UNIVERSITY OF CALIFORNIA
DIVISION OF AGRICULTURE AND NATURAL RESOURCES

FY 2005
ANNUAL REPORT OF ACCOMPLISHMENTS AND RESULTS

AGRICULTURAL EXPERIMENT STATION
AND COOPERATIVE EXTENSION

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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 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, 480 local extension programs were delivered in this program area. In addition, 39 statewide collaborative workgroups and 5 continuing conferences composed of both AES and CE academics planned and conducted research and extension projects. UC ANR has 6 Statewide 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 21 patents, and published 835-reviewed articles and 44 extension publications that addressed Goal 1.

FY 2004-2005 Allocated Resources

Extension Federal Funds (Smith Lever 3 b&c)	Extension State Match	Research Federal Funds (Hatch)	Research State Match
$3,067,108	$3,067,108	$2,988,338	$2,988,338

Extension FTE	Research FTE
104.14	212.60

Theme: 1.02 Agricultural Competitiveness
Title: CITRUS VARIETY COLLECTION

Description: The citrus industry in California is a three-quarter-billion-dollar industry, placing citrus in the top 10 of California crops. Oranges, lemons and grapefruit are also individually among the top 30 of California export crops. To sustain this level of productivity and competitiveness, UC breeders and researchers and the citrus industry must have access to collections of citrus genetic resources.
Impact: The range of diversity within the collection creates a priceless resource for research. Currently, the collection serves approximately 40 research projects covering a range of topics including citrus breeding; the study of the biological activities of citrus limonoids as anticancer agents; characterization of the different types for commercially important traits such as disease resistance/susceptibility; and the isolation, mapping and transferring of specific genes. In addition, the USDA-ARS National Clonal Germplasm Repository for Citrus and Dates in Riverside uses the collection as its field site to fulfill its mission to acquire, preserve, distribute and evaluate genetic diversity. The CVC is the major source of observations documented on the National USDA GRIN database, available for the public on the Internet.

Beyond the research mission, the Citrus Variety Collection serves as a resource for many extension activities. Industry representatives visit the collection to evaluate potential commercial varieties. The collection itself serves as a source of citrus for numerous fruit displays; for teaching at UCR and local schools; and for the Riverside Orange Blossom Festival, which has provided samples to approximately 30,000 people annually for the past eight years.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 1.02 Agricultural Competitiveness
Title: COTTON UPLAND VARIETY EVALUATIONS

Description: Difficult economic times and the introduction of transgenic cotton varieties in other parts of the United States have caused California cotton growers to wonder if they have been missing a valuable opportunity by not making use of varieties grown elsewhere. Changes in the San Joaquin Valley cotton-quality law, in 1999, have allowed farmers there to grow a much broader range of cotton varieties. However, many varieties originated outside of California and little was known of their yield potential and adaptability to San Joaquin Valley conditions--for example, their susceptibility to fungal organisms such as Verticillium. Growers needed independent, scientific evaluations of the suitability of these varieties for San Joaquin Valley production. Since 1999 UCCE trials have been conducted in San Joaquin Valley counties (Kern, Kings, Tulare, Fresno, Madera and Merced) to provide a continuing evaluation of various cotton varieties from elsewhere for crop earliness, susceptibility to diseases, potential for higher yield, and fiber quality. Each year as many as 18 to 21 newcomers were compared to Acala or Pima varieties. To determine crop responses under a range of environmental conditions and management, the research was conducted in large-scale field trials on grower fields and UC Research Center plots. The trials focused on mapping data to determine primary plant growth characteristics related to fruit development and timing important to yield and earliness. Information collected in these trials has been reported at UC and industry meetings, and has been made available in both UCCE newsletters widely distributed in California and on a UC cotton web site (cottoninfo.ucdavis.edu) where multiple years of yield and fiber quality data can be reviewed at any time.
Impact: This program has provided growers year-by-year updated comparisons of lint yield and fiber quality of non-Acala Upland cotton varieties widely grown elsewhere, compared to standard Acala varieties. Also, non-Acala Upland varieties with true short-season growth characteristics have been identified for potential use in double-cropping situations. This UC-developed information is crucial to growers and industry in deciding if higher lint yields possible with many
non-Acala Upland varieties offset some of the low fiber quality issues identified with those varieties.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 1.02 Agricultural Competitiveness
Title: ECONOMICS OF COMMODITY MARKETS AND COMMODITY PRICE BEHAVIOR JUSTIFICATION

