometime during a typical year, including 1 million in California, and over 80 percent of these hired farm workers are immigrants. For most, seasonal farm work is a job, not a career, and 10 percent or 250,000 farm workers exit the work force each year, including 100,000 in California. Thus, farm employers have a keen interest in reaching outside U.S. borders for additional workers, while farming communities and the state are concerned about the economic

mobility of low-wage workers and their children in the US. Most immigrant farm workers arrive in the U.S. between the ages of 15 and 30 and begin their American journeys by climbing ladders to pick apples and oranges. Many new arrivals find their first U.S. jobs with farm labor contractors (FLCs) and other middlemen who assemble workers into crews of 20 to 40, and deploy them from farm to farm. The process by which FLCs deploy crews is inefficient, so that sometime during a typical year about 2.5 workers are employed to fill one year-round farm job. Seasonality requires that there be more workers than jobs, and this project aims to develop more efficient methods of matching workers and jobs in order to minimize the number of new workers required. Many workers who used to commute between rural Mexico and rural California, settled in California; formed or sent for their families; and became U.S. residents, adding residents to often financially-stressed California cities. Their integration into the U.S. typically went through a four-phase process. First, solo males came to fill seasonal farm jobs and are largely invisible to local communities; second was the shift of some seasonal workers into year-round farm and nonfarm work in food processing, construction and services; third was immigrants settling in rural areas and sending for their spouses and children, or forming families in the U.S.; and fourth was marked by political activism by immigrants and their families. The researchers are refining and using this phases-of-integration model to help farm employers, community leaders, and worker advocates to understand the historic changes they are experiencing. They conduct annual "changing face" seminars in agricultural areas that involve all those affected, and the baseline studies have helped to promote an honest debate in rural areas about the benefits and costs of continued immigration.

Impact: The estimates of the relationships between farm jobs, immigration, and poverty have shaped state thinking about allocating housing and anti-poverty funds and federal policies on immigration and services for migrant and seasonal farm workers. They developed the term "changing face" to explain the changed demography wrought by the arrival of immigrants to fill farm and farm-related jobs, models to assess the relationships between farm jobs, immigration, and poverty, and the 4-stage integration process for federal, state, and local policy makers and their policy options: guest workers to avoid integration costs, or making workers immigrants and eventually citizens to speed their upward mobility in the US.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 5.16 Impact of Change on Rural Communities

Title: IMMIGRATION POLICY AND LABOR PROTECTIONS IN CALIFORNIA

Description: Objectives are: (1) To develop a conceptual understanding of the intersection between recent U.S. immigration policies and U.S. labor and employment laws, with an eye to clarifying whether underlying principles shaping each inherently conflict and/or are in the process of transformation. (2) To develop a systematic picture of the extent and manner of employer sanctions enforcement in the nation and state by economic sector over time, including shifts in INS funding, policy, and activities, and the involvement of other agencies (e.g. SSA, DOL, DLSE) in its enforcement efforts. (3) To develop an in-depth analysis of the impact of recent immigration policy in general, and employer sanctions in particular, on labor and

employment rights in California agriculture, including the extent and patterns of enforcement, the involvement of interagency collaboration, the impacts on labor market structure, and the role of increased border fortification. (4) To explore the resistance of local communities to the enforcement of employer sanctions, with an eye to determining patterns in the kinds of responses initiated, the conditions under which responses emerge, and the circumstances under which local pressure has enhanced the protection of workers' rights. First, 'State Structures and Social Movement Strategies: The Shaping of Farm Labor Protections in California,' was accepted for publication in Politics and Society. This article aims to explain the declining efficacy of California's Agricultural Labor Relations Act. It argues that the origins, terms, and outcomes of the Act emerged from an interplay between the capacity of the state to initiate and implement social reform policy and the capacities of key social classes to tilt outcomes to their benefit. It signals the mutually-constitutive character of political institutions and class strategies, and the crucial impact of union strategy on social reform policy outcomes. Second, 'The Grassroots Reconfiguration of U.S. Immigration Policy,' which analyzes the disparity between federal immigration policy intent and local immigration policy implementation, is currently being revised for resubmission to International Migration Review. Third, two lengthy reports were completed and submitted to the UC Institute for Labor and Employment on enforcement of the employer sanctions provision of U.S. immigration law: 'Whatever Happened to Employer Sanctions?' and 'Patterns of Employer Sanctions Enforcement.'

Impact: The evaluation of the efficacy of California's Agricultural Labor Relations Act provides insight into the respective impacts of state-based and society-based factors on the outcomes of social reform policy. Whereas conventional analyses place the blame for declining policy efficacy on the changing political climate, the researcher shows that in certain periods class strategies were as, or more, influential. The research on the grassroots reconfiguration of immigration policy surfaces important features of the structure of the U.S. state which permit, even encourage, local challenges to federal policy. My two reports to the ILE: (1) explain why the employer sanctions provisions of U.S. immigration policy have been so negligibly enforced; and (2) provide useful longitudinal data regarding exactly how and to what extent they have been enforced over time (the rate and geographical, industrial, and scale-based foci of enforcement).

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 5.19 Literacy

Title: AGRICULTURAL AND ENVIRONMENTAL LITERACY IN CALIFORNIA'S FORMAL AND NON-FORMAL EDUCATION SYSTEMS

Description: Objectives are to: 1. Define and measure learner understanding of agri-food system benchmarks related to science and technology education. 2. Ascertain what teaching practices most effectively foster conversational literacy of agricultural and environmental topics. 3. Determine which agri-food system contexts are fruitful for integration into K-12 science and social studies teaching and learning. 4. Design conduct, and evaluate educational programs to promote pre-service and in-service teacher capacity to teach through agri-food system contexts. There were four objectives established at the onset of this project. Objective 1: Define and

measure learner understanding of agri-food system benchmarks related to science and technology education. The researcher met this objective in two ways. First, he continued with his past work on ascertaining elementary student understandings of agri-food system benchmarks. For this, he used data obtained in Iowa and Michigan. From this work he published two referred journal articles in a premier journal. Second, he met this objective by focusing his work on the various cultures that make up California. Funding came from a Kellogg Foundation grant, entitled: Valuing Food and Fiber Knowledge of Others (Others). The grant promotes social equity within agricultural literacy educational programming by calling upon expert knowledge of people and cultures whose experiences, beliefs, and ideas are often ignored. With this $30,000 grant they have begun to: 1) bring together researchers and immigrant groups, 2) gain appropriate Human Subjects approval, 3) determine ways to ferret out expert knowledge of food and fiber system experts. Objective 2: Ascertain what teaching practices most effectively foster conversational literacy of ag and environmental topics. To reach this objective he has begun to build relationships with schools. The researcher traveled to 8 different secondary and 3 primary schools with agricultural or environmental education programs. Recently, he began work with the California Montessori Project garden. He plans on helping this school write grants to establish the garden and then, after gaining Human Subjects approval, research teachers and students progress in learning about ag and environmental concepts. Objective 3: Determine which agri-food system contexts are fruitful for integration into K-12 science and social studies teaching and learning. The work on this objective has been limited to one project. The researcher was asked to evaluate the effectiveness of a grant entitled: Ventura County Cooperative Extensions Ag and Environmental Newspaper for Elementary School Children. He garnered $10,000 to conduct a study to determine the effectiveness of a student-authored newspaper on literacy levels of 5th graders. Thus far, they have gained approval from the UCD Human Subjects Board for conducting the study. They are awaiting final word on which students will be in the study. Once this is determined, a pre-post test study will be conducted, data analyzed, and papers written. Objective 4: Design conduct, and evaluate educational programs to promote pre-service and in-service teacher capacity programs for teaching through agri-food system contexts. He meets regularly with all the California Department of Education Ag Education staff and all teacher educators from the five universities that have Ag Education programs. They are developing a Delphi Study to: 1) establish a research agenda in agricultural education, 2) help determine what teachers need most related to teaching, and 3) provide information to set a plan of action to meet the perceived issues. All the stakeholders are on board and will be soon be submitting appropriate materials to the Office of Human Subjects.

Impact: The impacts toward meeting the initial objectives are detailed below. Objective 1. The papers published set a new direction for agricultural education research because he used new research methods from the cognitive sciences. As a result, other researchers may use these techniques to ascertaining ag-food system literacy levels, thereby advancing the discipline. The Others project has the potential to include non-traditional ideas and values in the public school ag education agenda and increase the diversity of thought. Objective 2. The immediate impact of the work in public schools is to increase the visibility of UC Davis researchers in California public schools. The long-term impact through this type of action research is to determine methods that foster conversational literacy about ag and environmental topics in public schools. Objective 3. The impact of the Ventura project described above is determining the viability of the newspaper to increase Ventura County teachers' ability to teach their students about the agri-food system. The newspaper will directly affect some 35,000 fourth and fifth graders. With out

this research the impact of the educational newspaper could not be determined. Objective 4. The Delphi study has the potential to directly impact the future of California Ag Education. It can do this by making explicit the needs of educators and the issues they deem important. Without such a study policy decisions would most likely be made off the cuff.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 5.19 Literacy

Title: DEVELOPING AND TESTING CULTURALLY DIVERSE ARTS EXPRESSIONS IN COMPUTERIZED LEARNING PACKETS FOR CA K-12

Description: Objectives are: 1.To develop or improve awareness, understanding and appreciation of multi-cultural arts expressions among selected groups of California K-12 school children. 2.To enrich K-12 curricula with multi-cultural, multi-disciplinary focused lesson plans using California Department of Education Standards in English Language Arts; History and Social Sciences; Math; Sciences; and Visual and Performing Arts. 3.To enhance K-12 student learning in activities by fostering on-line computer and digital technology skills, developing new vocabularies; increasing understanding of geography connecting people and places; augmenting skills to respond to and analyze themes; and deriving meaning through analysis and interpretation of diverse arts and design forms. 4.To build partnerships through multi-cultural arts research, education and outreach between the University of California, California K-12 schools, museums, and community organizations using technology transfer in the form of Web-sites, on-line links and CD ROMs. Two learning packets developed by the P.I. (The Shining Cloth; Spirit Houses, Altars and Shrines), have been evaluated. A Sacramento City Department of Education computer-learning specialist and an authority on curriculum alignment with CA education standards have provided feedback to be implemented in the next learning packet. Plans are underway to also include aspects of the UCD Writing Ambassadors program in subsequent learning materials. The topic of the future learning unit and exhibition is in the organizational phase. The new theme is the design, materials and meanings of basketry utilized to support agriculture and the agrarian cycle in traditional Southeast Asian rural life. The P.I. has been developing the exhibition concept theme with experts and soliciting international lenders of important Southeast Asian basketry and agricultural-related artifacts. The exhibition is scheduled for winter to early spring, 2005 in the UC Davis Design Museum.

Impact: This project will improve understanding of multicultural issues by promoting increased knowledge and generating more appreciative attitudes toward diverse cultures through the subject of Design. Learning packets will have measurable positive affects on students' learning and computing skills; improve their cross-cultural competence; and improve teachers' pedagogy, as enrichment material, through alignment to CA educational frameworks. Materials are also useful to after-school programs and other learners.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 5.20 Parenting

Title: THE POWER OF PLAY: STRENGTHENING PARENT-CHILD INTERACTIONS AND KINDERGARTEN READINESS THROUGH EDUCATIONAL PLAY

Description: Parents are their children's first and most important teachers. Better than anyone else, parents can promote their children's enjoyment of learning and success in school. To be effective teachers, parents must understand their role in their children's early education and have the resources available to help their children learn. Cooperative Extension developed programs to engage low-income and at-risk parents in their children's early learning. These programs offer a unique way for parents to promote their children's readiness for school by using play to assess their children's educational strengths and weaknesses. Inexpensive homemade toys are used as aids to develop areas that need more attention. With the support of a grant from the Children and Families Commission of San Luis Obispo (Prop 10), 432 low-income parents from 27 agencies participated in The Power of Play hands-on workshops. Using common household items such as empty food cans, egg cartons and paper, the parents built educational toys to help their children develop introductory reading and math skills. Additionally, 119 childcare staff members from 24 agencies were trained in The Power of Play curriculum, to extend the program to even more parents.

Impact: 83% of parents interviewed reported using the homemade toys to play with their children at least twice a week and 92% reported using the toys at least once a week. All staff members participating in follow-up interviews indicated they extended the program to more parents through educational workshops, through homework assignments to foster positive parent/child interactions, and through loan libraries for parents to borrow materials for independent work with their children.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 5.22 Promoting Housing Programs

Title: FARMWORKER AND LOW-INCOME RURAL HOUSING IN CALIFORNIA

Description: Continuation of earlier research on creative design of low-income housing projects and furnishings through professional architectural participation in low-income housing projects, design development of manufactured housing prototypes, and affordable furnishings, and furtherance of low-income housing policy and funding. During this reporting period 40 new housing units for farmworker families and 24 beds for migrant male farmworkers were completed, and 187 new units of housing were designed in four separate low-income housing projects. The new projects serve three distinct low-income groups: elderly, mentally-disabled, and farmworker families. The work explored several issues critical to the design of low-income housing: the need to work with increased housing density on sites, the demand to provide more "fair market" design features in housing without comparable increases in funding, increased community requirements for on-site parking above the stated community zoning requirements, and the need for expanded on-site social service functions including child care, computer rooms, and recreational facilities for residents. Construction has begun on one of the projects and two

others will commence summer 2004. The need for affordable housing continues to be at a crisis level for the lower-income families in California. Non-profit developers are increasingly challenged by rising land costs, increased development costs, and competition with market rate developers for land to build housing on. Design of housing is consequently challenged to increase site density, which in turn impacts the ability to create site amenities for low-income residents. Unless some statewide commitment to support housing is put into place, the ability to provide high quality housing projects will be severely reduced. One migrant male farmworker housing project accomplished in this 5-year reporting period has demonstrated the ability to produce a manufactured housing unit suitable for migrant farmworkers, but the project has suffered from external financial problems that have put the project in jeopardy. However, there have been many visitors to the project and the model appears to be influencing other nonprofit and private housing developers to explore this unique housing format.

Impact: The ability of a stable housing environment to enhance the economic development of low income families can be measured in the success of resident families to provide new educational and health opportunities for their children, to purchase housing amenities, and to function in a less marginal fashion. The almost complete absence of turnover in families in affordable multi-family housing units completed in this project points to the steady and growing economic contributions to the communities in which the projects are housed.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 5.27 Workforce Safety

Title: CALIFORNIA AGRICULTURAL ERGONOMIC INTERVENTION PROJECT

Description: Objectives are: To describe and prioritize landmark ergonomic risk factors and hazards for musculoskeletal injuries in the agricultural industries; apply biomechanical, metabolic, and postural stress analyses to prioritized hazards; evaluate previously validated task and tool modifications; develop task and tool modifications for high-risk tasks identified by detailed ergonomic analysis to eliminate or significantly reduce hazards; conduct cooperative task and tool intervention trials; evaluate intervention trials and communicate project findings to industry and other agricultural industry groups.

Impact: After last year showing that the use of smaller wine grape picking tubs resulted in five-fold reduction in workers' post-season MSD pain and symptom scores, the work was continued to look at the impact on workers if machines were used to lift and carry the grapes. This resulted in very minor improvements in pain and symptom scores, leading us to conclude that most workers picking grapes would not significantly benefit from a further reduction in tub size. Over 8,000 smaller tubs were used this picking season, indicating rapid adoption of past research. Worker acceptance was excellent and the demand for the smaller tubs outstripped the suppliers' ability to supply them.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 5.27 Workforce Safety

Title: MEDIATING EXPOSURE TO ENVIRONMENTAL HAZARDS THROUGH TEXTILE SYSTEMS

Description: Objectives are: 1. To improve protection and human factor performance of PPE through product development. 3. To develop performance specifications for protective clothing materials. In the continuation of the study on protective clothing for first responders, a novel technology that can prepare self-decontaminating fire fighters' uniforms has been developed. Nomex fabrics, widely employed in firefighters' uniforms, can be directly chlorinated in a simple wet treatment, and the finished fabrics exhibited rapid and rechargeable antibacterial functions. The fabrics can inactivate both Gram-negative and Gram-positive bacteria in a short contact time, but without rendering any existing mechanical and fire resistant properties. These fabrics are the best materials so far for protective clothing and military textiles. These materials will significantly improve protective functions of the currently used materials and provide better protection for first responders. This research has received attention from National Personal Protective Technology Laboratory (NPPTL) of CDC.

Impact: The results of this research demonstrated the establishment of a new theory of chemical wet finishing of textiles, biocidal functions of the textile materials. The new technology can dramatically improve biological and potentially chemical protection on first responders.

Funding Source: Hatch Multistate Research and State

Scope of Impact: CA, CO, IA, IL, MD, MN, NE, NY, OK

Theme: 5.28 Youth Development/4-H

Title: 4H AND FSNEP HELP YOUTH AT ALESSANDRO CONTINUATION HIGH SCHOOL

Description: Alessandro High School, an alternative learning center or continuation high school in the Hemet Unified School District in Riverside County, serves about 8% of the district's 10th, 11th and 12th graders. These young people are behind in credits and in danger of not graduating. Finding a project that will motivate students and teach them about leadership, cooperation and commitment is a challenge that faces all teachers at Alessandro High School. ANR has played a key role in making a tree planting and campus beautification project at Alessandro High School a reality. National 4-H provided funding for the project as part of Youth In Action/Community Tree Planting Grant. The project idea came from the garden coordinator/teacher at the school. Students in her class wrote an application for the grant--and won the award. UCCE Youth FSNEP staff worked with the coordinator to teach to her students a special curriculum (TWIGS-Teams With Intergenerational Support). Students learned about nutrition and gardening, worked at gardening and tried recipes using fruits they had never tasted before. They researched drought-resistant trees to plant in the Hemet area, prepared a garden portfolio and plan, presented the plan to the school faculty, and took part in the actual planting.

Impact: As a result of the successful tree planting and campus beautification project, students and staff at Alessandro High School campus are proud of the new look. One student says: "There used to be trash around the native garden area, and now students are pulling weeds and picking up the trash." The students who participated in this project learned to work as a team. They also learned something about themselves and their potentials for successfully completing a project that they can be proud of. Their pride is shared by their teacher, Ann Hennessey, who said: "It's amazing the confidence that some of the students are showing. They've learned to work in groups, write thank-you letters and deal with the media and other real world situations that many high school kids never encounter." Says Principal Walt Brubaker: "We are very pleased that the funding from this grant enabled our students, faculty and community to join in a project that will have long lasting implications for our campus."