Description: This project was devoted to the development of a textbook on commodity futures and options markets. The book is now published and it has received good reviews,

with two 5 star reviews at amazon.com. It was published in November 2002 and the University of Maryland and Texas A&M have decided to adopt the book for their futures and options classes.
Impact: This book will be helpful to students and practitioners with an interest in commodity futures and options markets. These markets serve as mechanisms for price discovery and risk shifting. Commodity price risk is a critical issue facing California agriculture

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.02 Agricultural Competitiveness
Title: AGRICULTURAL POLICY, TRADE AND ECONOMIC WELFARE

Description: Work on this project involved the analysis of state trading enterprises, the importance of the WTO negotiations and other policy developments for California agriculture. An edited book on Agricultural Policy Reform and the WTO was published in 2004.
Impact: Trade is extremely important for California agriculture and this project helped identify how the WTO negotiations will impact California agriculture.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.02 Agricultural Competitiveness
Title: EMERGENCE OF CHINA AS A TRADING NATION AND ITS IMPACT ON GLOBAL FOOD MARKETS

Description: While the economy as a whole benefits from accession to the WTO, the case of agriculture is somewhat mixed. Producers of rice, most vegetables and fruits, many livestock and aquatic products and other higher-valued, labor-intensive goods will benefit if trade liberalization leads to higher exports. While maize, cotton and wheat farmers will be adversely affected, since most farmers are diversified and able to change product mix when relative prices change, the overall cost will be small. The only groups that are likely to be adversely impacted are a subset of poor, inland farmers. China needs to make complementary policy changes. The WTO agreement challenges China's farmers with competition in output markets from producers in the rest of the world. To compete, farmers need to have access to low-cost inputs and high-quality technologies. There are many restrictions keeping seeds and other inputs from moving around the country. There also are barriers against importing inputs and technologies or investment by foreign technology firms. These should be sharply reduced and eventually eliminated to improve the income of farm households. International experience shows the entry of foreign seed and technology firms into the country could lead to more competition and better transfer of technology.
While most of the facts on the accession of WTO are well known, China faces another set of issues in how they should move forward in the next round of international trade talks. While

there is always going to be uncertainty, research by economists inside and outside of China are producing many ideas with broad consensus. On the three 'pillars' of WTO agriculture negotiations now underway - market access, reducing export subsidies, and reducing domestic supports - China's interests lie in a robust liberalizing outcome to negotiations. China's analytical capabilities in agriculture policymaking have increased significantly in recent years. Although still far behind many nations, for the first time China has the expertise to make quantitatively derived choices about the best directions for its welfare. Chinese leaders know what is good for them and can pursue it with new confidence as a result. China's agriculture is evolving in the direction of national comparative advantage, in terms of sown area, investment in R&D and exports. China is shifting toward labor-intensive, high-value added production, instead of the land-intensive crops it emphasized in the past and where it has less comparative advantage. The negative impact some expected on China's agriculture has not occurred; China's agriculture is doing well post-WTO. China is increasingly concerned about market access problems abroad, as its competitive exporters bump into tariff and non-tariff barriers. Like all economies, China must address concentrated economic pain from structural adjustment at home if it is to push further reform; but China has sufficient WTO-consistent means to do so while remaining a good player internationally. If China can continue to improve in managing ongoing trade problems, it could gain in credibility that will allow it to be a positive player in future trade reform efforts.
Impact: The information in the corn report was made available to members of the US Grains Council that were in contact with the embassy officials in China who were negotiating with China to stop or reduce the subsidies that were being given to corn producers/traders. The information from the soybean report have been used by the American Soybean Association personnel to lobby for freer soybean trade, showing how even with the rise of soybean imports, prices did not fall and production was steady (and consumers and those in the livestock sector benefited). The work on horticulture has been the basis for educating many grower groups in California about the opportunities and competition that China will give to California in the coming years.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.02 Agricultural Competitiveness
Title: Volatility and Efficiency in Commodities Futures and Options Markets

Description: When they operate efficiently, futures markets are vital in risk management and cost minimization for participants in commodity markets. In this research program, a researcher studied the dynamic properties of commodity futures prices and made recommendations for improved risk management and market design. Contracts with various delivery dates trade simultaneously in commodity futures markets. However, applied researchers typically reduce the data to a single time series by choosing only one price observation per day. A common method for such a reduction entails splicing together the nearby contracts, i.e., when a contract matures, take the next observation in the series from the contract that is the next closest to delivery. This strategy precludes a full understanding of

these markets and induces complicated nonlinear dynamics around the points where the spliced series switches from contract to contract. In a forthcoming article in the Journal of Applied Econometrics, the researcher develops the partially overlapping time series (POTS) model to model jointly all traded contracts. The POTS model is applied to corn futures at the Chicago Board of Trade and the results uncover substantial inefficiency associated with delivery on corn futures. The researcher is working currently on several articles that will follow directly from this paper. First, the POTS model is used to assess the efficiency of the delivery mechanism in various commodity futures markets. Using a rational expectations storage model that market frictions around the delivery location can cause excess volatility in futures contracts that are close to delivery. The POTS model is then used to show that such excess volatility exists in the data, and then how this excess volatility differs across commodities, markets, and delivery institutions is explained. These differences will hopefully lead to recommendations for changes in market structure. Second, although futures markets play an important role in risk management, their benefits can quickly erode if inefficiencies arise. One symptom of inefficiency is excess volatility, which occurs if the futures price fluctuates too much relative to the underlying fundamental price. In the ARE Update publication and in ongoing work, this researcher uses the POTS model to show that cotton futures prices exhibit excess volatility for contracts that are close to delivery. This result derives an optimal hedging strategy for production and storage hedgers and illustrate the strategy for hedgers in several U.S. states.
Impact: Research in this area has produced strategies for California producers to effectively manage commodity price risk, as demonstrated for cotton in the ARE Update publication, and it will generate policy recommendations for improving market structure. In addition, this project has yielded a useful new method for modeling volatility dynamics and measuring inefficiency in futures markets. Finally, the POTS model will be valuable in pricing options on futures contracts and in analyzing price relationships across related commodities.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.02 Agricultural Competitiveness
Title: Mergers in Vertically Separated Markets and Wholesale Price Discrimination in Agricultural and Resource Markets

Description: Given the main data source, the research question is to assess the heterogeneous welfare implications of simulating changes in one of the major components of the dairy program: the dairy marketing order classified pricing, consisting of wholesale price discrimination for milk sold to be used in the production of fluid and non-fluid milk products. Data sources have been compiled and combined with institutional information on geographical dairy marketing order areas before and after 1999. The main data source obtained for studying the heterogeneous welfare implications is a scanner purchase data-set on dairy products sold at different geographical markets over the time period of three years. Products have been defined for a multinomial specification of a demand

model for fluid and non-fluid milk products. Auxiliary data on consumer demographics has been gathered. A model of vertical interactions between farmers, processors and final distribution and retail has been specified, taking into account the most frequently purchased/sold fluid and non-fluid milk products.
Impact: When price discrimination in allowed, and even enhanced by legislation (such as milk marketing orders) in the markets, wholesalers will set different prices for the same product if sold to different downstream markets. In particular, a lower price is set in more price sensitive markets and a higher price charged in low price sensitive markets. Whether welfare increases or decreases as a result of changing retail prices due to the elimination of upstream price discrimination is an open empirical question. And this question is of policy relevance in a variety of markets. The project is expected to provide the first welfare estimates from simulating a restructuring process in dairy industry. Given the data being collected, potentially we can do this simulation and provide results on the effects of policy reform on prices and welfare distribution not only for a particular representative geographical market but also for different markets in the U.S.. The results will also provide very useful information on the general question of the welfare effects of eliminating wholesale price discrimination in other markets, such as gasoline, where several states are passing and enforcing uniform wholesale price legislation.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.03 Agricultural Profitability