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H

Title: 4-H ASAP: A PIONEER IN AFTER SCHOOL PROGRAMS

Description: Many of the parents of youth residing in public housing communities are single mothers with several young children to care for. Living at or below the poverty level, many are not fluent in English and lack the financial and sometimes the social resources to provide all the support they would like to give their children. Public housing communities and other low-income neighborhoods are heavily impacted by gangs, drug abuse, physical and social isolation and poorly-performing schools. All combine to create an environment that places Los Angeles near the bottom of the list of cities that provide safe and healthy communities for children. Between 1988 and 2002, the 4-H After School Activity Program (ASAP) in Los Angeles County provided quality after-school programs in schools and community centers, serving children 7 to 13 years of age living in public housing communities and other low-income neighborhoods. Operating five days a week and fifty weeks a year, the program has been collaboratively supported by businesses, public agencies, school districts and UCCE. The program provided attractive alternatives to unstructured leisure time, in safe, accessible and nurturing environments. Activities included homework counseling, nutrition and physical fitness, and daily learning-by-doing supported by curricula from the 4-H Program, as well as the Kaufman Foundation, Junior Achievement and others. Community service projects helped youth play meaningful roles in their communities. With support from VISTA-recruited high school, college and community volunteers representing every ethnicity and walk of life, youth participants benefited from interactions with positive role models, mentors, tutors and project leaders.

Impact: Over 6,500 youth from 28 communities were engaged in the program. Participants showed improvements in self-concept, homework completion, attitudes towards school and feelings of safety. Participants also reported that they were better able to resist the temptation to become involved in gangs and other negative behaviors. Parents reported that their children were more cooperative, social and responsible, and did better in school.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H

Title: 4-H PROGRAM REACHES OVER 84,000 STUDENTS SINCE 1992

Description: Enhancing the elementary school classroom by bringing in outside resources helps children learn. Children's natural curiosity and interest in animals and plants creates learning moments, encourages agricultural literacy and provides opportunities for students to discuss and learn about life experiences. To affect the classroom, however, the program must be longer than a one-day exposure. The Fresno County 4-H School Enrichment Program provides a three to six week classroom presence, enhancing the atmosphere of elementary classrooms with a 4-H curriculum in avian embryology, plant science, nutrition and water rockets. Bringing animals, plants, rockets and nutrition information to the classroom provides a basis for students to learn about basic biology, health, agricultural literacy, basic physics and life skills. A 4-H youth development advisor in Fresno County, has developed the curriculum and 4-H staff train teachers and provide the necessary resources for classrooms presentation. The programs are self-contained to reduce effort on the part of the teachers. College interns deliver eggs and pick up incubators for the avian embryology program. Contact teachers in each school act as organizers of the program.

Impact: Interviews with many teachers have indicated that the 4-H School Enrichment Programs is an integral part of their overall strategy to keep their students in class and excited about learning. Having that egg or chick or plant in the classroom allows them to relate their other studies such as writing, math or biology to a real living object in their classroom. When something happens to the chick, such as dying or hatching handicapped, students have a chance to discuss life skills without the risk of talking about a real person. The Fresno County 4-H School Enrichment Program reaches over 7,000 students each year. About 350 elementary school teachers in over 40 elementary schools are inserviced and provided curriculum and supplies. The program has also expanded to Tulare, Kings and Kern counties, with their county 4-H staffs presenting it.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H

Title: 4-H YOUTH DEVELOPMENT: ADVANCING THE FIELD OF YOUTH DEVELOPMENT

Description: Much research has documented the important role that out-of-school activities play for today's youth: preventing risky behaviors such as drinking, drug use, or juvenile crime; providing safe and engaging environments for young people to continue learning; and promoting healthy youth outcomes and developmental assets. There are a wide range of organizations and approaches to youth development, but a shortage of research on which approaches work best,

and under what conditions. Youth development organizations feel pressure to develop tools for measuring outcomes, but do not always have the resources to accomplish that task. The mission of the California 4-H Youth Development Program includes "advancing the field of youth development." In addition to program management staff, the 4-H YDP has more than 40 full- or part-time academic staff that conduct research on youth development and share that research with others in the field. In this way, they help other youth development organizations be more effective in their work. The California 4-H Youth Development Program has also served as a convener of collaborations. In 2002, more than 30 youth organizations from all over the state participated in the State Conversation on the Future of Youth Development. During that event, the organizations identified issues facing youth in California and strategies for effectively addressing them. Many of the collaborations developed during the State Conversation process continue to flourish, strengthening the field, and thereby expanding opportunities for youth.

Impact: Research on youth development takes place on the local, state and national levels. California 4-H Youth Development researchers have participated in city and county commissions, worked with the California Department of Education, made presentations to youth workers in dozens of organizations, delivered and evaluated curricula for after-school programs and established many other links to youth-serving organizations. By sharing what they have learned about "best practices", they help advance the field as a whole. By helping develop collaborations among youth organizations, UC ANR leverages limited resources to provide more opportunities for more youth.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H

Title: 4-H YOUTH DEVELOPMENT: FOSTERING CIVIC ENGAGEMENT

Description: How do we help young people understand and effectively participate in the political and social processes and institutions that shape our society? How do we prepare and encourage youth to become engaged, competent civic leaders? In response to the events of September 11, 2001, there is increased national attention to these questions. Researchers, educators and others need to identify effective strategies for engaging diverse youth in their communities and preparing them for active citizenship. Various activities in the 4-H Youth Development Program support young people's engagement in their communities. At the local level, 4-H projects all over the state encourage youth to design and implement community service activities. At the state level, the California Focus Program provides a week-long, intense learning experience in which youth investigate the full meaning of citizenship--including rights and responsibilities, government structures and civic engagement--so that they can impact their communities in positive ways. California Focus participants return to their communities with "action plans" to address a local need or problem, and they spend the next several months implementing that plan. California youth also participate in the Washington Focus Program and the National 4-H Conference. Both of these programs help young people understand how the federal government affects their lives at the local level, and provide opportunities for them to meet their elected officials.

Impact: Every year, nearly 200 California youth participate in California Focus, Washington Focus and National 4-H Conference. They return from these programs with increased skills and knowledge about their government and how to make a difference in their communities. Among last year's California Focus participants, 88% showed an increase in knowledge about their state and its government.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H

Title: 4-H YOUTH DEVELOPMENT: REACHING DIVERSE AUDIENCES, BUILDING UNDERSTANDING OF DIVERSITY

Description: California is the most ethnically diverse state in the nation. It has 35% of all Latino children in the U.S., 30% of all Asian and Pacific Islanders and 14% of all Native Americans (Children Now, 1992). Approximately 62% of California's youth under age 18 are children of color. Additionally, California leads the nation in the number of new immigrants. In order to function effectively and successfully in today's world, our youth must learn how to work well with people from a wide diversity of cultures and backgrounds. The California 4-H Youth Development Program has created new programs and delivery modes to reach underserved audiences. They have integrated the value of diversity into our strategic planning for the decade ahead. They have developed financial assistance programs to ensure that cost does not deter participation. By working to ensure diversity within the program, they not only reach more youth but they help all of them develop skills in understanding, valuing and bridging differences. In addition, state and national exchange programs help youth gain skills in understanding global diversity. For example, the 4-H Japanese Exchange Program hosts Japanese youth and sends young Californians to Japan to spend a month living with a Japanese family.

Impact: More than half of the youth who participate in the 4-H Youth Development Program are children of color. Many are from low-income families who might not be able to afford the costs of many youth development opportunities. More than 40% of 4-H youth live in cities; approximately 30% live on a farm or in rural communities where other youth development opportunities may not exist. In short, the California 4-H Youth Development Program is reaching diverse youth in diverse contexts throughout the state, working with all our youth in understanding and appreciating diversity.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H

Title: CALIFORNIA YOUTH EARN NATIONAL AWARDS AT 2002 HORTICULTURE CONVENTION

Description: California is the number one horticultural state in the U.S. and has a sizable proportion of the nation's population, yet awareness of horticulture among its youth is questionable. Very few California youth have represented California in horticultural competitions in recent years, and only one in the past 10 years. This is a problem, since such young people are the future leaders of California horticulture. Several ANR entities were involved in preparing youths for and assisting them to attend the 2002 National Junior Horticulture Association convention in St. Louis, MO. The statewide 4-H program helped to inform youth in all counties about this opportunity. A farm advisor with UCCE in Riverside County, prepared youths for various competitions, including identification of a myriad of horticultural plants. A monetary award from the Hansen Trust in Ventura County, secured through the efforts of program administrator for the Trust, helped one member attend the convention. Another was able to attend via funding received from the Santa Clara County 4-H Council.

Impact: UCCE's educational efforts were successful, as youths from Blythe, San Jose and Thousand Oaks attended the 2002 National Junior Horticulture Association convention. California's contingent earned three grand national and three additional national awards. One who earned a grand national award was presenting his first demonstration and hadn't really known the basics until UCCE personnel helped him. All youths commented about the vast amount of horticulture science they had learned in the short time since beginning their preparations.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H

Title: COMMUNITY AGENCY LEARNING (CAL) SERIES

Description: Because over half (55%) of all California children ages 5 to 14 have both parents or a single parent working at least 30 hours per week, after-school programs are critically needed and play an important role in the lives of many children. The most important factor in the quality of this care, according to the RAND Corporation, is the quality of staff. However, maintaining staff quality is challenging due to factors such as funding uncertainty and short work hours. Although staff generally do not have teaching credentials, they are increasingly called upon to improve the academic work of low-achieving students. When that happens, traditional teaching methods that have failed the student during the school day are unlikely to succeed in after-school programs. The 4-H Youth Development staff in the San Francisco Bay Area developed 17 professional development workshops for after-school program staff: the Community Agency Learning (CAL) Series. These interactive workshops, based on expressed interests and needs and on the latest research information, cover youth development theory, after-school program management and after-school curricula. The 4-H staff team has trained more than 800 after-school program staff who in turn work with more than 8,000 children in Northern California. A similar program is being developed to serve Southern California communities.

Impact: Following their workshops, after-school staff consistently report improved knowledge and skills in working with children. Each of the workshops is evaluated, using a retrospective pre- and post-test. For example, 17 participants in the workshop titled Working with Challenging Children gave these responses:

--In regard to "ways to change the environment, curriculum/activities, teaching strategies, etc. to improve children's behaviors", respondents indicated a 41% improvement in knowledge.

--When asked if they "understand that staff has the strongest influence on children's behavior", respondents indicated 28% improvement.

--In regard to having "a rough plan to improve children's behavior", respondents indicated 67% improvement.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H

Title: FUN IN THE SUN: 4-H HELPS ENRICH SUMMER FOR KIDS IN NEED

Description: After years of neglect, after-school and summer enrichment programs for urban children from low-income neighborhoods are finally attracting the attention and the support they deserve. Educators and researchers are focusing on what these children are learning from their participation in organized after-school programs and summer camps. These venues are often ideal for integrating non-formal science and environmental literacy activities. They also provide excellent opportunities for children to learn and practice positive social and civic skills. Since 1998, Fun In The Sun (FITS) has been a free educational summer day camp for boys and girls ages 6-11 from very low-income families in Santa Barbara and Goleta. Collaborators include the California 4-H Youth Development Program, Girls Inc. and the local YMCA. FITS is funded through the local chapter of United Way. The camp's summer-long educational and recreational program includes a variety of activities, from character education to science and environmental topics. Reading and social skills are integrated into all activities. UCCE 4-H staff helps recruit and train FITS staff, who are mostly Latino undergraduates from UC Santa Barbara and the local community college, as well as teen volunteers who serve as staff assistants. Parent involvement is also encouraged through Family Fun Nights, where campers share their camp achievements with their family members. 4-H provides programming focused on natural science and the environment. Topics include watershed restoration and water quality, gardening, oak woodlands and their wildlife, reuse and recycling, and the very popular sports fishing program.

Impact: Through FITS, 4-H has helped provide a no-fee summer enrichment program for nearly 300 young people from disadvantaged families every summer since 1998. Surveys show that children who participated in FITS have:

-Increased their interest in and appreciation for science by 56%

-Increased their reading skills by 50%

-Improved their social skills and ability to bond with a group

-Appreciated the opportunity to spend time with caring adults

In addition, participation in Family Fun Nights by the campers' family members has consistently been close to 100%.

Funding Source: Smith-Lever, Hatch, and State

Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H

Title: GREENNET: COLLABORATION BUILDS SOCIAL CAPITAL

Description: It is generally agreed that the children of low-income families have fewer opportunities to succeed in today's society. The Neighborhood GreenNet Project is a collaborative project engaging low-income families and their children in small horticultural (green) business startups that utilize cutting edge computer technology. By working with these families, the program strives to direct youth toward a path of responsible, self-directed and productive membership in society. GreenNet is a collaboration of the Santa Barbara County 4-H /Cooperative Extension program and the Housing Authority of the City of Santa Barbara (HACSB). The project provides ten weeks of hands-on training to K-12 at-risk children in the areas of gardening, computer technology and entrepreneurship. Blending these three unique themes into one project works to increase cohesiveness between families. Children work alongside their parents to design small enterprise gardening projects that benefit from state-of-the-art information technology for research, planning and development of market sources. Teen volunteers mentor younger children in project activities, who in turn help teach their parents such things as how to access information technology to enhance their family gardening projects.

Impact: Since 1998, GreenNet has involved more than 550 youth and 350 housing resident families throughout the city of Santa Barbara. The majority of the teen participants in GreenNet have gone on to college education, and several have elected to major in business, technology, science or science-related fields. These teens said their GreenNet experience helped them develop new work skills and self-confidence. A Family Opportunity Learning Center with a computer lab and Arroyo Gardens garden learning center were developed on Housing Authority property. Various micro-enterprise projects, including a native plant nursery and a cut-flower project, were launched. In the past, vandalism, including graffiti and intentional damage to landscaping and property, have been a serious problem for the Housing Authority. Prior to GreenNet, property damage repairs costs ran over $60,000 a year, not including the cost of policing the property. GreenNet staff were delighted to hear that after just one year of the program, housing property damage costs had dropped to near zero. This change was attributed by the police and the housing property management to the efforts of GreenNet.

GreenNet was selected as a National Program of Excellence by the USDA in 2002.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H

Title: HANDS-ON SCIENCE PROGRAMS TEACH IMPORTANT LIFE SKILLS

Description: Strong science skills and processes are essential for everyday living, academic success, and job performance. Yet, nearly half of all California 8th graders test below grade level in science abilities. 4-H has long been recognized as a national leader in non-formal, out-of-school science activities. Many classroom teachers believe these same quality inquiry-based experiences belong in the classroom as well. The Hands-On Science Program was developed to meet this need. Brief updates and easy-to-use curriculum are shared through the monthly Hands-on Science Newsletter. Teacher workshops are also held annually, training classroom teachers in the science processes and inquiry approaches for delivering the hands-on curriculum. Science-based curriculum shared with classroom teachers include Earth Connections, 4-H Embryology...An Eggciting Adventure, Worms Recycle For Us, Water-Wise Guys, Primary Planters, PlacerGROWN Ag-tivities, and Bread & Little Hands. In-service and continuing education certificates are given to attending teachers. Teachers are also encouraged to participate in other extension sponsored educational activities.

Impact: A total of 42,000 newsletters were distributed to elementary school teachers in Placer and Nevada Counties the past three years. Eight workshops were conducted for elementary school teachers. A total of 17,832 youth were group enrolled through these efforts. Classroom teachers report that students benefit from the hands-on/minds-on approach. They are more engaged in the learning and are more apt to extend their learning on a particular topic because of the experiential focus of the materials.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H

Title: HOMEWORK CLUB PROVIDES A MODEL FOR AFTER-SCHOOL PROGRAMS

Description: Although there is general consensus that homework can make a positive contribution to academic achievement and the development of positive personal characteristics and habits of youth, there is growing concern and frustration on the part of parents. Many believe homework is having a negative impact on family time, contributing to stress and conflict and limiting participation in other activities beneficial to growth and development. Parental attitude toward homework has also been identified as the most important factor in shaping the attitude of children toward homework. Concern has also been voiced by some educators that homework is just one more arena where the disadvantaged student is lacking the resources and/or motivation to compete successfully. Low-income students and ESL (English as a Second Language) students are much less likely to have access to computers or help from family members, and are much more likely to have a home environment lacking in structure. Most after school programs provide assistance to students with their homework. But do they know how effective they are in helping students be successful in school? Research has been conducted to learn how a homework assistance program can impact students, parents and teachers. In our study, they

learned that community collaborations with schools can make a difference by providing homework assistance programs and extra-curriculum activities for children at risk for academic retention. They examined the outcome of a homework assistance program for third through fifth grade children in a rural school. The overall goal of the after-school program was to enhance the educational experience and provide activities to encourage positive parent-child interaction. Students were referred by teachers because of their critical need for homework assistance. The students participating were performing below grade level, not making a consistent effort outside the classroom to complete homework assignments or needed special assistance with assignments. Intake and follow-up forms were completed by the referring teacher for each student in the program. The intake form was completed before a student began participating, while the follow-up form was completed by the same teacher at the end of the year. In addition, at the conclusion of the Homework Club, questionnaires were completed by the referring teachers, participating students and their parents.

Impact: The results showed the homework club had a strong impact on the increased amount of homework turned in. Teachers and parents also reported personal growth for the participating students i.e. enhanced self-esteem, sense of accomplishment, learned responsibility, positive attitude about school and homework and felt more supported throughout the day. They feel the Homework Club was successful because it increased the value of doing homework in three ways: 1. It is more interesting to do homework in a group setting than alone; 2. Students were able to get the individual help they needed and they had more free time to play when they arrived home; and 3. Doing homework became important and useful because it led to immediate positive feedback from adults and the opportunity to participate in enrichment activities, and long-term positive response from parents and teachers. These outcomes facilitated a more positive self-image and improved attitude toward school on the part of the students and a more positive attitude toward homework, as well as toward their children as students, on the part of parents. Our research and others have shown that homework assistance programs can do much to help level the academic playing field for disadvantaged children, serving as a protective factor against the downward spiral of academic failure often experienced by these children. By sharing our experiences and model nationwide, they hope others will be able to form partnerships with more schools to address the concerns of student poor academic achievement and how community collaborators can sponsor homework assistance programs and extra-curriculum activities.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H

Title: HOW DO STRUCTURED OUT-OF-SCHOOL EXPERIENCES CONTRIBUTE TO POSITIVE YOUTH DEVELOPMENT?

Description: Objectives are: 1. To identify and analyze the dimensions of key developmental processes that occur in structured out-of-school activities. 4. To track over time the key developmental processes that occur across single or multiple structured out-of-school experiences. A UC researcher worked with University of Arizona and Penn State University colleagues in development of web-based survey of youth activity participation. He examined

youth interests in participating in out-of-school time activities and there barriers to it and has co-developed (along with University of Arizona & Pennsylvania State University) an on-line survey to examine participation in detail. They developed and piloted an online survey. As they come to better understand the motivations and barriers to youth program participation they will be better able to design programs that attract young people and enhance their development.