Title: UC'S CROP DETECTIVES

Description: A myriad of problems plague crops, including biotic pests such insects, plant diseases, weeds, vertebrate animals and nematodes. In addition there are potential problems from non-biological factors such as adverse temperatures, salinity, fertilizer injury, phytotoxicity and wind. When something goes wrong with a crop, who does the farmer call to help investigate? One logical answer is the pest control advisor, fertilizer dealer, the seed salesperson and perhaps other farmers. But if the problem still is not solved, then who can the farmer turn to?
Impact: Examples:

--A farmer shows the advisor a field of lettuce, yellow and scorched on the leaf-margins. He plans to apply more nitrogen fertilizer. The advisor runs a quick soil test and finds extremely high levels of nitrogen. (The previous crop, onions, had been heavily fertilized.) The advisor recommends sprinkler irrigation to flush the excess nitrogen from the root zone. The crop yield was normal. Saving to the farmer: about $40,000.

--Another lettuce grower plans to treat his field for powdery mildew. The farm advisor determines that the infection is another pest, downy mildew. The treatment would have

been useless and the crop destroyed by the disease. In a 40-acre field, the grower would have lost $76,000.
--A field of watermelons is wilting and dying. A plant pathologist farm advisor determines that the problem is a soil-borne fungal disease. The melons are lost, but the advisor provides a crucial warning: Do not, as planned, grow cantaloupes as a rotation crop--they're susceptible. The grower switches to broccoli and saves an estimated $30,000.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 1.11 Biotechnology
Title: RESEARCH LEADS TO ELEVATED VITAMIN C IN PLANTS

Description: Vitamin C is an essential human nutrient promoting tissue, cardiovascular and immune functions; but as much as 30 percent of the U.S. population, especially the elderly and low-income, do not receive the current recommended daily allowance of 75-90 milligrams, an amount that some health officials suggest should be raised to 200 milligrams. Increasing the level of vitamin C in grains and other crops would provide a means to deliver more of the needed nutrient to the world population. A UC Professor of Biochemistry at the University of California, Riverside, and a researcher with the UC Agricultural Experiment Station, together with his research team, worked for five years to develop corn and tobacco (used as a model for green, leafy plants) with raised levels of vitamin C. Most plants rapidly lose the ascorbic acid, or vitamin C, they produce. The team overcame this by causing the plants to overexpress a plant enzyme, dehydroascorbate reductase (DHAR), responsible for vitamin C recycling. They isolated DHAR cDNAs from wheat and introduced them into tobacco and corn using technology developed by the professor.
Impact: As described in an article in the March 18, 2003, issue of the Proceedings of the National Academy of Sciences, the altered plants increased their DHAR activity by 11- to 100-fold. The amount of vitamin C in the leaves and kernels of the plants also increased two to four times.

Grains are the major source of nutrition for the world's population, yet they do not contain high levels of vitamin C. This research lays a foundation that can be used to increase the nutritive value of grains and other foods. This will enable people to obtain the recommended daily allowance of vitamin C more readily.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.11 Biotechnology
Title: Novel Technology for Stabilization of Biological Cells in the Dry State

Description: This project is aimed at achieving stabilization of living cells in

the dry state. In the past year we have: (1) provided a mechanism by which the sugar trehalose maintains lipid domains in dry membranes; (2) investigated the mechanism of interaction between membranes and stress proteins; (3) provided a structural characterization of proteins involved in stabilizing membranes under stress.
Impact: These studies are already leading to applications in the worlds of human therapeutics, biosensors, and gamete biology.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.11 Biotechnology
Title: Agricultural Sustainability Through Biotechnology

Description: Several aspects of the project were advanced during this year. In particular, tissue cultures of blueberry and tomato were initiated and capacity for in vitro regeneration were studied. Preliminary transformation experiments were initiated on these species, and several DNA constructs were designed to provide a vector with potentially useful traits for transfer to relevant crop species. The project also initiated work with the DHAR gene construct in collaboration with a UCR Biochemistry professor. They hope to transfer this gene into crop species to facilitate improved water use efficiency.