Impact: This project has had impact in the following ways. First, it has brought national attention within USDA to the science of youth development programming, and they are beginning to see change in many other federal agencies around the need for research and evaluation of youth programs. A direct result of the work has been to influence the funding of USDA programs that have demonstrated their effectiveness through evaluation and research. Second, the project has laid the foundation for several research projects that can take key questions in the field to scale, primarily the question of the barriers and opportunities that exist for youth participation in programs.

Funding Source: Hatch Multistate Research and State

Scope of Impact: AZ, CA, IA, IL, IN, KY, MA, MI, MN, OH, PA, WVA

Theme: 5.28 Youth Development/4-H

Title: OCEAN SCIENCE CAMP FOR YOUTH

Description: Compared to other developed countries, school children in the U.S. rank poorly in science and math scores. Many people today are concerned that they will lose our competitive edge in the global economy unless they train our youth to apply scientific methods and new technologies, particularly in the use and management of our finite natural resources. A Marine Advisor has worked with leading educators, business people, scientists, researchers and resource managers in Central California to establish a national ocean science camp for children: Camp SEA Lab Monterey Bay. The goal is to use community resources to provide children with an appreciation for science, resource conservation and potential marine-related careers. In partnership with local and regional businesses, educational institutions and resource agencies, Camp SEA Lab programs provide adventures for youth that are grounded in real-life experiences. In 2002, the first full summer of operation, 110 students participated in the SEA Lab program, which integrates inquiry-based, hands-on science activities with exposure to working professionals in the fields of marine science and advanced technology. In delivering the program, Camp SEA Lab worked with 19 regional institutions. As a result, SEA campers interacted with coastal naturalists, watershed educators, marine biologists, deep-sea engineers and technicians, research divers, coastal managers, marine mammal trainers and specialists, and the owners and staff of coastal related businesses. Science not only became a fun adventure, but also presented realistic options for careers. Enrollment in the camp programs is expected to double in 2003.

Impact: After just one year, participant responses in written evaluations as well as one-on-one interviews show that Camp SEA Lab positively affects youth and the Monterey Bay community. The campers, many of whom had never before experienced Monterey Bay at first hand, are proud at having overcome fears and tried new activities, kayaking and snorkeling in particular. As the 2002 week-long program progressed, SEA Campers became enthusiastic and noticeably

more confident, asking questions and sharing perceptions about science. Many expressed interest in continuing their education about the oceans, wanting to know how they could stay involved in ocean protection. Camp SEA Lab also had significant indirect impacts on the families, friends, teachers, scout leaders and neighbors of participants. One parent wrote "This was the best thing my son did all summer! When are you going to have a program for the entire family?"

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H

Title: ON THE WILD SIDE

Description: Many children today--particularly those from urban, economically disadvantaged communities--do not have opportunities to experience the wonder of nature. These children are the stewards of both our future and the ecological health of the planet. They need an understanding of ecological principles and life sciences, and the chance to discover the workings of nature. Creating opportunities for youth to explore, learn about and enjoy natural places is an investment in our children and our Earth. ANR leads a collaborative project that brings environmental education and outdoor experiences to children and teenagers living in Sacramento's economically disadvantaged neighborhoods. "On the Wild Side," a program funded by the Sierra Club's Youth in Wilderness Project, brings 4th to 6th graders from the Sacramento START after school program to an overnight outdoor living experience filled with experiential learning and a lot of smiles. Teens and adult volunteers work in partnership to plan and staff the overnight camping experience for the children. They receive training in environmental curricula, and then design a two or three day program. Children rotate through the teen-led activities to learn about ecosystems, migration, habitat and the food chain. They also have the opportunity to paddle a canoe, sing around a campfire and fall asleep under the stars.

Impact: The program is now in its fourth year and both quantitative and qualitative data consistently point to a rich learning experience. Pre- and post-tests reveal that the youth gain knowledge about the environmental concepts presented through the program. The children's journal entries confirm the learning that takes place. Those returning scored significantly higher on pre-tests than those who are new to the program, indicating a high retention rate for what was learned in past years. A powerful part of On the Wild Side is the teens who give their time and energy to plan and run the events. These young leaders both add to and grow from the experience. They enjoy a rapport with younger students that differs from that of adults, and prove themselves excellent teachers. The outdoor environment is completely new for many of the children (as well as some of the adults who accompany them). When asked to list three things learned, one child wrote: "How fires feel, how to sleep outside, and the stars are brighter than in the city." Some youth commented on having to walk so much, testimony to the rather sedentary lifestyle many children lead.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H

Title: RAISING AWARENESS OF DOMESTIC VIOLENCE

Description: More women are victims of domestic violence than of burglary, muggings and other violent crime combined. Most attacks on women (about 70%) are committed by someone the victim knows--often a husband or boyfriend. Last year in America nearly 4,000,000 women were physically abused in this way. Domestic crime against adults accounts for nearly 15 percent of total crime costs--$67 billion per year--according to a 1996 study by the National Institute of Justice. A National Crime Survey has shown that almost half (48%) of all incidents of domestic violence against women go unreported. In Santa Clara County, 18 people were killed during 2000 by their spouses, ex-spouses or lovers. Local law enforcement received nearly 10,000 domestic violence calls, with actual incidents estimated to be even higher. Three Santa Clara County youth and a 4-H leader, members of the 4-H Youth Development Program, became interested in the issue of domestic violence in the summer of 2002 when they attended the statewide citizenship conference 4-H California Focus in Sacramento. These youth partnered with an Assembly member and several non-profit organizations in the county (such as Next Door Solutions to Domestic Violence) to orchestrate a Domestic Violence assembly at Westmont High School, Campbell, in March 2003. The next assembly will be conducted in Lynbrook High School, in San Jose. The Assembly member's office worked closely with the 4-H members to develop informational flyers and a professional brochure written by teens for teens. One of the 4-H youth works at her office focusing on domestic violence.

Impact: More than 1,000 youth participated in the Domestic Violence assembly at Westmont High. The event was broadcast in local TV news stations. The success of that event and the experience of partnering with youth, motivated Assembly member Cohn and community partners to implement this assembly at all high schools in Santa Clara County.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H

Title: SAN BENITO 4-H YOUTH LEARN LEADERSHIP SKILLS

Description: The 4-H Youth Development Program has identified leadership and citizenship as core skills that all youth must have to be successful and contributing members of society. With the help, guidance and support of adult volunteers, youth can learn skills that enable them to develop positive self esteem and the attributes of integrity, honesty, responsibility and restraint. During the past three years, ANR 4-H Youth Development Staff have worked with the San Benito County 4-H Council, which has assets valued at $1.4 million, to develop strategies that will help and encourage youth to become active participants in their communities and clubs. One strategy has been a mini-grant process, in which 4-H youth identify community needs and then plan projects. They must present their plans and funding requests to the San Benito 4-H Council for consideration. Through this process, they learn the skills of planning, budgeting, goal setting and presentation. The mini-grant program expands the opportunities for local youth to

focus on projects that will improve their communities while developing skills that will be needed as they advance through life.

Impact: Since 2000 when the 4-H Council developed its mini-grant program, 11 youth have completed community service activities with a county wide or community focus, involving younger members in the process. For example:

--A "blanket drive" focused on collecting blankets for the homeless in San Benito County.

This 4-H member cooperated with the San Benito County social services department to collect and deliver the blankets. This community effort taught this 4-H member the life skills of goal setting, communication, responsible citizenship, empathy and sharing.

--For the past three years, 4-H members have conducted canned food drives for the Second Harvest Food Bank. They have also collected toys or donated club funds to the annual Toys for Tots drive coordinated by the Hollister Fire Department. This community effort has taught these 4-H members the life skills of goal setting, communication, responsible citizenship, empathy, cooperation and sharing.

--One Hollister 4-H club has been working annually to improve a community park by planting roses. This year the San Benito 4-H Council contributed $750 to the project, which has taught these members goal-setting, budgeting, planning and organizing, and teamwork.

In all nine 4-H clubs in the county, 35 youth in grades 6-12 have provided leadership to younger members in year-round projects that are planned and completed at the local club level. Each year, 45 youth have served as club officers performing their monthly duties in their clubs. They receive mentoring and training from adult volunteers and other 4-H members who have served as officers.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H

Title: THE DEVELOPMENT OF LEARNING AND COGNITIVE PROCESSING IN CHILDREN

Description: Objectives are: A. To continue with our analysis of relations between attachment and temperament in the sample of children involved in studies to date. B. To assess the interaction of the caregiving system (i.e. parenting, along with attachment and temperament) with the parents of children who have participated in the studies to date. C. To examine the links between attachment, temperament and cognitive development. D. To examine how the links between attachment, temperament and cognitive development influence academic achievement in a variety of contexts. E. To develop educational strategies for children from impoverished developmental environments. A collaborative study with Carol George of Mills College and Malcolm West of the University of Calgary Canada assessing the validity of an adult attachment measure was conducted from March 2003 to September 2003. Another study nearing completion is using the same adult attachment measure to assess the processing of the prefrontal cortex in relation to the viewing of parent-child scenarios of separation and reunion in college students.

Information has been collected from 122 participants to date with data needed on eight more students before completing the study. Another study is looking at differences in the development of the prefrontal cortex, parietal and temporal areas in relation to reading development in 1st, 2nd and 3rd graders.

Impact: The development of learning and cognitive processing in children is greatly impacted by parenting styles. These styles develop in the early attachment relationship and have been shown to be intergenerational. All of the studies in our laboratory are focused on understanding and linking how attachment patterns of parents go on to affect the development of the brain and future cognitive and emotional processing.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H

Title: YOUTH STYLE AND IDENTITY DEVELOPMENT: ARTICULATING CULTURAL AMBIVALENCES AND ANXIETIES

Description: Using appearance style as its analytical focus, this study explores the ways in which youth become both the subjects and the objects of cultural ambivalences and anxieties. It addresses the ways in which dominant culture projects its ambivalences and anxieties about the future onto youth, as well as how and why youth articulate complex and contradictory meanings in their developing expressions of identity. Specific objectives are: 1) to characterize diverse cultural understandings of youth and youth style, as represented in media and other institutional discourses, 2) to compare diverse youth perspectives on style as a medium for expressing overlapping identities (i.e., gender, race, sexuality, class), and 3) to delineate various adult perspectives on youth and youth style. In the last year, a UC researcher has begun to collaborate with a colleague from the University of Illinois on an extensive, multi-method study of the historical and institutional constructions of the 'tween' apparel consumer. Drawing upon trade discourses from the children's clothing industry since the 1940s, interviews of children and views expressed by children's market observers, they have completed a manuscript (in press) that identifies how 'the tween' has been constructed and maintained as an ambiguous, age-delineated marketing and merchandising category. In this paper, they argue that what is now known as 'the tween' cannot be understood apart from its articulation with, the market exigencies of childhood-specifically girlhood-as they have emerged since World War II. The terms 'subteen,' 'preteen', and even 'newteen' had been used between the 1940s and the 1970s to characterize what became reconstructed in the early 1990s as a 'tween' market-semantic space.

Impact: Their analysis reveals that the tween must be understood within a larger history that has produced and reproduced a 'female consuming subject' who has generally been presumed to be white, middle or upper middle class, and heterosexual. The tween girl-both as a biographical person and as a commercial persona constructed through market discourses-resides in an unstable cultural space where ambiguities of social identity invite, even tolerate, polysemous and polyvalent renderings of who 'she' is. They find that the tween girl is both a beneficiary of and is subjected to a 'trickle down' fashion process of increasingly sexualized versions of femininity. Systematic though it may sound, the trickle-down process they describe is fraught with

ambivalence and anxiety. A complex array of mixed emotions regarding gender, sexuality, and age (as well as race, class, and other modes of identity) intersect uneasily as they become embodied and visualized. Through their everyday stylings, and in their interaction with peers and the offerings of marketplace identities, our interviews reveal that girls articulate these cultural ambivalences and anxieties-especially those surrounding female socialization and sexualization. At the same time, popular discourse abounds with concerns about children (especially girls) growing up too fast. Even apparel retailers worry in trade discourse about how to 'keep' girls from jumping to the next age/size category: junior. The solution, it seems, has been to 'downsize' brands (e.g., Abercrombie, Gap Kids, Limited Too) into separate retail spaces that feature accessories, clothes, and music enabling a sense of tween identity. Then, as a girl matures, the idea is that she will graduate to the junior versions of these labels (e.g., Abercrombie & Fitch, Gap, The Limited). Similar concepts apply to downsized versions of fashion magazines (pegged 'baby glossies'). Marketing attempts to construct a clear age category aside, however, our interviews reveal a great deal of ambiguity and anxiety as to just when and how girls should begin to appear as subjects with sexual identities. The principal investigator has established contacts with a number of reporters who aim to reach consumers (i.e., 'tweens,' parents, school teachers) striving to (a) make sense of the current anxieties about girls looking 'too old too soon' and (b) think more critically and creatively about how to shop and dress.

Funding Source: Hatch and State

Scope of Impact: State Specific

SECTION B. STAKEHOLDER INPUT PROCESS

The University of California Division of Agriculture and Natural Resources (UC ANR) continued to use a variety of mechanisms to seek stakeholder input on the development of Division program priorities and use of its research, extension and education funds. In addition, CE advisors delivering programs in 57 California counties receive input on local needs from their local clientele on a daily basis. All of the input received from stakeholders is used by ANR members in program planning and implementation at the local, regional, and statewide level.

ANR Listening Sessions
In January and February, 2004 UC ANR hosted a series of ten Listening Sessions as part of ongoing strategic planning for the Cooperative Extension and Agricultural Experiment Station system in the University of California. Key leaders, partners and members of UC's Division of Agriculture and Natural Resources were invited to participate in one of a series of ten listening sessions as part of ANR's continuing effort to plan the Division's future direction and programs. The experience, vision and insights of these stakeholders are valuable to ANR leaders who listened to their comments to help ensure the success of ANR in the future. ANR administrators, including campus deans and Cooperative Extension regional directors attended to hear stakeholders' thoughts. A total of 240 external and 273 internal stakeholders attended sessions at five locations in the state (San Luis Obispo, Riverside, Redding, Parlier and Davis). ANR administrators listened to stakeholders as they discussed:

- Challenges and opportunities they are facing;
- Expectations they have of ANR in the future;
- Ways ANR can assist them in meeting these challenges and opportunities in the future;
- How ANR should position itself to be most effective in the future.

UC ANR administrators (Vice President, Associate Vice President, Deans, Associate Deans, Regional Directors, and Program Leaders) met immediately following the final Listening Sessions to identify the initial themes that they heard across all the Listening Sessions. From external stakeholders, they heard very strong support for ANR programs, especially those located locally. They voiced considerable concern over the potential loss of these programs. Internal stakeholders expressed widespread concern about ANR’s ability to maintain the excellence of its programs and respond to changing and growing critical needs throughout the state without additional resources. Here are other major themes they heard from stakeholders and their perspectives about what ANR needs to do in the future:

- Confirm ANR’s core mission as a land-grant institution, identify priorities and focus programs on relevant needs of clientele through continued dialogue and a “bottom-up” planning process that includes external stakeholders.
- Improve statewide, campus and county linkages to strengthen the research-outreach continuum through a variety of means, including recognizing and rewarding ANR academics for work relevant to the land-grant mission and contributing to an effective research/outreach continuum, as well as expanding forums for interaction between statewide, county and campus-based ANR academics.

- Maintain a visible and responsive local presence for CE focused on local issues and problem solving. Establish methods by which to encourage campus-based academics to contribute to the resolution to these problems.
- Improve marketing and promotion of ANR – including raising public awareness of the value of ANR and ongoing public relations with state, county, other partners and ANR members to maintain and increase support for AES and CE programming.
- ANR's role as provider of critically needed unbiased science relevant to issues facing California today was highly valued by all clientele representatives from agriculture, natural resources and human services. All sectors advocated for continued, if not expanded, services of this kind.
- Make ANR and campus administrative services more responsive to programs and as efficient and non-duplicative as possible – instill a customer service orientation and culture in all service units.
- ANR leadership must commit to a team effort to provide vision and direction for ANR as well as restore confidence and boost morale of stakeholders. There is a sense of urgency to begin now, recognizing that this is a unique opportunity to transform the organization and recommit to the land-grant mission.
- Create mechanisms for effective statewide coordination of ANR programs and resources – through empowerment of Program Leaders and further strengthening of ANR workgroup system.
- Develop strategies to increase resources through cost recovery, extramural funding and other sources. Engage clientele in the process of identifying and securing new resources. Build and leverage existing and new partnerships with other agencies and external groups.

Program Planning Advisory Committees (PPACs)
These committees are comprised of forty-five Division members representative of the diversity of UC ANR disciplines and program areas, from all Division-affiliated campuses and from county offices throughout the state. Fifteen individuals serve on each of three subject area committees, Agricultural Resources, Human Resources and Natural Resources.

The PPACs are charged with recommending Division-wide program priorities by identifying Critical Issues facing California that the Division can address and Target Issues, those Critical Issues where additional Division resources are most needed to address the problem. The three year planning cycle includes an "environmental scan" of stakeholders to determine the Critical Issues; assessment of current Division capabilities and resource commitments to the Critical Issues, and program evaluation to determine how effectively the Division has been able to address the Critical Issues.

During the fall of 2003, PPAC members took the results of their "environmental scans," surveys of external and internal stakeholders and used the input to make an initial list of critical issues. Both ANR members and external stakeholders were then given the opportunity to comment on the draft lists and to indicate their top priorities. This information was then used by each PPAC to finalize the list of ANR Critical Issues for use in programmatic decision making by ANR leadership and individual members. The final report, *ANR Critical Issues*, was submitted to ANR administration in December 2003.

During 2004, ANR's Program Council (systemwide, campus and regional administrators) further refined the PPAC Critical Issues into 21 Core Issues, issues of greatest relevance and importance to California and appropriate for ANR's mission. These were announced in September, 2004.

UC ANR Workgroups

Division program workgroups are a primary mechanism for accomplishing ANR's high priority research and extension goals through grassroots leadership. They bring together Agricultural Experiment Station (AES) and Cooperative Extension (CE) personnel along with non-ANR partners to work on emerging and continuing priority issues in Division program areas. Non-ANR participants are identified by the scientists, advisors and specialists working in the specific program area and invited to participate in workgroup activities, including needs assessment and issue identification and evaluation and reporting of program results. The involvement of external stakeholders in the workgroups ensures that real world needs are brought to the attention of University scientists and extension specialists and advisors as programs are planned and implemented. There were 81 Divisionwide workgroups with a total membership of over 3500. These workgroups involved nearly 600 external stakeholders in their program planning process and workgroup activities and projects. External stakeholders on the workgroups include individual producers, representatives from local community groups, state and federal agencies, industry groups, consumer groups, and colleagues from other higher education institutions.

UC ANR Coordinating Conferences.

Coordinating conferences bring together department Agricultural Experiment Station (AES) faculty and Cooperative Extension (CE) specialists, CE advisors, and selected clientele into a Divisionwide forum to promote effective communication and interaction among the members and to promote statewide programmatic coordination of research and outreach activities relating to a major subject matter or commodity area. The nine coordinating conferences:

- Foster interactions, communication, and collaboration across traditional inter-campus, interdisciplinary and inter-departmental boundaries, and among campus and county-based academic staff.
- Create a more visible and active focal point - both within and outside the University - for research and outreach activities.
- Facilitate the formation and activities of appropriate workgroups addressing targeted areas within the overall programmatic area.
- Provide leadership for addressing crosscutting issues.

The California Communities Coordinating Conference in 2004, "Making A Difference in Communities: Bridging Research and Community Agendas through a Participatory Research Approach," is an example of how the coordinating conferences brought together both UC ANR and external stakeholders to share information and identify program needs. The purpose of the conference was to demonstrate how participation of community members in the research process can enhance the quality of scholarship, lead to a greater appreciation of research within the

community, and increase the likelihood that scholarship will result in tangible community improvements. The aim of this 2-day workshop was to explore how adopting a participatory research approach can make research more responsive to community needs and aspirations. Using case presentations to identify relevant skills, the colloquium explored strategies and techniques for involving the community in setting the research agenda, participating in data collection, and interpreting the meaning of collected data. In kind-support for the conference was provided by the Pacific West Community Forestry Center and Forest Community Research. Attendance was 67 including 22 ANR and 55 non-ANR. The colloquium is one of the few venues that brings together participants from across ANR program areas and mixes them with representatives of communities and community-based organizations.

Evaluations were quite positive. Sample comments include: "I liked the opportunity to learn and share experiences on the topic of participatory research. All of the presenters were excellent. It was great to hear from our colleagues from Mexico." "The dynamics were great. The workshop was organized in such a way that everyone had a chance to express their needs and interact with the presenters." "I liked the diversity of participants, both those with experience in participatory work and those in attendance who are exploring the topic. What makes the diversity an asset is when there is interaction and sharing between diverse perspectives and engagement in areas that make differences." "… I also think that the workshop addressed some key issues and brought together a wide diversity of people to share ideas." "It was great hearing about the realities of participatory research - both how it made the project much more
effective, and the messiness of the process. I found this conference to be very inspiring, and I came away with a lot of ideas and practical suggestions. It was time well spent."

Formal advisory groups

The President of the University chairs the President's Advisory Commission on Agriculture and Natural Resources to identify the education needs of California's agricultural, natural and human resources interests and advise him on how the University can best meet these needs through its science-based research, classroom instruction and educational outreach. The members represent 28 business, consumer, youth and government leaders from throughout California and meet twice a year to provide input. The Vice President - Agriculture and Natural Resources participates as a member of this Commission and brings the Commission's advice to the Executive Council, the Division's administrative group charged with Divisionwide strategic planning.

Each of the three colleges at Berkeley, Davis and Riverside and the School of Veterinary Medicine at Davis, have external stakeholder advisory councils that meet at least annually to provide feedback on their research, extension, and teaching programs. Members of these councils represent the spectrum of clientele who use the Division's programs and who have expressed interest in providing input to the college/school planning efforts.

Several of the Statewide Special Projects and Programs have external Advisory Councils that meet at least annually to review progress and offer recommendations for future program direction.

Commodity Organizations/Marketing Order Boards
Members of these organizations provide annual input on research and extension needs for their commodities to UC ANR members through regular meetings and discussion of funding for research projects. These individual groups also come together on an annual basis to form the California Commodity Commission. This Commission meets with the Vice President and offers specific recommendations on program planning and funding issues.

SECTION C. PROGRAM REVIEW PROCESS

There has been no significant changes to the California program review processes since the UC Plan of Work Update, submitted in July 2000.

SECTION D. EVALUATION OF SUCCESS OF MULTI AND JOINT ACTIVITIES

(1) Did the planned programs address the critical issues of strategic importance, including those identified by the stakeholders?

California's research and extension professionals planned and delivered programs that addressed the critical issues facing the state in the areas of agriculture, natural resources and human resources by pooling the expertise of California AES and CE academics, by collaborating with colleagues in other institutions, agencies, and states, and by consulting and working with the external stakeholders. As described in the Planned Programs narratives in Section A, University of California research and extension programs addressed critical issues facing the state such as invasive pests, water quality and water distribution, and food security.

Below are a few examples of UC research and extension programs addressing the critical issues identified by California stakeholders:

Theme: 2.03 Food Quality
Title: BEEF QUALITY ASSURANCE PROGRAM
Description: There is growing concern among consumers about the quality and safety of the beef they consume. The 2000 National Beef Quality Audit listed the top concerns/desires of consumers as concerns about bacterial contamination and antibiotic residues; desire for "traceback" information, "natural" beef and organic beef; and concerns about animal welfare and the environment. In response, the National Cattlemen's Beef Association (NCBA) has set a series of industry goals to be achieved by 2005. One of the most important of those goals is 100% Beef Quality Assurance (BQA) training for beef producers. The mission of the Beef Quality Assurance program is to maximize consumer confidence in and acceptance of beef by focusing the industry's attention on beef quality through the use of science, research and education. For the past 11 years, a team of UCCE advisors and specialists and Experiment Station scientists (Beef Safety and Quality Assurance Workgroup) has been working to achieve the industry's listed goals. They developed a Beef Quality Assurance curriculum in addition to conducting research and presenting educational training through workshops, seminars and field days. In Mendocino and Lake Counties, a UCCE livestock and natural resources advisor conducted a total of eight beginning and advanced Beef Quality Assurance workshops and field days on such topics as Cattle Residue and Contamination Avoidance and Reproductive Efficiency in Beef Cattle. In addition, a special multi-state program on the Cow-calf Producer Manual was delivered, insuring that producers received the best technical manual available.
Impact: In Lake and Mendocino Counties, 426 ranchers are certified as having completed the eight beginning and advanced Beef Quality Assurance programs (100% participation). Of the 115 producers attending a recent field day on vaccination technique in the Covelo area, 70% indicated that they had been giving injections improperly or not disposing of biologicals or medical waste safely, and that they would change their procedures and keep better records. Training in chute inspection and passive handling techniques have significantly reduced carcass bruising and improved animal welfare. Many producers are marketing cattle as meeting beef quality assurance guidelines. Four cattle ranchers in Mendocino are now producing certified organic beef.
Funding Source: Smith-Lever, Hatch and State
Scope of Impact: State specific

Theme: 1.11 Biotechnology
Title: ENGINEERING CROPS RESISTANT TO ABIOTIC AND BIOTIC STRESS WITH IMPROVED GROWTH AND ENHANCED QUALITY
Description: The aim of this research is the molecular characterization the network required for the adaptation of crops to environmental stress. The objectives are to engineer salt tolerant crop plants; to characterize the cellular network required for the activation of the many adaptive responses of plants, in particular protein modules; and to characterize and identify the gene network that determines fruit quality traits. The researchers have developed transgenic plants that are able to grow, set fruit and seed at a concentration of 200 mM NaCl (equivalent to 40 percent of the salt concentration in sea water). The results also showed that transgenic plants accumulated sodium in their leaves but not in the fruits and that the agronomical attributes of the transgenic fruits and seeds were comparable to those of the wild type plants. Field trials are being initiated in order to test the ability of the salt-tolerant transgenic plants to grow under field conditions They have identified and characterized a T-DNA insertion knockout mutant of the vacuolar sodium/proton antiporter in Arabidopsis thaliana and used these mutant lines and also lines overexpressing the antiporter to analyze global gene expression under salt stress using DNA arrays citrus fruits proteome. The aim is to identify gene networks associated that could serve to developed cDNA markers (derived from EST) to assist the selection of quality traits.
Impact: The development of salt tolerant crops will have a significant impact in California's economy. These crops will allow the development of sustainable agriculture using marginal lands and lower quality waters. The efforts aimed at the characterization of gene networks associated with fruit quality traits will serve to improve fruit quality.
Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.20 Managing Change in Agriculture
Title: CHERIMOYA RESEARCH BENEFITS RARE FRUIT INDUSTRY
Description: In the early 1980s, almost no one in North America had heard of the lumpy fruit with white flesh known as the cherimoya. But Americans were yearning for new and exotic flavors. For many of California's rare fruit growers, the cherimoya, which had been introduced almost 100 years earlier, seemed like a natural solution. The fledgling California cherimoya industry faced a number of challenges. Growers recognized that the different cherimoya varieties, propagated by bud grafts, had different properties. The puzzle came from the fact that the different varieties are difficult to tell apart--impossible when not bearing fruit. Collections of marked trees had all but disappeared from Southern California. University of California, Riverside faculty decided to use cherimoyas for their research, which used molecular genetic markers known as allozymes. Cherimoyas were amenable for allozyme analysis for almost two dozen genes, with every different variety having its own allozyme "fingerprint." They found that almost any plant tissue could be genotyped, including leaves. Thus, a fruit-free method for identifying the genotypes had been established. Fortunately, the University of California had saved its cherimoya variety collection at the South Coast Research Station. Researchers used , the collection of marked trees as a control for research so names could be assigned to allozyme genotypes. By the late 1980s, they had identified 25 varieties. Nurseries and growers were now able to identify their trees and compare varietal performance in different locations and under different growing conditions.

Impact: California, the U.S. state producing the vast majority of domestic cherimoyas, now sells an estimated 4 million pounds of the crop each year. The work of UC researchers was critical in converting cherimoya growing from a hobby to a viable commercial enterprise because it provided the means to develop reliable data about which varieties would perform well for particular areas and conditions, said Rob Brokaw of Brokaw Nursery Inc.
Funding Source: Smith-Lever, Hatch, and State
Scope of Impact: State Specific

Theme: 1.22 Niche Market
Title: GRASS FED BEEF, A WAY TO PRESERVE OPEN SPACE IN CALIFORNIA
Description: A large part of California's open space and wildlife habitat is provided by ranchers, whose yearly return on their investment ranges from 3% down to minus 4%. In addition to this economic squeeze, increasing urban encroachment is limiting the sustainability of these open spaces. Marketing grass-fattened beef directly to the consumer could provide both a higher return to ranchers and a product that has many health advantages for consumers. In 1996, a California CE Advisor and Specialist teamed up with California state university researchers to research the feasibility and logistics of grass-fed beef operations in California. The culmination of this work was a 77-page publication including four cost studies, a sample business plan, consumer surveys and legal requirements. After the first 200 copies were quickly taken, the decision was made to publish the information on the UC Sustainable Ag website. An Advisor organized producers in Marin County to focus on working together to produce grass-fed beef. An advisor in Placer-Nevada and a USDA Resource Conservation and Development Area Specialist started a study of niche marketing of beef for six counties in Northern California. They joined with the UC Center for Cooperatives to organize a highly successful two-day course, "Niche Marketing of Meat", attended by 105 people. The information has also been distributed in other educational meetings and on the Web.
Impact: UCCE has led the development of California's grass-fed beef industry by organizing key information and presenting it to audiences that can use it. The project has assisted more than 40 California ranchers in starting a new business to increase their incomes, thus bettering their chances of staying in business and not having to sell their land to developers.
Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 1.23 Organic Agriculture
Title: FARMING WITH NATURE: ORGANIC WINEGROWING IN MENDOCINO COUNTY
Description: Since the early 1990s, Mendocino winegrowers have been converting large acreages to organic farming. Impressed by early experiments in other crops such as vegetables, they worked to improve their land, their fruit quality and their image in the market. However, concerns about soil fertility, disease and pest control and costs made growers cautious in their initial efforts. Collaborative research by UCCE, UC scientists and local growers has provided essential information on virtually all aspects of organic winegrowing:

--Covercrop studies have resulted in many vineyard floor management options that help growers protect their soils from erosion, improve fertility, create beneficial insect habitat and compete against troublesome weeds.

--Benefits of creating beneficial insect habitat with "insectary plantings" of prune trees, as well as ornamental plants that attract natural pests of grape leafhoppers and mites, have been demonstrated.
--Modern canopy management techniques developed by UC have been demonstrated and widely adopted by growers.
--The use of electronic weather monitoring equipment for predicting powdery mildew was perfected in Mendocino County, helping growers to pinpoint when to apply precise applications of sulfur dust and other environmentally friendly fungicides.
--Farming costs have been documented by UC agricultural economists and published as cost sheets, allowing growers to plan budgets for organic winegrowing based on accurate information.

Impact: Mendocino County is now the world leader in organic winegrowing, with over 3,500 certified acres of organically-farmed wine grapes. Winegrowers have greatly reduced their pesticide usage, with most applying only sulfur dust or spray to control powdery mildew. Cover crops are planted in over 70% of the county's vineyards and cover cropping techniques developed in Mendocino County are now widely used in California. Wine grape quality has actually improved as growers have taken better care of their vineyard soils. Mendocino County has one of the largest electronic weather networks in the state, with over 80 stations. Growers now routinely use electronic weather monitoring as part of their pest management decision-making. Many growers no longer spray insecticides, relying instead on beneficial insects that live in cover crops and insectary plantings. Nearly all growers use improved canopy management techniques that improve the overall health of the vines, making them less susceptible to insect and disease attack. This environmentally friendly farming system is also very cost-effective. Wine quality has improved in many instances, and organically farmed vineyards are safer places for workers, beneficial insects, birds and wildlife.
Funding Source: Smith-Lever
Scope of Impact: State Specific

Theme: 2.06 Food Safety
Title: ASSURING FRUIT AND VEGETABLE PRODUCT QUALITY AND SAFETY THROUGH THE HANDLING AND MARKETING CHAIN
Description: Increases in pathogen outbreaks associated with fresh produce over the last 10 years have demonstrated the need for on-site screening systems to ensure that uncooked foods are safe for consumption. Researchers are working to develop, evaluate, and apply rapid non-destructive sensing technologies to assure food safety, including bio-security, purity, and integrity of produce. The objectives of this research were to (1) develop real-time PCR assays for the detection of Salmonella enterica and pathogenic E. coli, (2) design a flow-through PCR biosensor, and (3) design a system for collection and concentration of bacteria in water samples.
Impact: A real-time automated biosensor suitable for detection of bacterial pathogens could significantly enhance food safety.
Funding Source: Hatch Multistate Research and State
Scope of Impact: CA, GA, HI, IN, MD, ME, MI, NC, NYC, NYG, PA, WA

Theme: 2.06 Food Safety
Title: LOWERING FOOD ALLERGIES

Description: Common staples like cereal grains and milk provide critical sources of nutrition for many people, but can cause problems for people with food allergies. A food allergy is an abnormal response to a food triggered by the immune system and it can result in diarrhea, vomiting and in the worst cases is life-threatening. Two foods that cause allergies in children, milk and wheat, do so because certain of their proteins are held together tightly with chemical "bungee cords" and are not digested. The allergens then interact with target cells in the small intestine, causing an allergic response. Scientists at UC Berkeley demonstrated that a specific protein present in all living cells, thioredoxin (TRX), can break the chemical "bungee cords" that are often responsible for allergenicity. Using biotechnology, they wheat grains with higher levels of TRX, causing the chemical bonds of some of the allergenic proteins to relax. In preliminary experiments, dogs-- the closest model to humans in their allergic responses-- exhibited less sensitivity to milk treated with TRX and to the modified, high-TRX wheat grain compared to standard wheat. This demonstrates that the approach can be used to reduce food allergenicity.
Impact: Researchers have demonstrated a method that could be adopted by industry to lower food allergies in common staple foods. Such an approach could provide a specialized market for certain foods and improve food safety for the nearly 4 million people in the U.S. who suffer from food allergies.
Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 3.02 Human Health
Title: HELPING CLINICAL LABORATORIES STANDARDIZE FARMWORKER TESTS
Description: Growers are required to test the blood of pesticide mixer loaders, applicators and others who contact organophosphate (OP) and organocarbamate (CB) pesticides -- such as diazinon and carbofuran -- in the workplace. A UC researcher, his students and colleagues showed that tests used by California clinical laboratories often were not optimal and that results were not comparable from laboratory to laboratory. This led to a change in state regulations requiring that mandatory tests be consistent and conversion factors be generated. He worked with Cal EPA Department of Pesticide Regulation researchers,to help clinical laboratories improve and standardize their blood cholinesterase measurements -- the blood enzymes used to detect exposure to the OP and CB pesticides. The team developed a bovine red blood cell enzyme standard using cow blood from the Department of Animal Science; they also devised an optimal assay procedure. The UC researcher's laboratory served as the benchmark in comparing blood test results with participating clinical laboratories.
Impact: The studies with clinical laboratories are standardizing results from many laboratories, offering growers and workers in the agricultural workplace more accurate tests to provide for their safety, and helping to keep California in the forefront of producing safe and nutritious food for the consumer.
Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 3.03 Human Nutrition
Title: OBESE FEMALE RESTRAINED EATERS: TWO TREATMENT OPTIONS
Description: The specific aim of this project was to improve the psychological health and well-being of obese female restrained eaters through a non-restrictive ("non-diet") approach. This

non-diet approach emphasized eating in response to physiological cues (i.e., using hunger and satiety as regulators of food intake) and enhancing body acceptance. The non-diet approach was compared to a standard behavioral obesity treatment program (control group) which emphasized reducing energy intake and weight loss. The hypothesis was that on a long term basis (12 months, 18 months), improvements in self-esteem, depression, body image and more general psychological characteristics would be greater in the non-diet group compared to the weight loss group. These results were anticipated because restrained eaters are unlikely to maintain the weight loss (45), and previous studies suggest that improvements in individuals participating in traditional weight loss programs are predicated upon lost weight (95). Additionally, the non-diet group received treatment directly aimed at enhancing psychological well-being, independent of attempts at weight loss. In contrast, it was anticipated that early in treatment (3 months), improvements would be greater in the weight loss group compared to the non-diet group. It was anticipated that these early treatment results because participants in weight loss groups typically lose weight early in treatment, which is associated with increased psychological health and well-being. It was not anticipated that non-diet participants will lose as much weight, as they will be instructed not to actively restrict intake. At the same time, metabolic fitness was monitored in both treatment groups. This helped provide information about changes in risk factors such as blood pressure, lipoproteins (total cholesterol, very low density lipoprotein-triglycerides, low density lipoprotein cholesterol, high density lipoprotein cholesterol), markers of insulin sensitivity (glucose, insulin, hemoglobin A1C), percent body fat and intraabdominal fat. Finally, information was collected about physical activity (amount of physical activity, resting heart rate, and indirect measures of daily metabolic rate) and eating behavior (quality of diet and degree of restrictive eating, leptin levels). Two year follow-up was conducted and analyzed. Results showed that cognitive restraint increased in the Diet Group and decreased in the HAES Group, indicating that both groups implemented their programs. Attrition was high in the Diet Group (41%), compared to 8% in the Non-Diet Group. The Diet Group showed initial improvement in many variables, including weight, low-density lipoprotein, systolic blood pressure, energy expenditure, Hunger, Disinhibition, Bulimia, Body Dissatisfaction, Interoceptive Awareness (markers for eating disorders), depression and self-esteem, although only the improvement in Disinhibition was sustained at two year follow-up. The HAES group, on the other hand, improved in all of the above variables except weight, which exhibited no change, and sustained these improvements at two years.