Impact: This program is designed to enable the application of biotechnology to enhance sustainable production of Californian crops.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.13 Diversified/Alternative Agriculture
Title: AGRITOURISM MANUAL HELPS CALIFORNIA FARMERS GROW ECONOMICALLY

Description: The University of California (UC) Agriculture and Nature Tourism Workgroup had a goal: to produce a comprehensive manual, providing information on starting, maintaining and expanding an agritourism or nature-tourism venture. The result is a 250-page manual covering such myriad topics as assessing one's business, marketing and promotion, employee management and relations, regulatory compliance, and business-plan development. Widely considered the definitive guide for California agritourism and nature tourism, the manual is currently being used by several organizations involved with economic development in the state's rural and agriculturally depressed regions. Completed in 2002, the UC manual sold out in only six months. However, an updated, Fall 2005 edition is currently available, published by ANR. To order Agritourism and Nature Tourism in California online, visit: http://www.sfc.ucdavis.edu

Impact: The UC Workgroup has trained over 900 farm operators across California in diversifying their businesses with tourism. Using the UC manual as a guiding tool, ranchers and farmers in diverse communities are taking preliminary steps toward embarking on new tourist ventures.

Funding Source: Smith Lever and State
Scope of Impact: State

Theme: 1.16 Grazing
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 which 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 UCCE Weed Science Advisor Carl Bell, we 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 Entomology Advisor Eric Natwick, 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: 1.16 Grazing
Title: Management of Spatial Patterns of Plants and Livestock Impacts

Description: Data were analyzed, interpreted and publications prepared. Modeling of animal behavior and spatial choice was undertaken. Researchers modeled choice of area by cattle on the basis of topography, forage distribution, and time of the day. Cattle were observed while grazing large paddocks to calibrate activity sensors of GPS collars.
Impact: The basic information they generated and published provides guidelines for land and livestock managers to control spatial distribution of resource use. By careful spatial and temporal distribution of attractants and repellants, managers can promote lighter use of sensitive areas, and heavier use of areas that are infested with weeds or that need heavier grazing.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.17 Home Lawn and Gardening
Title: FAIR OAKS HORTICULTURE CENTER

Description: Both the public and landscape professionals need hands-on information about growing edible and water-efficient landscape plants to complement information provided by UC publications and web sites. The Fair Oaks Horticulture Center is a collaborative project of Sacramento County UC Cooperative Extension, the Fair Oaks Recreation and Park District and the Fair Oaks Water District. The Center provides a hands-on facility for teaching both landscape professionals and the public how to grow fruit trees, grapes, berries, vegetables and landscape plantings using the least toxic and most water-conserving methods. Each year UC Master Gardeners offer several Saturday morning public workshops at the Center, as well as the annual Harvest Day.
Impact: In 2002, more than 2,000 people attended the workshops and tours and over 700 attended Harvest Day 2002. The newly installed 1/2-acre water-efficient landscape demonstration gardens will include handicap-accessible pathways and signage for a self-guided tour.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 1.18 Innovative Farming Techniques
Title: MICROIRRIGATION: MANAGEMENT PRACTICES TO SUSTAIN WATER QUALITY AND AGRICULTURAL PRODUCTIVITY