Impact: Increasingly more of us are trying to lose weight. Indeed, many women, regardless of their size, experience a life-long battle and preoccupation with their weight. Despite the attention to weight and the increase in diet behavior, the incidence of obesity continues to rise. There is little data to show improved long term success for the majority of participants who engage in weight loss behaviors. This study documented that HAES, an alternative approach to obesity treatment, enabled participants to maintain long-term behavior and health change, while the Diet approach did not. It provides evidence that encouraging size acceptance, a reduction in dieting, and a heightened awareness of and response to body signals is effective in supporting improved health for obese women.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 3.03 Human Nutrition

Title: PROJECT LEAN (LEADERS ENCOURAGING ACTIVITY AND NUTRITION)

Description: Healthy eating and regular physical activity have a positive impact on some of the most important factors of teen life: learning, feeling and looking good, energy level and motivation, and the risk of chronic diseases like obesity, heart disease and diabetes. At a time in their life when teens begin making independent choices about what they eat and how active they are, they may have limited opportunities to choose healthy food and engage in physical activity. This is particularly true in their school environment. Project LEAN trained teen advocates for healthy school policies about food and physical activity choices. With school and community partners, the teen advocates have conducted school assessments and worked toward policy changes. UC advisors worked with student groups in several Central Valley communities, including Firebaugh, Fresno, and Mendota in Fresno County, and Woodlake and Farmersville in Tulare County. The districts' student enrollment ranged from 2,500 to 70,000. The Project LEAN staff also worked with a community coalition to support the work of a local school district to adopt a district-wide Healthy School Environment policy. The goal of this policy was to enhance a school's learning environment by providing access to good food options, physical activity, and nutrition education for lifelong health.
Impact: The significant Project LEAN successes included: school food policy change from 1% milk in three school districts, fresh salads and salad bars added to student cafeteria options in two districts; additional water and juice options available in soda machines in two districts. Successes in Woodlake Unified School District (WUSD) include: a 1% milk vending machine placed on Woodlake High School's campus, carrying flavored and non-flavored milk. (The profits from the sale of milk belong to the Future Farmers of America chapter on campus.) During the 2003-2004 school year, Woodlake Unified School District applied for and received a universal "Breakfast in the Classroom" grant that feeds breakfast to all students from kindergarten through 5th grade. In addition, WUSD Food Service has introduced a "100% Fruit Smoothie" to the snack bar (seasonal), and no longer purchases candy for sale on campuses district wide as of February, 2004.
Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 4.01 Agricultural Waste Management
Title: CE HELPS TO SOLVE DISPOSAL PROBLEM IN ERADICATING EXOTIC NEWCASTLE DISEASE.
Description: In October 2002, a devastating foreign animal disease was discovered in several small flocks of chickens in Southern California. By December, Exotic Newcastle Disease had spread to large commercial flocks of egg-laying chickens. To eradicate the disease, over 3.5 million chickens had to be euthanized and disposed of. Sending the dead birds to landfills was the safest and most feasible option for disposal. At the time, covering the carcasses with several feet of compacted soil was the only accepted method of disposal. However, not enough soil was available at the landfills to dispose of so many carcasses in that way. Some other method of burial had to be developed. A UCCE poultry farm advisor, worked with the Riverside County Waste Management Department and the private company operating the landfill to develop a biosecure and rapid method of covering the carcasses with 12 feet of trash that could be compacted to form a three-foot cover, thus reducing the need for additional soil. Each delivery of carcasses could be completely covered within 10 minutes with an impervious layer of compacted trash that would prevent access by sea gulls and other scavengers that could spread Exotic Newcastle Disease. A videotape of the disposal procedure was developed and presented

to the CDFA and the USDA for their approval of the disposal method. The video was then used as a guide to train other landfill operators in Southern California who received birds from infected flocks. This video has now been widely distributed throughout the United States.
Impact: The disposal method provided an environmentally safe and effective approach to the disposal of infected birds. This method, approved by USDA, enabled landfills to continue receiving carcasses throughout the effort to eradicate Exotic Newcastle Disease in California. This method assisted in reducing the spread of Exotic Newcastle Disease, thus assisting growers, while not filling up landfills unnecessarily.
Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 4.02 Air Quality
Title: REVEGETATION CONTROLS DUST IN ANTELOPE VALLEY
Description: A long drought in the 1980s had reduced vegetation cover in Antelope Valley in the western Mojave Desert. Dust storms had wiped out crops and forced farmers to reseed fields repeatedly. Suspended soil had blown into Lancaster, Palmdale and surrounding rural areas, causing unhealthy levels of airborne particulate matter. Reduced visibility had caused traffic accidents and disrupted operations at military facilities. Exacerbating matters, wind erosion had increased the barren areas. Beginning in early 1992, a collaborative effort of UC Cooperative Extension (UCCE), USDA Soil Conservation Service (now Natural Resources Conservation Service), the Los Angeles County Fire Department, the Antelope Valley Resource Conservation District and local air pollution districts instituted a massive revegetation campaign. Seeds were flown in by fire department helicopters and planted on 2,500 acres by local contractors. Throughout the 1990s, UCCE conducted plant density measurements to identify the most successful native shrub species. UCCE planted replicated trials of alternative revegetation practices to determine optimal seeding and transplanting techniques and to identify ways to reduce revegetation costs. Combination strategies of revegetation and wind-fencing were developed, and UCCE measurements validated their ability to suppress dust emissions.
Impact: The 300,000 or so residents of the area obtained more healthful air to breathe, farmers experienced fewer problems, and dust-related traffic accidents declined. Maximum daily particulate matter concentrations in Lancaster declined from 780 micrograms per cubic meter of air in 1991 to an average of 75.6 during the next 10 years, with many fewer instances in which state and federal air quality standards were exceeded. Drought conditions returned in the mid-1990s, but the revegetation held the soil in place.
Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: ALTERNATIVES TO METHYL BROMIDE FUMIGATION OF SOIL FOR STRAWBERRY
Description: A field experiment on chemical alternatives to methyl bromide was repeated in 2002-03 near Watsonville, CA. Selected beds were fumigated with shank-applied methyl bromide/ chloropicrin (MBC, 67/33) at 325 lb/a (rates per unit treated bed area) and covered with standard black polyethylene mulch or black virtually impermeable plastic film (VIF). The use of VIF plastic as compared to standard plastic improved the control of buried inoculum of Verticillium dahliae significantly where chloropicrin or InLine was used. The effects of

fumigation treatments on berry yields varied with the time of harvest and variety. All the chemical fumigation treatments more than doubled total yields and the effects of the various chemical treatments on the yields of Camino Real, Aromas, and Diamante, were generally similar. Bacterial growth promotion of strawberry following inoculation of bare-root transplants in the field was variable and depended on soil background treatment, strawberry variety and isolate. In nontreated soil, none of the bacteria decreased yield and 2-3 isolates increased yields of both Aromas and Camarosa slightly. While only one isolate increased yield of Camarosa in MBC- or metam sodium-treated soils, several isolates did so in chloropicrin-treated soil (200 lb/a). A marked stain of one bacterial isolate used was found to colonize strawberry roots at high populations for at least 6 months after inoculation.
Impact: California produces over 80% of the nation's strawberries and nearly 1 billion strawberry runner plants each year. The California strawberry industry relies heavily on methyl bromide fumigation of soil to control soil borne plant pathogens and obtain profitable yields in high-cost production systems. This research project is further identifying and optimizing some chemical and non-chemical alternatives to methyl bromide for strawberry production.
Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: ENHANCING POSTHARVEST QUALITY OF FRUITS WITH REDUCED DEPENDENCE ON CHEMICAL TREATMENTS
Description: The deadline for the phase out of methyl bromide is in January 2005. Alternative methods of postharvest insect control are needed for stored products such as walnuts and almonds to prevent excessive product damage in storage and to prevent loss of critical export markets. The objectives of this project were to develop effective, nonchemical alternatives for decay control using heat, controlled atmospheres, and biological control; develop effective, nonchemical insect quarantine treatments using various methods of heat treatments and controlled atmospheres as alternatives to methyl bromide fumigation; and develop methods to control postharvest insects and disease using safer chemistries. Researchers continued developing radio frequency heating treatments as a non-chemical method to control insects in harvested produce. These treatments have the potential to be rapid (up to 5 minutes), on-line processes providing for insect control and maintaining product quality. These alternative treatments are essential to replace methyl bromide fumigation and to maintain the existing export markets for US crops. Treatment of in-shell walnuts is particularly promising. Nuts can be heated in as little as 3 minutes and all species and life stages of critical concern are controlled while nut quality is maintained and perhaps improved. This season hot air was combined with radio frequency heating and investigated the potential to use radio frequency heating on washed in-shell walnuts to accomplish re-drying and insect control in one treatment. Researchers also explored radio frequency heating for sweet cherries. This was a more challenging treatment because of issues with stem browning and reduced shelf life of the cherries. They have concluded that radio frequency heating shows little potential for use on sweet cherries. They are also exploring the use of surfactants to control surface insects on produce. This work looks very promising to completely control or greatly reduce surface insects on produce that can cause problems during the export of these crops.

Impact: A nonchemical alternative is attractive to consumers in the US and abroad. Radio frequency heating would be a new tool for postharvest insect control and quarantine treatments for organic products where tools are currently unavailable or limited.
Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: IPM PROGRAMS FOR CELERY, TOMATOES AID GROWERS, AND THE PUBLIC
Description: North American vegetable growers face a compelling need to reduce pesticide use for several reasons, including the decrease in available and effective pesticides due to the development of resistance in pests and to increasingly restrictive state and federal legislation. A UC researcher at UC Riverside has led research on novel, low-input pest management strategies that have greatly reduced the use of toxic class-one and class-two pesticides by California celery and tomato growers. His research provided substantial background information needed to develop and implement new IPM programs. This information included new and effective monitoring techniques; an understanding of plant compensation for insect herbivory, which will affect plant growth, chemistry, physiology, and photosynthesis; and determination of economic thresholds.
Impact: Pesticide use in California for tomatoes and celery has decreased by more than 50 percent in the past eight years alone due to the development and implementation of new IPM programs. Aside from obvious economic benefits, which drive the acceptance of the programs, other significant benefits have accrued. Major advantages include a reduction in the potential for environmental contamination and pesticide poisonings and related health concerns for farmworkers, the virtual elimination of the development of pesticide resistance in key pest species, and a potential reduction in the consumption of fossil fuels used in pesticide applications. In response to pest management programs developed at UCR, the California Tomato Commission voted to move as an industry toward IPM strategies. A similar commitment has been made by the California Celery Board, representing growers with more than 70 percent of the U.S. production of celery.
Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: MANAGEMENT OF FORAGE QUALITY IN STRIP-CUT ALFALFA
Description: Lygus bugs prefer alfalfa to many other crops, but don't damage it. Alfalfa can sustain high populations of lygus, but when the fields are cut every month the pest moves into neighboring susceptible crops. Retaining lygus populations in alfalfa fields is the centerpiece of a promising regional pest management strategy. This involves leaving strips of uncut alfalfa, which act as a temporary habitat for lygus bugs, thus limiting their movement out of the field. The method works well, but growers are concerned about the effect that the strips of more mature alfalfa have on hay quality and marketability. A strip cutting trial has been conducted for the past three years. At each of three cuttings during each production season, hay bales were produced with various mixtures of old and new growth alfalfa, ranging from no old growth to 100%. Bale compositions were created during swathing and raking. Chemical analysis as well as visual inspection detected reduced quality of bales containing 14%, 25% or 50% old hay. However, bales containing only 7% old hay were similar in quality and appearance to bales with

100% new hay. When quality is lower, the hay value is less and the markets may be limited. For example, dairy hay must meet a very high standard of quality. Blended hay with more than 7% old hay would not be acceptable to this market, but could be used in the beef or horse markets.
Impact: Forty-five percent of cotton growers surveyed said they use strip or block cutting of alfalfa as part of their pest management program. Using the information developed by UCCE, they can now make informed decisions how to manage the hay in the uncut strips. They may choose to blend it with the new growth and handle the lot as a single unit, or they may segregate out the bales containing the old hay. By having a much better idea of the reduced quality that will result from blending old hay with the new, growers may be more willing to use this strategy to limit lygus migration from alfalfa hay fields.
Funding Source: Smith-Lever, Hatch, and State
Scope of Impact: CA, AZ

Theme: 4.12 Integrated Pest Management
Title: OUTBREAK OF NEW DISEASE AFFECTS ALMOND ORCHARDS STATEWIDE
Description: During wet years in the 1990s a new and unknown plant disease, later identified as an anthracnose fungus, occurred throughout most of California's almond growing region. It destroyed flowers and developing nuts, producing toxins that killed almond tree branches up to two inches in diameter. Losses continued throughout the season whenever rains occurred. Growers were at a complete loss for control of this disease and believed they might have to remove the affected orchards. Processors also were concerned because nuts infected near harvest could have internal discoloration that was difficult to detect and reduced product quality. A UCCE farm advisor recognized the problem as a new disease on almond trees and a plant pathologist at UC Riverside succeeded in identifying the pathogen as the fungus Colletotrichum acutatum. UCCE, UCR researchers and the almond industry then established a partnership to determine the disease life cycle and develop control strategies. Since most registered fungicides had no effect on the disease, initial field work focused on identifying materials that could begin to control anthracnose on almonds. These trials led to the eventual registration of four new fungicides that were effective and also more selective and environmentally friendly. Potential resistance to the fungicides was managed by rotating use of materials. Meanwhile, research to identify susceptibility of almond varieties indicated where efforts were most needed to help control the problem, and which varieties growers might choose to plant in new orchards. Other field trials confirmed that sprinkler irrigation contacting the tree canopy increased disease pressure. The irrigation industry developed new sprinklers with lower trajectories and growers modified their sprinkler systems. UCCE also determined that the fungus over-winters in dead wood where infected nuts had been the previous year. Field trials confirmed that meticulous pruning to remove the dead infected wood is essential. As these results unfolded, the UC research pathologists and UCCE farm advisors have communicated their findings at numerous local meetings, in newsletters, in trade journals and at the statewide Almond Industry Research Conferences. Work continues to investigate additional fungicides and to develop a disease-forecasting model that will result in still more effective control with fewer sprays.
Impact: This comprehensive program involving cultural controls and fungicide rotation has led to adoption of effective management strategies by almond growers. Through UCCE's work, the almond industry now knows how to handle this problem and substantial crop loss has been prevented. Returns to growers have improved and production of top quality almonds for the

consumer is the end result, with a reduction in pesticide use due to partial use of cultural controls.
Funding Source: Smith-Lever, Hatch, and State

Theme: 4.14 Natural Resources Management
Title: MICROIRRIGATION TECHNOLOGIES FOR PROTECTION OF NATURAL RESOURCES AND OPTIMUM PRODUCTION
Description: The objective of this project was to evaluate and refine microirrigation management strategies to promote natural resource protection and optimal crop production; to assess and develop decision criteria for adoption of microirrigation technologies; and to promote appropriate microirrigation technologies through formal and informal educational activities. In many locations across California, grower demonstration dried plum (prune) orchards are being managed using a Regulated Deficit Irrigation (RDI) regime developed as part of this research project. The current RDI recommendation in prunes is based on allowing mild to moderate deficits in stem water potential (SWP) over the season, allowing SWP to reach -15 bar by harvest. Three northern California sites (Tehama, Butte and Yolo counties) which have been using this RDI regime for the past 2-3 years were selected for a detailed irrigation study. The uniformity of the microirrigation systems at these sites were evaluated, and plots were instrumented to accurately record the amount of water being applied under RDI. The applied water averaged 18.6 inches for the three sites in 2003, compared to an average calculated crop water demand of 41.6 inches, with yields and fruit quality at or above normal yields for these growing areas.
Impact: Compared to the calculated crop water demand, the range in water savings documented in this study was 49% to 80%, with an average of 56%. Compared to the currently recommended levels of irrigation for prune, the substantial water savings observed will accrue to the great benefit to the states' water supply as more prune growers adopt midday SWP for the management of RDI.
Funding Source: Hatch Multistate Research and State
Scope of Impact: AZ, CA, FL, GU, HI, ID, IA, KS, MN, NM, TX, VA, WA, WY, VI

Theme: 4.14 Natural Resources Management
Title: TEN YEARS OF WATERSHED RESTORATION IN THE GOOSE LAKE BASIN
Description: When Goose Lake went dry in 1992, threatening fish habitat in the Goose Lake Basin of California and Oregon, a unique bi-state working group was formed to protect and reestablish native fishes in the Basin. The Goose Lake Fishes Workgroup included local ranchers, landowners, interest groups and representatives of state, local, and federal agencies. Members of the Workgroup developed a memorandum of understanding emphasizing the need for a conservation strategy plan which would consider social, economic, and environmental issues. The MOU and plan provided an opportunity for local residents to take part in setting recovery priorities and developing restoration projects. A CE advisor assisted with formation of the initial working group, insuring that a broad spectrum of interested citizens could provide input into the Goose Lake Fishes Conservation Strategy. He has served as the group facilitator for the past ten years, guiding the development of the Conservation Strategy. In collaboration with the UC Davis rangeland watershed specialist; a Lassen County farm advisor; and andan Oregon State University Extension agent in Lake County, Oregon, he initiated a water quality/stream temperature monitoring research project which was the first of its kind in