Description: Over the past five years, two separate investigations were initiated and completed that focused on the following objective of this project: to improve, modify, and evaluate microirrigation system design and components for natural resource protection and optimal crop production. In the first investigation, a mathematical model was developed to simulate the effects of emitter clogging in microirrigation subunits and was later validated with field data. Emitter clogging is an important problem associated with the operation and maintenance of microirrigation systems. Clogging leads to incorrect water application, resulting in plant stress in dry areas and water loss in wet areas. The mathematical model included a set of equations based on fundamental hydraulic principles and inlet lateral discharge relationships, and used a nonlinear equation solver. Different lateral clogging rates, ranging from 0% to 100%, were simulated in the study. Clogging was also simulated at different locations along the manifold, including sections near the manifold's upstream, middle, and downstream points. The results of the study indicate that to reasonably detect clogging rate and location, the pump pressure head value and manifold pressure head profile need to be monitored. Pressure transducers are therefore needed at the pump, manifold inlet point, manifold endpoint, and few other selected points along the manifold

depending on the cost and manifold length. In the second investigation, 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. 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. In phase one, a step-by-step (SBS) model was built to simulate the effects of study variables on lateral hydraulics. 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% 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.

Funding Source: Multistate Research and State
Scope of Impact: AZ, CA, CO, FL, IA, ID, KS, LA, NM, NYG, OH, OR, PR, TX, UT, VI

Theme: 1.19 Invasive Species
Title: CONSERVATION AND RESTORATION OF GRASSLAND AND OAK SAVANNA PRODUCTIVITY AND BIODIVERSITY

Description: Researchers have been investigating the relationship between the native plant diversity of local communities and how invasible they are by exotic species, and how this changes depending on the spatial scale considered. While small-scale studies tend to show that more diverse native communities are less invasible by exotics, studies at large spatial scales often find positive correlations between native and exotic species diversity. It is thought that this large-scale pattern arises because landscapes with favorable conditions for native species also have favorable conditions for exotic species. Research at the U.C. McLaughlin reserve developed empirically based theory that links native and exotic diversity at small scales with the relationship between native and exotic diversity at large scales. The relationship between cumulative native and exotic diversity (gamma diversity) depends on both 1) the relationship between mean native and exotic diversity (alpha diversity), and 2) the relationship between native and exotic among site (beta) diversity. In a nested data set for serpentine grassland, researchers detected negative relationships between native and exotic diversity at small spatial scales and positive relationships at large spatial scales. The positive relationship between cumulative native and exotic diversity at large scales was driven by the relationship between native and exotic beta diversity. This led researchers to hypothesize that the relationship between native and exotic diversity at large spatial scales depended on the spatial heterogeneity of extrinsic (e.g. abiotic) conditions, rather than the average extrinsic conditions. The field data from an intensively sampled field grid supported this hypothesis. Both cumulative native and exotic diversity were positively correlated with spatial heterogeneity in abiotic conditions (variance of soil depth, soil nitrogen and aspect) but were

uncorrelated with the average abiotic conditions. Similarly, both native and exotic beta diversity were positively correlated with spatial heterogeneity in abiotic conditions but were uncorrelated with mean abiotic conditions. Researchers conclude that native and exotic diversity covary at large spatial scales because of spatial heterogeneity in the environment, and not because of how favorable the environment is on average.
Impact: Invasive species have a major impact on the economy of California and society at large. In particular, invasive species threaten rangeland productivity and the conservation of biodiversity on range and wildlands. This research provides critically needed information on how spatial heterogeneity influences the covariance of native and exotic species diversity at large spatial scales. This information can be used by land managers to understand why some plant communities are more vulnerable than others to invasion.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.19 Invasive Species
Title: INTERACTIONS AMONG BARK BEETLES, PATHOGENS, AND CONIFERS IN NORTH AMERICAN FORESTS

Description: Pitch canker of pines and Douglas-fir is caused by the fungus Fusarium circinatum. In California, infections by F. circinatum occur largely through insect caused wounds. Field experiments were initiated to determine whether the colonization activities of twig beetles, Pityophthorus spp. (Coleoptera: Scolytidae), could explain the incidence of pitch canker on Monterey, Bishop, ponderosa, and knobcone pines and Douglas-fir. Asymptomatic branches were cut from each of four pairs of tree species (Monterey-Bishop, Monterey-ponderosa, Monterey-knobcone, Monterey-Douglas-fir) in each of 4 sites and attached to the lower canopy of both heterospecific and conspecific host trees (total 4 combinations per pair). After 10 weeks, branches were collected and placed into rearing tubes in the laboratory. Emerging insects were identified and placed on a Fusarium-selective medium. Monterey, Bishop and ponderosa pines were more heavily infested by Pityophthorus spp. than Douglas-fir and knobcone pine. Furthermore, more Pityophthorus spp. emerged from Monterey pine branches placed in Monterey pine canopies than from Monterey pine branches placed in Bishop or ponderosa pines, indicating that reduced emergence (colonization) was caused by the heterospecific host. Relatively fewer insects emerged from sites either containing Monterey and knobcone pines or Monterey pine and Douglas-fir. Fusarium circinatum was not isolated from emerging Pityophthorus spp. Susceptibility of the five host species, based on mean lesion lengths resulting from mechanical inoculations, varied significantly. The longest lesions were on Monterey pine and the shortest were on ponderosa pine and Douglas-fir. The low incidence of pitch canker on Douglas-fir and ponderosa pine in nature compared to Monterey, Bishop and knobcone pines may be explained by the low colonization by twig beetles and greater resistance of Douglas-fir and ponderosa pine to this disease, compared to the other three hosts. Same- symptom (Phytophthora ramorum) cohorts were followed from March 2000 through March 2003. In the asymptomatic Q. agrifolia cohort, 11.5% developed bleeding, but only 0.4% of these trees died. For the bleeding only cohort,

22.7% of Q. agrifolia died, but 73.5% of the beetle-colonized bleeding cohort died. Of the initially asymptomatic L. densiflorus cohort, 40.9% were bleeding by 2003, and 9.6% of this cohort had died with bleeding. By 2003, 24.6% of the initially bleeding L. densiflorus cohort had died. The median survival time estimated by Weibull regression models declined rapidly by disease category (asymptomatic, bleeding only, bleeding with beetles), from 29 years to 2.7 years for Q. agrifolia, and from 12.6 years to 2.9 years for L. densiflorus. By 2003, structural bole failure had occurred in 21.5% of the Q. agrifolia that were bleeding in 2000, 93% of which had ambrosia beetle tunnels at the breakage point. For both Q. agrifolia and L. densiflorus, health failure analysis modeled by Weibull regression found a greater probability of developing sudden oak death for trees with larger stem diameters. Beetles were also positively correlated with larger diameter Q. agrifolia.
Impact: These studies attempt to determine the role of bark beetles in the death of trees, such as spreading the pathogen to new areas and hosts and causing structural failure of infected trees. These investigations are important to the development of management guidelines for these new destructive diseases that are becoming more widely distributed in California's wildland and urban forests.

Funding Source: Multistate Research and State
Scope of Impact: CA, CO, FL, ID, IA, KY, OH, UT, WI

Theme: 1.19 Invasive Species
Title: INSECT INVASIONS: MOLECULAR GENETICS, DATABASE AND MODELING APPROACHES

Description: This project contains 3 elements, molecular genetics, databasing, and modeling.
1. Molecular Genetics- Researchers continue to develop genetic methods for the studies of origins and biology of non-indigenous, invasive (exotic) insects. The insects that were worked with this year include a number of tephritid fruit flies (Medflies, Mexican fruit fly, walnut husk fly, pumpkin fruit fly, olive fly, flies in the Bactrocera dorsalis complex), rice brown planthopper, Argentine ant, glassy-winged sharpshooter, and some insect parasitoids used for biological control. Researchers have developed methods to distinguish between ancient and recent (cryptic) invasions of insects and we have developed markers for new species. This is a collaborative work effort between researchers in Riverside, CA, Australia and Italy.
2. Database- Researchers are continuing to develop a prototype of a database of exotic organisms which includes exotic insect pests of California and the Pacific Rim, original and current distributions, as well as links to ecological and genetic data. This is a collaborative work effort with researchers in San Diego, Berkeley, CA and Moorea as well as database scientists with the UC Berkeley Natural History Museum. They are using a Distributed Generic Information Retrieval (DiGIR) model in which different databases can be queried from a central location. To date, they have linked the Essig Museum (UC Berkeley), the Australian National Insect Collection, (CSIRO, Australia), and the Bishop Museum (Honolulu).
3. Modeling- Researchers are building on their prior approach to analyze recent histories of populations (available on the web at http://www.bio.sdsu.edu/pub/andy/ESP.html). They are

continuing the use of approximate Bayesian methods to estimate simultaneously relevant population parameters of population size and dispersal.