California. He coordinated stream habitat and fish population/distribution surveys with private landowners and federal land management agencies, and implemented innovative grazing management practices. The Cooperative Extension team coordinated in-stream restoration projects and conducted workshops and field days on riparian grazing and stream monitoring and restoration.
Impact: In March of 2000 the US Fish and Wildlife Service determined that Great Basin Redband Trout did not need the protection of the Endangered Species Act, due in part to the excellent cooperative partnerships which balanced economic and environmental concerns in addressing the needs of sensitive species. The Goose Lake Fishes Workgroup was credited with "developing a conservation strategy which was to conserve all native fishes in Goose Lake by reducing threats, stabilizing population numbers and maintaining the ecosystem."
Funding Source: Smith-Lever and State
Scope of Impact: CA, OR

Theme: 4.23 Water Quality
Title: BENEFICIAL USE OF BIOSOLIDS
Description: California communities treat billions of gallons of municipal wastewater each year. The impurities that are removed during treatment are collected into a stabilized residue, called "biosolids," which must be disposed safely. Land filling or incineration of biosolids has proven difficult and costly. Application to land is less expensive and, since they are rich in the nutrients needed by plants, biosolids are also effective fertilizers. Because wastewater treatment collects dissolved and suspended heavy metal in the biosolids, research was needed to determine the metal concentrations land-applied without affecting human health. UC faculty members have researched the fate of metals applied to California soils for many years. They considered how applied metals react with soil particles over time as well as how they are taken up by plants. They were centrally involved with the EPA as it developed legal quality standards for land application and have published recommendations for the World Health Organization. They also have published background metal concentrations naturally present in California soils. In 1993 a Cooperative Extension Specialist began to share their research, as well as that of other waste management scientists, with the community through workshops, a conference, and a notebook.
Impact: Wastewater treatment plants have reduced the concentrations in biosolids dramatically by regulating the discharge of metals into sewage systems. Land application (including composting) has increased from approximately 25 percent of generated biosolids to over 75 percent today, savings millions of dollars in disposal fees, conserving landfill space, and providing valuable nutrients to California farmlands, recreational areas, and urban landscapes. Extension advisors have worked with county governments around the state to develop regulations appropriate for local conditions and concerns.
Funding Source: Smith-Lever, Hatch, and State
Scope of Impact: State Specific

Theme: 4.23 Water Quality
Title: INSECTICIDE CHOICE FOR ALFALFA MAY PROTECT WATER QUALITY
Description: Some insecticides used for controlling Egyptian alfalfa weevil have been detected in California's surface waters. Many are of concern due to their impact on water quality and toxicity to some aquatic life. UCCE farm advisors and specialists teamed up to determine how organophosphate insecticides move offsite from alfalfa fields, and to find alternative pesticides

that do not impair water quality in irrigation runoff. In a three-year project, they demonstrated that using pyrethroid pesticides rather than the more common organophosphates is more effective for controlling Egyptian alfalfa weevil and also reduces the amount of pesticide that could run off the field into natural waterways. This project involved working directly with 30 farmers in the northern Sacramento Valley. UCCE's link with farmers helped this project succeed because ANR members worked together for a solution on water quality problems.
Impact: As a result of this project, annual use of the organophosphate chlorpyrifos in alfalfa decreased by 50% in Yolo County (14,000 lbs to 7,000 lbs) and by 75% in Solano County (12,000 lbs to 3,000 lbs). Reduced organophosphate use in alfalfa will help improve water quality in areas where there is irrigation runoff from alfalfa fields and organophosphates are found in surface waters.
Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 4.23 Water Quality
Title: NORTH COAST RANGELAND OWNERS BENEFIT FROM WATER QUALITY PLANNING COURSES AND APPLIED RESEARCH
Description: Improving North Coast water quality requires accelerated efforts to create phased-TMDL's (total maximum daily loads) for more than 18 watersheds. Most of these watersheds are listed as impaired for the beneficial use of habitat for Coho salmon and steelhead trout. Causes of the impairment are sediment, temperature or both. During the past seven years a concentrated effort was made to assist rangeland owners to understand and deal with water quality issues on their property. Water quality planning short courses provided 22 hours of instruction on clean water laws, sources of non-point pollution, management to mitigate problems, fish habitat improvement and monitoring programs for both sediment and temperature. In completing the short course, landowners prepared individual plans that identified and prioritized water quality problems on their property. In addition, watershed groups were formed to work collectively on water quality problems. Local applied research by UC specialists and UCCE assessed sediment, temperature and riparian health. A long term study of eight paired watersheds was established at the Hopland Research and Extension Center to test grazing and fire as management practices to improve water quality. A cattle grazing behavior study at the Sierra Foothill Research and Extension Center will help develop new management practices to protect riparian areas without costly fencing.
Impact: In Mendocino County more than 150 landowners have prepared plans, inventoried sediment sources and begun mitigation. Management practices include exclusionary fencing, revegetation of riparian corridors and repair or modification of range and forest roads. Twenty landowners in the county now routinely monitor temperature in the Eel and Russian River watersheds. Watershed groups have been formed in the Garcia, Russian, Eel, Noyo, Navarro, Albion, Gualala, Big River, Little River, and 10-Mile watersheds. Most of the chairs or co-chairs of these watershed groups have taken the UC short course at least twice. The North Coast Regional Water Quality Control Board adopted two resolutions: (1) that UCCE rangeland water quality plans developed during the short course meet the TMDL requirement of a site-specific sediment reduction plan and (2) that the UCCE sediment inventory method, developed to help landowners quickly and cost- effectively identify and prioritize natural and man-caused sediment sources, is an acceptable method for meeting TMDL requirements. A survey of ranches in

Mendocino County using this UCCE sediment inventory method determined that ranch roads are a significant contributor of sediment.
Funding Source: Hatch, Smith-Lever, and State
Scope of Impact: State Specific

Theme: 5.01 Aging
Title: CAREGIVER TRAINING PROGRAM
Description: In California, the elderly population is expected to grow more than twice as fast as the total population. The demand for in-home caregivers continues to increase as the population grows older. The Sacramento County In-Home Supportive Services Public Authority (IHSS) is mandated to provide education to caregivers on their registry. However, the Authority lacks the staff to conduct the mandated education programs. Thus developed a partnership with the University of California Cooperative Extension (UCCE). The UCCE Sacramento County's Caregiver Training Program is designed to meet the needs of the IHSS caregiver workforce. The training enhances the caregivers' knowledge and skills in activities of daily living and job skills. This is the second year UCCE Sacramento County has provided caregiver training. The training sessions were conducted in a two-hour time frame. A combination of instructional methods (i.e. lecture, small group discussion, handouts and visual aids) were used to enhance the learning process. Small group activities allowed participants to share issues and concerns for providing care to their in-home residents. The following training topics were covered during the sessions: skin care, bowel and bladder care, diabetes, infection control, dementia/memory loss, preventing falls, self-neglect, and job skills. Participation evaluations were completed after each session.
Impact: An overall total of 482 participated in the training program. Eighty-two of the participants received certificates of Activities of Daily Living and 78 received certificates in Job Skills. Male caregivers were 16% of those attending the program while 84% were female. The caregiver workforce represented a diverse group: white (38%), African American (16%), American Indian (1%), Hispanic (22%) and Asian (23%). Participants consistently rated the sessions as relevant, well organized and having improved their knowledge, skill, attitude, and interest. When asked if they would advise others to attend the training, 100% responded "Yes".
Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 5.05 Children, Youth, and Families at Risk
Title: LEARNING AND PROBLEM SOLVING IN YOUNG CHILDREN
Description: Studies of early cognitive functioning suggest that infants are capable of inventing strategies to solve novel problems and generalizing the strategies to unfamiliar problems. However, virtually nothing is known about how they accomplish these feats. Examining young children's learning processes will help link research on cognitive development during infancy and during later childhood. This project examined toddlers' ability to use strategies and the processes involved in infants and toddlers acquisition and generalization of problem solving strategies. The general goal of the experiments was to 1) identify the strategies that infants and toddlers use to solve problems, 2) to examine the changes in those strategies that result from experience, 3) to examine the transfer of strategies to novel problems, and 4) to document the developmental differences in infants and toddlers learning and transfer of strategies. A UC researcher obtained trial-by-trial assessments of infants' and toddlers' problem-solving strategies and examine how their strategies change with experience. The first four experiments conducted

over the last few year focused on toddlers' discovery and generalization of strategies. Preliminary analyses revealed that toddlers demonstrated the ability to learn strategies involved in tool use from a video. However, younger children's performance in problem solving remained low, suggesting that their difficulty in transferring a learned strategy might have been due to the difficulty in accessing relevant information from the video when solving problems. The two follow-up studies conducted over the past year focused the issue of reminding of the relations between the solution illustrated in the video and the problems toddlers encountered. It was hypothesized that one obstacle of young children's strategy generalization was due to the absence of hints concerning the relations between the video and the problems. Thus, providing a hint that reminds children the relations between the video and the problems was predicted to improve their application of the strategy learned from the video. The researchers hypothesize that toddlers' strategy learning and generalization are facilitated when hints are provided to remind them the analogous relations between the video and the problems. The researchers have finished analyzing the data for two experiments, and are currently analyzing other data, and designing further experiments to pinpoint the learning processes involved in discovery of tool-use strategies.
Impact: Every day, even young children face the challenge of various problems that need solutions. When encountering a novel problem-solving situation, young children, in addition to using trial and error, often retrieve relevant prior experience such as procedural strategies and attempt to apply familiar approaches to solve novel problems. Findings from this research will provide a foundation for improving early education in preschool, daycare, and home settings.
Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 5.09 Consumer Management
Title: MAKING USE OF POST-CONSUMER TEXTILES AND CLOTHING
Description: Each month, more than 350 garbage bags of clothing and textiles from thrift shops in Siskiyou County were being disposed of in the local landfill. Other sources added to the problem. Thrift store managers in Yreka verified that this was common practice, but few options were available. In spring and summer of 2001, interviews were conducted in Siskiyou County with managers of thrift shops, operators of yard sales and customers of both types of outlets. Questions focused on the amount and type of clothing and textile waste the managers and operators had each month or after each sale, and also how they disposed of the waste. Customers were asked how often they shopped at thrift shops and/or yard sales for clothing and textiles, what items they sought and what determined whether they would buy. They were also asked if they purchased items for other than the original purpose and whether they would use an alteration service if available. While conducting this research, the advisor also worked with a group of volunteers to develop products from the waste textiles and clothing from one non-profit thrift store. Group members have made home decorating products such as pillows and rugs, have woven rugs on floor looms and frame looms from denim and wool skirts, and have crocheted rugs from jeans and sheets. They have also made pillows from T-shirts, flannel shirts and sheets and have painted on denim to increase its salability. These items have been sold at craft fairs and more recently from their own shop, bringing over $10,000 to one non-profit group in less than two years.
Impact: To date, members of the group have recycled and kept from the landfill an estimated 700 pairs of jeans, 300 flannel shirts, 500 wool garments and many boxes of fabric and notions.

They have demonstrated that a garbage bag of waste denim jeans can be reduced to only a grocery bag of waistbands that needs disposal. Publicity and education have increased the number of volunteers from five to 38. Continuing education about alternatives for re-use of clothing and textiles can bring additional income to the non-profits operating the thrift shops and extend the life of the landfills. This research project has been selected for presentation at several national consumer science and other events. It was the 2002 Western Regional winner in the Environmental Education category of the National Extension Association of Family Consumer Science.
Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 5.20 Parenting
Title: THE POWER OF PLAY: STRENGTHENING PARENT-CHILD INTERACTIONS AND KINDERGARTEN READINESS THROUGH EDUCATIONAL PLAY
Description: Parents are their children's first and most important teachers. Better than anyone else, parents can promote their children's enjoyment of learning and success in school. To be effective teachers, parents must understand their role in their children's early education and have the resources available to help their children learn. Cooperative Extension developed programs to engage low-income and at-risk parents in their children's early learning. These programs offer a unique way for parents to promote their children's readiness for school by using play to assess their children's educational strengths and weaknesses. Inexpensive homemade toys are used as aids to develop areas that need more attention. With the support of a grant from the Children and Families Commission of San Luis Obispo (Prop 10), 432 low-income parents from 27 agencies participated in The Power of Play hands-on workshops. Using common household items such as empty food cans, egg cartons and paper, the parents built educational toys to help their children develop introductory reading and math skills. Additionally, 119 childcare staff members from 24 agencies were trained in The Power of Play curriculum, to extend the program to even more parents.
Impact: 83% of parents interviewed reported using the homemade toys to play with their children at least twice a week and 92% reported using the toys at least once a week. All staff members participating in follow-up interviews indicated they extended the program to more parents through educational workshops, through homework assignments to foster positive parent/child interactions, and through loan libraries for parents to borrow materials for independent work with their children.
Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 5.27 Workforce Safety
Title: CALIFORNIA AGRICULTURAL ERGONOMIC INTERVENTION PROJECT
Description: This project's objectives were **t**o describe and prioritize landmark ergonomic risk factors and hazards for musculoskeletal injuries in the agricultural industries; apply biomechanical, metabolic, and postural stress analyses to prioritized hazards; evaluate previously validated task and tool modifications; develop task and tool modifications for high-risk tasks identified by detailed ergonomic analysis to eliminate or significantly reduce hazards; conduct cooperative task and tool intervention trials; evaluate intervention trials and communicate project findings to industry and other agricultural industry groups. After last year showing that the use

of smaller wine grape picking tubs resulted in five-fold reduction in workers' post-season MSD pain and symptom scores, the work was continued to look at the impact on workers if machines were used to lift and carry the grapes.
Impact: This resulted in very minor improvements in pain and symptom scores, leading us to conclude that most workers picking grapes would not significantly benefit from a further reduction in tub size. Over 8,000 smaller tubs were used this picking season, indicating rapid adoption of past research. Worker acceptance was excellent and the demand for the smaller tubs outstripped the suppliers' ability to supply them.
Funding Source: Hatch and State
Scope of Impact: State Specific

(2) Did the planned programs address the needs of under-served and under-represented populations of the State(s)?

Listed below are several examples of California efforts to address the needs of under-served and under-represented populations in the state.

Theme: 3.03 Human Nutrition
Title: ADULT FOOD STAMP NUTRITION EDUCATION PROGRAM (FSNEP)
Description: The Food Stamp Nutrition Education Program (FSNEP) is the largest of the federal safety net programs and first line defenses against hunger. Unfortunately, not all who are eligible and can benefit from this program are enrolled. Additionally, even with financial assistance, many families are unable to effectively use this resource to provide healthy diets for their families. In Placer County in 1997, there were 17,812 low-income residents. Of these, 7,412 received Temporary Assistance for Needy Families (TANF) assistance and 9,173 received food stamp assistance. UCCE's Adult Food Stamp Nutrition Education Program (FSNEP) educated these consumers on healthy food choices, wise food purchasing, and safe and proper food handling and preparation. Programs were delivered through educational classes, mini-workshops and correspondence courses. A monthly newsletter, Foodlines, was delivered with the food stamps to each Placer County food stamp recipient. A Foodlines for Professionals newsletter is distributed monthly to agencies and organizations that work with food stamp-eligible families and individuals. Over 1,700 individuals received the Adult Food Stamp Nutrition Education Program (FSNEP) over the past three years. A total of 82,800 Foodlines newsletters were distributed to food stamp recipients. Strong relationships were established with other agencies in support of these nutrition education efforts. One television segment was presented on 'Good Day Sacramento.'
Impact: Low income families have improved their diets, increased the variety of food choices, improved their food preparation, budgeting, and meal planning skills and improved their knowledge of safe food handling practices. Success in this program has contributed to funding for two other Placer County Nutrition Education projects that serve families with children 0-5 years of age.
Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 3.03 Human Nutrition
Title: CALIFORNIA BONE HEALTH CAMPAIGN

Description: Osteoporosis is a serious calcium-loss disease that thins the bones and makes them brittle and very vulnerable to breaking. However, it is a disease that can be slowed down, or prevented. One in two women, and one in eight men, over age 50 will have an osteoporosis-related fracture in their lifetime. Simple falls for people with osteoporosis can lead to hip, spine and wrist fractures and up to 20% of those with hip fractures die within a year of their injury. One in six Latino women already has osteoporosis. Interactive, hand-on nutrition and health education are essential tools to serve our community in the battle against osteoporosis. Fresno County's Project LEAN offered a series of four classes to low-income Latino women, ages 18-55, living in six Fresno zip code areas. Fresno County Cooperative Extension hired Community Health Program Representatives, "Promotoras," from within the communities they serve. This offered employment opportunities and opportunities to grow in the respected role of teacher and advocate "Promotora" in the community.Huesos Fuertes, Familia Saludable asked Latinos over two years one drink an extra cup of 1% milk every day to increase their calcium consumption. The program also taught about other sources of calcium and bone-strengthening exercises. During this year, ten food demonstrations at five neighborhood grocery stores were conducted. The very popular "strawberry smoothie" recipe using fresh fruit and 1% milk was demonstrated. Brochures with 1% milk recipes were handed out in Spanish and English. The message is: Adequate calcium consumption and exercise are the keys to preventing osteoporosis.
Impact: Between January and April 2004, the program reached over 6,000 individuals at community events such as health fairs and parent fairs at schools. An additional 200 women are scheduled to participate in the bone health classes. Pre- and post-class surveys from previous years indicate a significant change in knowledge about sources of calcium and the importance of regular physical activity to bone health. Milk sales data documented their self-reported increased consumption of 1% milk. This program will continue in 2005 and expand at additional zip codes in Fresno.
Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 4.14 Natural Resources Management
Title: ENGAGING LATINO YOUTH AND FAMILIES IN WATER RESOURCE ISSUES
Description: In Santa Barbara, the highest Latino population density is also where the creeks are the dirtiest from upstream sources. These polluted creeks drain into the Santa Barbara Channel, forcing beach closures. Like everyone else, many of the Latino community go to the beach and the kids play in the creeks. It has been shown that Latinos are generally interested in environmental issues, and that they are particularly concerned about the health impact of a polluted environment. However, because of language and cultural issues, they are often not engaged in water protection activities. Agua Pura (Pure Water), began in 1999 as a partnership of the University of Wisconsin Cooperative Extension's Give Water A Hand, Santa Barbara County UCCE 4-H Youth Development Program and Santa Barbara City College. Its goal was better understanding of how community educators and youth leaders can involve Latino youth and the Latino community in watershed protection and adaptation of resources to meet the community's needs and interests. Agua Pura has been sustained by the Santa Barbara County 4-H Youth Development Program. It is assisting the county in meeting best practices under NPDES (National Pollution Discharge Elimination System) guidelines.
Impact: Agua Pura has significantly contributed to engaging the Latino community in watershed resource issues:

--A six-week, hands-on after-school watershed education program that has graduated over 560 Latino children.
--Incorporation of watershed education into a nine-week summer day camp for over 1,200 Latino children from low-income families.
--The local Housing Authority, whose leadership is primarily Latino, has led in development and delivery of the ongoing "Splash to Trash" watershed education program. Sixty-two Latino young people from public housing have graduated from the program.
--Publication of the Agua Pura Leadership Institute Planning Manual (available on line at: http://www.uwex.edu/erc/apsummary.html).

Agua Pura has served as a model for Latino leadership development involving watershed resource issues at national conferences (Coastal Zone '99, NAAEE '01 and '02) and in professional journal articles.
Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 5.07 Community Development
Title: CAPACITY-BUILDING IN THE SOUTH LAKE TAHOE LATINO COMMUNITY
Description: South Lake Tahoe (SLT) is a California community well known for its natural beauty, recreational opportunities and proximity to Nevada's gambling economy. Less known is its growing reliance on, and the increasing size and importance of, the immigrant Latino community. From 1970 to 2000, population nearly doubled from 13,000 to 24,000, while the Latino population increased six times from under 1,000 to nearly 6,500. Today, Latinos constitute 30-35 percent of the population. Despite this growth, the Latino community and associated issues have been largely unacknowledged. In 2001, SLT officials created the Latino Affairs Commission (LAC) to identify and address issues related to housing, education, employment, health and safety. In 2002, UC Cooperative Extension (UCCE) officials met with LAC members in El Dorado County. This connection and the resulting outcomes and products have been beneficial for both entities and the Latino community. SLT was isolated from county central services; significant connections did not exist with UCCE and its 4H programs. A new connection was established as the result of assessing, documenting and reporting the needs and assets of the local Latino community. The project involved the conceptualization, design and implementation of a SLT Latino community assessment by personnel from the LAC Commission, El Dorado County Cooperative Extension and UC Davis faculty. The assessment team used existing census and other secondary data, a series of key informant interviews of Latino and other residents, and systematic observations. Updates were provided to LAC members, local newspapers, radio outlets and the community. A bilingual report, now in production, will be shared with the larger community.
Impact: Awareness of the issues and the role of the Latino Affairs Commission is increasing. CE's role in the community has been enhanced, and the UCCE office is engaged directly with a new community. UCCE is developing collaborative research with new partners and has undertaken new strategies for building local capacity. This project provides the means to create networks and on-going dialogue between the Latino community and previously unconnected organizations and agencies. As the result of this project, the El Dorado Community Foundation is addressing Latino issues in the county and in its program planning, expanding the assessment process to a county-wide level, and committing resources to the effort. This project demonstrates

the power and utility of meaningful linkages among county-based Extension staff, campus Extension personnel and graduate students. Such linkages benefit the university and local Extension systems while focusing greater attention on local issues and the mobilization of community resources.
Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H
Title: 4H AND FSNEP HELP YOUTH AT ALESSANDRO CONTINUATION HIGH SCHOOL
Description: Alessandro High School, an alternative learning center or continuation high school in the Hemet Unified School District in Riverside County, serves about 8% of the district's 10th, 11th and 12th graders. These young people are behind in credits and in danger of not graduating. Finding a project that will motivate students and teach them about leadership, cooperation and commitment is a challenge that faces all teachers at Alessandro High School. ANR has played a key role in making a tree planting and campus beautification project at Alessandro High School a reality. National 4-H provided funding for the project as part of Youth InAction/Community Tree Planting Grant. The project idea came from the garden coordinator/teacher at the school. Students in her class wrote an application for the grant--and won the award. UCCE Youth FSNEP staff worked with her to teach to her students a special curriculum (TWIGS-Teams With Intergenerational Support). Students learned about nutrition and gardening, worked at gardening and tried recipes using fruits they had never tasted before. They researched drought-resistant trees to plant in the Hemet area, prepared a garden portfolio and plan, presented the plan to the school faculty, and took part in the actual planting.
Impact: As a result of the successful tree planting and campus beautification project, students and staff at Alessandro High School campus are proud of the new look. One student says: "There used to be trash around the native garden area, and now students are pulling weeds and picking up the trash." The students who participated in this project learned to work as a team. They also learned something about themselves and their potentials for successfully completing a project that they can be proud of. Their pride is shared by their teacher who said: "It's amazing the confidence that some of the students are showing. They've learned to work in groups, write thank-you letters and deal with the media and other real world situations that many high school kids never encounter." The principal said: "We are very pleased that the funding from this grant enabled our students, faculty and community to join in a project that will have long lasting implications for our campus."
Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H
Title: FUN IN THE SUN: 4-H HELPS ENRICH SUMMER FOR KIDS IN NEED
Description: After years of neglect, after-school and summer enrichment programs for urban children from low-income neighborhoods are finally attracting the attention and the support they deserve. Educators and researchers are focusing on what these children are learning from their participation in organized after-school programs and summer camps. These venues are often ideal for integrating non-formal science and environmental literacy activities. They also provide excellent opportunities for children to learn and practice positive social and civic skills. Since

1998, Fun In The Sun (FITS) has been a free educational summer day camp for boys and girls ages 6-11 from very low-income families in Santa Barbara and Goleta. Collaborators include the California 4-H Youth Development Program, Girls Inc. and the local YMCA. FITS is funded through the local chapter of United Way. The camp's summer-long educational and recreational program includes a variety of activities, from character education to science and environmental topics. Reading and social skills are integrated into all activities. UCCE 4-H staff helps recruit and train FITS staff, who are mostly Latino undergraduates from UC Santa Barbara and the local community college, as well as teen volunteers who serve as staff assistants. Parent involvement is also encouraged through Family Fun Nights, where campers share their camp achievements with their family members. 4-H provides programming focused on natural science and the environment. Topics include watershed restoration and water quality, gardening, oak woodlands and their wildlife, reuse and recycling, and the very popular sports fishing program.
Impact: Through FITS, 4-H has helped provide a no-fee summer enrichment program for nearly 300 young people from disadvantaged families every summer since 1998. Surveys show that children who participated in FITS have:

-Increased their interest in and appreciation for science by 56%
-Increased their reading skills by 50%
-Improved their social skills and ability to bond with a group
-Appreciated the opportunity to spend time with caring adults

In addition, participation in Family Fun Nights by the campers' family members has consistently been close to 100%.
Funding Source: Smith-Lever, Hatch, and State
Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H
Title: GREENNET: COLLABORATION BUILDS SOCIAL CAPITAL
Description: It is generally agreed that the children of low-income families have fewer opportunities to succeed in today's society. The Neighborhood GreenNet Project is a collaborative project engaging low-income families and their children in small horticultural (green) business startups that utilize cutting edge computer technology. By working with these families, the program strives to direct youth toward a path of responsible, self-directed and productive membership in society. GreenNet is a collaboration of the Santa Barbara County 4-H /Cooperative Extension program and the Housing Authority of the City of Santa Barbara (HACSB). The project provides ten weeks of hands-on training to K-12 at-risk children in the areas of gardening, computer technology and entrepreneurship. Blending these three unique themes into one project works to increase cohesiveness between families. Children work alongside their parents to design small enterprise gardening projects that benefit from state-of-the-art information technology for research, planning and development of market sources. Teen volunteers mentor younger children in project activities, who in turn help teach their parents such things as how to access information technology to enhance their family gardening projects.
Impact: Since 1998, GreenNet has involved more than 550 youth and 350 housing resident families throughout the city of Santa Barbara. The majority of the teen participants in GreenNet have gone on to college education, and several have elected to major in business, technology, science or science-related fields. These teens said their GreenNet experience helped them develop new work skills and self-confidence. A Family Opportunity Learning Center with a computer lab and Arroyo Gardens garden learning center were developed on Housing Authority

property. Various micro-enterprise projects, including a native plant nursery and a cut-flower project, were launched. In the past, vandalism, including graffiti and intentional damage to landscaping and property, have been a serious problem for the Housing Authority. Prior to GreenNet, property damage repairs costs ran over $60,000 a year, not including the cost of policing the property. GreenNet staff were delighted to hear that after just one year of the program, housing property damage costs had dropped to near zero. This change was attributed by the police and the housing property management to the efforts of GreenNet.
GreenNet was selected as a National Program of Excellence by the USDA in 2002.
Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H
Title: ON THE WILD SIDE
Description: Many children today--particularly those from urban, economically disadvantaged communities--do not have opportunities to experience the wonder of nature. These children are the stewards of both our future and the ecological health of the planet. They need an understanding of ecological principles and life sciences, and the chance to discover the workings of nature. Creating opportunities for youth to explore, learn about and enjoy natural places is an investment in our children and our Earth. ANR leads a collaborative project that brings environmental education and outdoor experiences to children and teenagers living in Sacramento's economically disadvantaged neighborhoods. "On the Wild Side," a program funded by the Sierra Club's Youth in Wilderness Project, brings 4th to 6th graders from the Sacramento START after school program to an overnight outdoor living experience filled with experiential learning and a lot of smiles. Teens and adult volunteers work in partnership to plan and staff the overnight camping experience for the children. They receive training in environmental curricula, and then design a two or three day program. Children rotate through the teen-led activities to learn about ecosystems, migration, habitat and the food chain. They also have the opportunity to paddle a canoe, sing around a campfire and fall asleep under the stars.
Impact: The program is now in its fourth year and both quantitative and qualitative data consistently point to a rich learning experience. Pre- and post-tests reveal that the youth gain knowledge about the environmental concepts presented through the program. The children's journal entries confirm the learning that takes place. Those participants returning score significantly higher on pre-tests than those who are new to the program, indicating a high retention rate for what was learned in past years. A powerful part of On the Wild Side is the teens who give their time and energy to plan and run the events. These young leaders both add to and grow from the experience. They enjoy a rapport with younger students that differs from that of adults, and prove themselves excellent teachers. The outdoor environment is completely new for many of the children (as well as some of the adults who accompany them). When asked to list three things learned, one child wrote: "How fires feel, how to sleep outside, and the stars are brighter than in the city." Some youth commented on having to walk so much, testimony to the rather sedentary lifestyle many children lead.
Funding Source: Smith-Lever and State
Scope of Impact: State Specific

(3) Did the planned programs describe the expected outcomes and impacts?

The planned programs achieved many of the performance goals as described by the case study examples in Section A.

(4) ***Did the planned programs result in improved program effectiveness and/or efficiency?***

Collaboration with other institutions results in efficient programs delivered to the citizens of California. Collaborative work with other institutions builds on the comparative advantage of each institution and leverages the expertise within the region/area. This results in less duplicative efforts or "reinventing the wheel" in each state. The collaborations bring about improved program efficiency, making the most effective use of the resources in each institution. This is particularly important in the current economic environment of limited or declining resources. This is illustrated, for example, in the continuing multistate activities in the Tahoe Basin and the livestock collaborations among California, Oregon, Idaho, and Nevada.

The strong integration of California's AES and CE research and extension programs ensured effective and efficient programs addressing the needs of California citizens in agriculture, human and natural resources. The strong linkages between the local county CE programs and the campus research base guaranteed that there is a research base for the county programs to draw upon as the local clientele identify the problems and issues affecting them. Through the program planning processes described in Section B., AES faculty, CE specialists and CE advisors interacted through the workgroups and Program Planning Advisory Committees throughout the year, keeping communication from the field to the laboratory constant.

SECTION E. MULTISTATE EXTENSION ACTIVITIES

(1) Did the planned programs address the critical issues of strategic importance, including those identified by the stakeholders? The programs described below were initiated in response to the critical needs of stakeholders.

Theme: 1.03 Agricultural Profitability
Title: Evaluation of a plant growth regulator loosen pomegranate fruit for mechanical shaking
Cooperating State: Florida
Large scale production of pomegranates is underway in western Kern County and Kings County in California. Labor for picking pomegranates manually is difficult to procure in this relatively isolated area and is expensive as much of this crop that will be mechanically harvested is destined for the juice market. Improving the efficiency and reducing the damage associated with mechanical harvesting would be of economic value to the producers involved. The project is evaluating a compound under investigation in Florida to loosen oranges on the tree so that they may be more easily removed by mechanical harvesters and to determine if this compound might be used in the same way with pomegranates in California. Finding a compound that will facilitate mechanical harvesting will make the production of pomegranates for juice a more profitable enterprise. Labor costs, repetitive work and other injuries associated with manual picking, and damage to trees due to lower shaking force required for harvesting would all be reduced if a useful compound could be found. Unfortunately, the compound tested was not found to be effective in reducing the force required to remove pomegranates from the tree and the project has been terminated.

Theme: 1.23 Organic Agriculture
Title: Organic Strawberry Production
Cooperating State: Oregon
Source of funding: Smith-Lever and State
Organic growers expressed concern about the lack of non chemical options for production of organic strawberries. A California advisor is working with his Oregon colleague to reduce chemical inputs into strawberry nursery production. At the beginning of this project, 100% of the strawberry nursery industry in Northern California and Southern Oregon was on fumigated land. The goal is to provide a truly organic option to production of strawberry nursery transplant stock. Transplants were successfully produced in 2003. In 2004, the project was advanced to commercial scale but transplants were not shipped due to nematodes at one site and verticillium wilt at the second site. This work will eventually benefit small scale, often minority strawberry fruit growers producing organic certified fruit and new organic nursery growers. A jointly published literature report of the project in the Shasta Lassen Cooperative Extension office was issued. Similar reports were produced in Santa Cruz, Ventura, and Santa Clara counties of performance and yield of transplants.

Theme: 1.27 Plant Health
Title: Detection of changes in fungus that causes melon powdery mildew and management of the disease.
Cooperating State: Arizona
Source of funding: Smith-Lever and State

There has been severe disease pressure in commercial cantaloupe varieties that had been declared resistant to powdery mildew believed to be present in California. In addition, there were reports of commercial failures of previously effective fungicides. A California advisor is working with Arizona researchers to investigate the failure of fungicides and mildew resistant varieties to control melon powdery mildew and to identify new control measures. In addition, they are educating agricultural professionals responsible for controlling the disease regarding resistance management. The presence of a low number of fungicide resistant strains were recorded. During the investigation of the failure of fungicides, it was noted that unsound management techniques were being practiced: Consecutive applications of fungicides with the same mode of action were being made. Due to his educational efforts, a sound fungicide resistance management program is being practiced by those that previously had questionable programs. Melon lines with resistance to the new race of powdery mildew have been identified. Materials with different modes of action are near registration. Many of the pest control advisors that the advisor worked with are Hispanic. In addition, the fungicide resistance aspect of this work is pertinent to the mostly minority, small scale producers of squash, and specialty melons.

Theme: 1.27 Plant Health
Title: Spinach Downy Mildew
Cooperating States: CA, AK
Source of Funding: Smith Lever and State

During recent years, consumers in California and throughout the country have greatly increased their consumption of spinach. As a result, the state's growers are producing more spinach that ever before. Monterey County alone grows over 16,000 acres, about 60% of the state's spinach crop. Spinach has an extremely high vitamin and nutrient content, and contains high levels of beneficial carotenoids such as the antioxidant lutein. Being a leafy vegetable, spinach is susceptible to damaging leaf diseases that reduce the yield and quality of the harvested crop. Coincidentally, several new spinach disease problems have developed while acreage has expanded, increasing the potential for significant losses. These diseases must be managed effectively so that the spinach industry can meet increasing market demands for fresh, high quality spinach. A California advisor continued his collaboration with his counterpart at the University of Arkansas to identify new strains of the spinach downy mildew in California. His projects have tested fungicides for short-term control of downy mildew and have helped develop varieties that resist new races of the fungus. He set up the state's only public testing laboratory that can identify different races of spinach downy mildew. The lab continues to analyze the race population of downy mildew in the state and will serve as an early warning system if other new races appear. This collaborative program has helped develop fungicides that protect the state's spinach crop. Also, in conjunction with industry groups, varieties have been released that resist the new downy mildew races. Planting of this resistant stock has helped reduce the amount of chemicals applied to spinach..

Theme: 1.27 Plant Health
Title: Celery Integrated Pest Management Project
Cooperating State: CA, MI
Source of Funding: Smith Lever and State
A California advisor is working with a Michigan State colleague on development of an integrated pest management system for celery. The goal of the project is to improve control of pests and to document IPM advances.

Theme: 1.28 Plant Production Efficiency
Title: National Sweetpotato Collaborators Trial
Cooperating States: CA, NC, SC, LA, MISS, AL, TX
Source of funding: Smith-Lever and State
The objective of this on-going collaboration is to evaluate new sweet potato cultivars in various locations throughout the United States for production, quality, insect and disease resistance and potential commercial release. California is the number two producing state for sweet potatoes but it does not yet have a breeding program. The Collaborators Trial allowed academics in California to evaluate potential new lines from other states to determine their potential use in this environment. The release of new cultivars with greater disease and insect resistance, greater productivity, or both, directly impacts the profitability of growers in California. Many Japanese, Hispanic, and Indian growers, and all growers regardless of race, benefit from the availability of new varieties that the growers may not be able to test or acquire on their own. Publications include the Annual National Sweet potato Collaborators Group Progress Report and the Annual National Meeting Minutes.

Theme: 1.28 Plant Production Efficiency
Title: Wild Rice Agronomic Research
Cooperating State: MN
Source of funding: Smith-Lever and State
A California advisor is working with his Minnesota colleague to optimize the ideal harvest moisture and water depth for wild rice. Wild rice shatters if not harvested at the ideal moisture; too early or too late is not ideal. Growers worry that water depths that control weeds are less than ideal for maximum yield. Both California producers and the Native American populations in Minnesota will benefit from specific knowledge developed by this project.

Theme: 1.30 Rangeland and Pasture Management
Title: Integrating Weed Control and Restoration for Rangelands: Soil Organic Matter Monitoring and Soil Physical Properties
Cooperating State: CA, NV, UT, ID, OR
Source of funding: Smith-Lever and State
Exotic annual grasses represent a permanent degraded state on many western rangelands influenced by Mediterranean climates. Long-term dominance by exotic annual grasses may deplete soil organic matter content and change its distribution and composition in the soil profile. this alters soil water and nutrient profiles and makes restoration to perennial grasses very difficult. Researchers from California, Nevada, Utah, Idaho, and Oregon began research last summer to screen native plant materials for competing with annual-dominated vegetation and to test restoration strategies, including the use of prescribed burning, grazing, and reseeding. The

California advisors will be monitoring soil organic matter dynamics in soils beneath the various restoration species and treatments.

Theme: 1.30 Rangeland and Pasture Management
Title: Influence of Medusahead Removal Techniques and Imazapic on Medusahead Control and Perennial Grass Establishment
Cooperating State: CA, OR
Source of funding: Smith-Lever and State
Oregon and California advisors and researchers worked on an experiment 1) to determine the effects of a newly developed herbicide (imazapic) on medusahead control and perennial grass restoration; 2) Determine if combining burning or tillage with imazapic can improve medusahead control and perennial grass restoration; and 3)Examine the feasibility of establishing introduced perennial grasses following suppression with a herbicide. The is designed to help with imazapic registration in California. Results will help land managers effectively control medusahead and re-establish productive range.

Theme: 4.12 Integrated Pest Management
Title: Western IPM Coordination
Cooperating States: Western States
Source of Funding: Smith Lever and State
The goal of this collaborative project is to foster cooperative regional research and extension programs that solve critical pest management problems by enhancing communication among stakeholders, IPM research scientists, IPM extension specialists and other professionals involved with IPM strategies in the West. The group conducted assessment of pest management research and extension activities; fostered development and delivery of IPM systems that protect human health and the quality of environmental resources, and encouraged collaborative pest management strategies. A whole system training exercise with the Sustainable Cotton Project (California Alliance of Family Farms) was well received. The overall activity has improved inter state cooperation. In addition, training in the whole system and interaction with Hawaiian vegetable growers was useful for AES/CE researchers and advisors and growers.

Theme: 4.01 Agricultural Waste Management
Title: National Dairy Environmental Stewardship Council (NDESC)
Cooperating States: CA, IL, NE, KS, TX
Funding: Smith Lever and State
When most people think about pollution, they envision automobile exhaust fumes and smoke billowing from factory pipes; but what about dairy farms? According to the State of California Water Quality Control Board, dairies are one of agriculture's most significant sources of water pollution. In fact, dairy waste threatens the quality of drinking water for up to 20 million Californians. The pollution created by dairies comes primarily from manure. Across California, dairy cows create more than 65 billion pounds of manure per year. Even when excess manure is used as fertilizer, this waste runs off fields into California's waterways, eventually contaminating aquatic habitats and public water sources. A major source of reactive organic gases, dairy manure also contributes to air pollution. Working with colleagues across the nation, California researchers, specialists, and advisors work on activities through the National Dairy Environmental Stewardship Council to find cost-effective solutions to managing dairy waste.

The objective of the NDESC is to identify successful treatment options for dairy waste that are both environmentally beneficial and economically viable, and to recommend strategies for increased adoption of these practices. The NDESC Members, experts in waste management, represent dairy producers, environmental organizations, USDA, academia, and cooperative extension. The final NDESC report published in the fall of 2004, *Cost Effective and Environmentally Beneficial Manure Management Practices,* highlights the most promising treatment options for dairy waste as well as models for implementation. Use of this information should result in Improvements in manure management practices on dairies across the U.S.

Theme: 4.14 Natural Resources Management
Title: Development of Sage Grouse Conservation Strategy
Cooperating States: CA, OR, NV
Source of Funding: Smith Lever and State
Northern California advisors continued to work with colleagues in neighboring states on the development of a conservation strategy that will prevent the need for a threatened and endangered species designation for sage grouse. The goal is to develop a comprehensive plan that will meet the needs of sage grouse through their range in our three states, and be accepted by the US Fish and Wildlife Service as a habitat recovery plan. Stakeholders include state and federal agencies and private land owners and managers in Nevada, Oregon, and California. Major cooperators were Cooperative Extension colleagues and state game biologists working to develop a plan that will meet the needs of the three states. The Greater Sage Grouse Conservation Plan for Nevada and Eastern California was submitted to the Governor of Nevada in July 2004.

(2) Did the planned programs address the needs of underserved and under represented population?

The programs described below involved under served/under represented stakeholders with specific needs.

Theme: 1.17 Home Lawn and Gardening
Title: Training Master Gardeners in the Las Vegas region
Cooperating States: CA, NV
Funding: Smith Lever and State
A California advisor continued his work with his Nevada colleagues and trained master gardeners about growing fruit trees and grape in the home garden. He continued to train the group of volunteers that operates the Cooperative Extension experimental orchard in North Las Vegas. Many of the participants were senior citizens and area gardeners. They learned how to raise healthy fruit and nuts to supplement their diets and to extend their food budgets.

Theme: 5.05 Children, Youth and Families at Risk
Title: 4-H Cooperative Curriculum System (4-H CCS) Strengthening the Capacity of Volunteers to Manage Youth Groups
Scope of Impact: CA, CO, ID, KS, ME, MD, PA, SC, TN, TX, WA
Source of Funding: Smith Lever, State and 4-H Cooperative Curriculum Grant

Children and youth, in particular Hispanics/Latinos, are experiencing an increase in high school drop-out rates, violent crime and teen pregnancy. Communities that experience at risk youth behaviors need tools to respond to these emerging issues and have expressed a need for knowledge about effective youth programs, methods for evaluating program success, information on healthy youth, family and community development. Working with colleagues across the nation, California advisors are working to identify/apply culturally relevant practices that are effective in working with Latino youth and families; promote positive youth development in adolescents through leadership development and service-learning programs; strengthen the capacity of youth professionals, volunteers and other caring adults to effectively work with diverse groups of youth. The outcomes will be the increased ability of youth serving professionals and volunteers to work effectively with adolescents. A synthesis of two of the workgroups' articles on Latino teen pregnancy prevention was prepared and will be piloted as a handbook this year.

Theme: 5.07 Communications Skills
Title: Extension en Español (EEE)
Scope of Impact: National
Source of Funding: Smith Lever and State
This project continued to serve the Spanish-speaking audience in the United States, a population that is growing much more quickly than any state or Extension service's ability to keep up. Initiated in FY 2003, the Extension en Español (EEE), a clearinghouse for Spanish-language educational materials contains hundreds of Extension-related documents in Spanish and English free of charge for users to view and download.
The database continued to provide

- Bilingual news reports, columns and feature stories
- Links to other extension Web sites with Spanish-language materials
- Resource guides, such as glossaries of Spanish-language translations for Extension and USDA agencies and institutions, and style guides for Spanish usage
- Educational materials to learn more about Hispanic communities and reaching out to Spanish-speaking audiences
- An online forum to consult with other specialists about Spanish-language materials
- Extensive contact lists to communicate individually with specialists on specific issues

In addition, specific individuals are listed to contact for specific assistance. Several California academics and staff are listed.

Theme: 5.11 Family Resource Management
Title: Rural Families Speak: Tracking Their Well Being and Function in an Era of Welfare Reform
Cooperating States: CA, CO, IA, KY,LA, NE, NH,NY, MD,MA, OH, OR, SD, MI, MN
Source of Funding: Smith Lever and State
Rural communities and families have unique issues and needs compared to their urban counterparts. While poverty rates dropped in rural areas during the 1990s, they were consistently higher than those for urban areas, and persistent, long-term poverty is much more common for rural families than urban families. Furthermore, although rural areas experienced employment gains during the economic boom of the late 1990s, unemployment rates remained higher than in metropolitan areas. In rural areas, family life is at the core of the rural community. The

functioning of the family is important not only to the immediate family, but also to the well-being and viability of the rural community. Tracking changes in rural families across time is vital in the face of changing economic conditions and federal and state policies related to public assistance. The dearth of data on rural families' post-welfare-reform well-being continues with regard to food security and use of support systems. This project will add to the multidimensional understanding of rural low-income families over time. A California extension advisor worked with low-income rural families in Madera and Kern Counties. She acquired permission from preschool programs and administrators for the study and conducted interviews with 29 families in Madera, Delano and Wasco during the summer with the research instrument developed through national collaborative effort. The analyses done so far suggested that providing information on assistance programs will help, but probably needs to be part of the larger issue of improving overall access to public benefits for limited resource families, especially minorities. The challenge will be to utilize our many networks to reach minority families in rural areas.

Theme: 5.11 Family Resource Management
Title: Increasing Use of the Earned Income Tax Credit for Low Income Families
Scope of Impact: State
Source of Funding: Smith Lever and State
The Earned Income Tax Credit has been described as the largest and most successful federal assistance program for low-income working families. In FY 03, the EITC was responsible for elevating the families of 5 million children above the federal poverty line. However, many eligible families do not take advantage of this valuable income supplement for various reasons, as indicated by the findings of Rural Families Speak. Recognizing the need to reach out to rural families about the EITC, Rural Families Speak distributed English and Spanish IRS materials explaining eligibility and the filing process to research participants between their first- and second-year interviews. California advisors continued to make efforts to disseminate information to those rural families' that could benefit from the EITC. EITC information is being included as part of EFNEP (Expanded Food Nutrition Education Program) and FSNEP (Food Stamp Nutrition Education Program) efforts. The University of California Cooperative Extension Spanish Broadcast and Media Services is disseminating written materials and radio announcements. Additional efforts wre made to set up county coalitions to provide direction for implementation and expansion of VITA sites. They helped IRS recruit VITA volunteers and identify locations for training. They trained their staffs on the importance of utilizing the EITC so the staff could refer clientele to VITA sites and encourage clientele to apply for the EITC. Hispanic audiences in rural areas were a key target as they underutilize the EITC program.

(3) Did the planned programs result in improved program effectiveness and/or efficiency?

Collaboration with colleagues in other states results in improved program effectiveness by maximizing the use of available expertise. All states have faced budget reductions and need to use the remaining resources in the most effective manner. With declining numbers of academics to do research and conduct extension programs, it has become even more critical to share expertise across state borders.

Theme: 1.03 Agricultural Profitability
Title: Beltwide Defoliation Workgroup: Uniform Harvest Aid Performance and Fiber Quality Evaluations
Cooperating States: CA, LA, MS, TX, OK, AL, TN, NC
Source of funding: Smith Lever and State

Defoliation is necessary to prevent leaf stain and trash from contaminating cotton lint. There are over 30 different chemical combinations that growers are presently using. Information is needed to evaluate new defoliants and tank mixes to determine the best defoliant for different conditions maintain efficacy, and reduce costs. There was less information in California. In addition, urban areas and environmental groups have increasing concerns over the use of certain defoliants that are odorous or hazardous. It had become apparent that the cotton industry needed to address the issues and begin to build an authoritative body of knowledge on the subject of cotton defoliation. Through a coordinated research effort every region of the Cotton Belt conducted uniform trials on cotton defoliation. The group's mission was to develop practices that would help producers deliver a higher quality fiber to the mills. The objectives were to cooperate with uniform testing through the Beltwide Work Group, conduct screening for material registration for local use and develop cost effective and efficacious practices for Acala cotton. This work has contributed to improved guidelines for cotton defoliation. Educational efforts have lead to a major change in the use of cotton defoliants and the voluntary removal of one specific product used as a desiccant in California. With defoliation costs averaging $15-50/acre, the researchers and CE academics developed economics of the many defoliant options to help growers make these end of the year decisions. The new products registered for use are applied in ounces per acre instead of pounds per acre. The shift to newer products has had a significant impact in the reduction of materials applied and the presence of noticeable odors in the SJV air. According to the County Agricultural Commissioners, complaints decreased 95 percent since 1995 due to the shift to new chemicals.

Theme: 1.06 Animal Production Efficiency
Title: National Pork Board Swine Educators Advisory Committee
Cooperating States: CA, SC, IA, MI, MS, WA, TN, MT, VT, UT, IL, MN, GA, OK, WI, PA, OH, KS, KY, OR, NE, MO, NC, IN, ND, SD, AR, TX, AL
Source of Funding: Smith Lever, State and National Pork Board

This activity continued to provide opportunities for Extension Swine Specialists and adult educators to network for the benefit the nation's pork producers. This is a high priority activity for the National Pork Board who provided the funding for meetings and two educational meetings/tours per year. Activities included the conducting the annual Swine Educators' Conference and the dissemination of a CD with information swine educators can use in their educational programs. This is one effort funded by the National Pork Board where funding has continued in the face of a reduction of funding for education overall. The educational information made available to pork producers improved their financial status and/or ability to stay in business. The 2004 major publication was the Swine Welfare Assessment Program (SWAP) booklet and CD.

Theme: 1.02 Agricultural Competitiveness
Title: Western Region Professional Improvement Conference
Cooperating States: Western States

This conference provided an opportunity for western states Extension Agents to report activities and projects to each other. Approximately 100 extension agents paid to attend this activity. By keeping well-informed of research and extension projects that are being conducted in the western region, Cooperative Extension County Agents were better able to address the needs of their local clientele. The conference produced peer reviewed proceedings.

Theme: 1.06 Animal Production Efficiency
Title: California, Oregon, Idaho, Nevada Livestock Programs (C.O.I.N.)
Cooperating States: CA, OR, ID, NV
Source of Funding: Smith Lever and State

With decreasing staffing in livestock extension positions in all western states, this activity has provided a critical mass to address the livestock industry's education and applied research needs. The project has an email list serve that Extension livestock advisors and specialists use to post questions and obtain educational and research information from the four western states. An annual tour is held in one of the states to review their research and education programs in livestock. The impact is quicker problem solving by staff for clientele through the sharing of coordinated research and education programs and has allowed members to be able to access a larger network of expertise in responding to clientele questions. The group produced the *COIN Beef Book,* used by all members with their clientele.

SECTION F. INTEGRATED RESEARCH AND EXTENSION ACTIVITIES

Cooperative Extension (CE) and the Agricultural Experiment Station (AES) in California are administered by a single authority, the Vice President for Agriculture and Natural Resources, University of California. In his dual role as CE Director and AES Director, the Vice President ensured integration of *all* research and extension activities, including all activities supported by Hatch and Smith-Lever 3(b)(1) and (c) funds.

California AES and CE programs were planned and conducted so as to form a seamless continuum from creation and development of new knowledge to the dissemination and application of that new knowledge. Research and extension programs were coordinated at a statewide level by four Program Leaders - Agricultural Policy and Pest Management, Agricultural Productivity, Human Resources, and Natural Resources - who promoted the integration of research and extension goals and activities across and within AES and CE.

The Program Leaders had oversight of a network of "workgroups," each of which brought together AES and CE personnel collaboratively as they planned and coordinated research and extension programs in a particular high priority program area. Workgroups also included clientele and other external stakeholders as appropriate. Through the workgroups, research goals were developed that addressed practical information needs and mesh with outreach and educational capabilities. Likewise, extension goals were defined in keeping with the available and anticipated stream of research findings.

Many campus-based faculty held joint appointments in CE and AES, thus fully integrating the research and extension functions. The growing number of these appointments ensures that the research generated on campuses has the natural conduit to the CE counterparts in the counties and most importantly, to the end user clientele. In addition, the CE specialists are academic members of appropriate campus departments, facilitating their role as the link to the CE county advisors' programs.

The complete integration of strong AES and CE programs in the University of California ensures that stakeholder needs are identified at the local and statewide level and are brought to the campus researchers' attention. Working closely with their CE counterparts, CE Specialists and county advisors, the AES scientists can then design research projects that will address the stakeholder issues. Results of the research are then applied and disseminated through the CE county programs.

The Rice Workgroup demonstrates the AES/CE continuum at work. The Workgroup members from different organizational units work seamlessly in relation to planning, research coordination and extension activities. AES, CES, and CE members collaborated to plan and write numerous successful research proposals within the last year. Funded research includes such diverse topics as management of herbicide resistant weeds, integration of waterfowl into rice cropping systems, methane emissions, and application of remote sensing to site specific farming. A notable accomplishment in this regard is a recently funded project designed to address questions of water quality. The Rice Workgroup, as the team leader, in collaboration with the California Rice

Commission, California Rice Research Board, Regional Water Quality Board, USDA, Rice Experiment Station, and collaborating growers successfully crafted a multi-million dollar CALFED funded project to investigate rice farming system dynamics in context of water quality. The project embodied DANR mission priorities and was timely in the context of recent changes in agricultural water discharge changes.

Another example of Workgroup team building included working closely with industry, state and federal personnel to evaluate grain grade appraisals at the CDFA laboratory; securing funding for an experimental plot combine ($150,000 obtained from non-UC sources thus far), partnerships to secure research grants, grower education programs and publishing costs of research results.

Outreach remained a high priority of the Workgroup. Campus based members frequently make presentations and assist with field days at the county level. The Rice Workgroup embodies very well the Land Grant model of a programmatic continuum between campus and community. The Workgroup worked diligently to build strong linkages with different segments of the industry to improve coordination of efforts and identify high priority issues affecting clientele.

The Workgroup initiated a committee of industry representatives and Workgroup members to collectively prioritize concerns and research initiatives. Representatives from the California Warehouse Association, Farmers Rice Cooperative, California Rice Commission, the Rice Experiment Station, and the Rice Research Board worked closely with DANR personnel in this endeavor. This was a landmark effort to pull together the various factions of the rice industry to collectively address problems. Workgroup members collaborated with California Rice Commission on the implementation of the Rice Certification Act legislation and played a deciding role in the recent debate over the proposal to commercially produce genetically modified rice in California.

Leadership provided by DANR Workgroup members that provided the catalyst for these actions and many others cannot be understated. Rice industry representatives recognized the utility of the DANR Workgroup structure in facilitating interaction with the University and for partnership building to better serve the citizens of the state.

The UC rice program has historically maintained close industry ties and excellent financial support that leads to high expectations of information delivery. To that end, the Workgroup crafted a statewide newsletter that portrays the breadth of UC rice work. The overall objective was to improve the educational impact and visibility of the UC rice program, while promoting collaboration between AES and CE. As a result, they launched a high quality, professional newsletter. Workgroup funds were used to supplement and remain essential to this important outreach effort. The California Rice Commission covers the cost of mailing. The newsletter is mailed out to over 3000 recipients on a quarterly basis. The most recent edition can be viewed at: http://agronomy.ucdavis.edu/uccerice/NEWS/news.htm.

Rice Quality Workshop: Workgroup members from CE and AES collaborated on a one-day workshop in August 2003. Over 100 farmers and agricultural professional attended the annual Workshop, sponsored by the California Rice Commission. The objective was to provide practitioners with useful ‘how-to’ information in a classroom setting designed to encourage

meaningful discussion and learning. The 15 chapter workbook written specifically for and used for instruction at the workshop has become an industry standard. Attendance of the workshop is required training by some rice farms and processors for employees. Over 1000 of the Rice Quality Manuals have been distributed to clientele in California, several states, and six countries.

Rice Production Workshop: Workgroup members from CE and AES collaborated on a one-day workshop held at two locations in March 2004. The California Rice Research Board offered financial and organizational support. This was the first year that the workshop was offered. Nearly 200 people attended. A 10-chapter notebook covering production related topics from land preparation to harvest was written expressly for the workshop. All participants received a copy. Attendee response was very positive. This will become an annual Workgroup educational and outreach activity. The outcome of this activity is that a Rice Quality Manual is being developed by Workgroup members with plans to publish it as a DANR publication. Additionally, these workshops demonstrate the productive alliance between the UC Rice Workgroup and the agricultural industry. Moreover, our educational programs embody the continuum from research to extension and exemplify the continued relevance of the Land Grant mission.