Impact: Methods and analytical methods have been developed for studying the biology and history of invasive insects that are economically important for agriculture, biodiversity, and human health. The approach uses molecular genetics, databases, and computer modeling.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.19 Invasive Species
Title: MICROBIAL ECOLOGY OF SAP-FEEDING INSECTS

Description: Effects of sublethal doses of pesticides on flight of glassy-winged sharpshooters (GWSS)- A rotary flight mill was used to study the effects on insect flight of sub-lethal dosages of soil-applied imidacloprid. Over 90% of males and females flew at least 60 m ('fliers') during the 6-12 hour flight trials; over 90 % of total distances were flown by individual fliers the first 4 hours. GWSS flew up to 4.2 miles (6.8 km) in a 4 hr period. Soil-applied imidacloprid (Admire) dosages that caused 33% mortality during a 24-hr exposure to treated plants reduced average flight performance of surviving GWSS, but some of the insects that survived this exposure flew almost normally. Dosages that caused about 10% mortality and that have been shown to drastically reduce GWSS feeding did not significantly reduce flight on flight mills. Admire treatments probably reduce long distance movements of GWSS from treated crops having sap concentrations of imidacloprid that kill at least 30% of the GWSS within 24 hours. Adult GWSS not exposed to insecticide treatment flew an average of 3.9 km for males, 2.5 km for females. Secondary bacteria in GWSS- A wide-ranging search for secondary symbionts of the GWSS did not identify candidates for studies oF biological effects on this insect. The prevalence of a Wolbachia species, and the well known importance of Wolbachia to other insect hosts make it the best candidate to pursue in further studies. Role of bacterial attachment in transmission of Xylella Fastidioda (Pierce’s Disease)- Blue-green sharpshooters (BGSS) were fed 4 days on grapes with Pierce's disease, followed by a week on test plants. Scanning electron microscopy consistently revealed extensive monolayers of cells of Xylella fastidiosa (Xf) in the precibarium, the narrow channel leading from the junction of the stylet mouthparts with the head to the entrance of the sucking pump. BGSS given short acquisition and inoculation periods that transmitted Xf to test plants also had small colonies or isolated attached cells of the bacterium in the precibarium. Findings are consistent with the hypothesis that Xf must be present in this small area of the sharpshooter foregut and also consistent with reports that small numbers of Xf cells in this area are adequate for efficient transmission. Patterns of movement of X. Fastidiosa in plants- Anatomical comparisons of three cultivars, 'Sylvaner' (least susceptible), 'Cabernet Sauvignon' (moderate) and 'Pinot Noir' (most susceptible) revealed that all three varieties had similar numbers, lengths and distributions of xylem vessels. In four symptomless alternate hosts: morning glory (Ipomoea purpurea), mugwort (Artemisia douglasiana), sunflower (Helianthus annuus) and annual bur- sage (Ambrosia

acanthicarpa), the longest vessels measured were less than 13 cm long, whereas in grapes the longest vessels averaged 62 cm. A green- fluorescing protein (GFP)mutant of X. fastidiosa was useful in visualizing this bacterium within plant tissues. The use of GFP-mutants enables details studies of the fate of the bacterium in a variety of plants.
Impact: 1. Flight mills are useful to estimate the flight potential of GWSS and lab experiments with flight mills revealed that GWSS adults are capable of flying several miles without feeding. Imidacloprid, which is widely used to control GWSS has the added benefit besides killing GWSS of reducing its ability to move from plant to plant at doses that kill less than half the insect in a single days exposure, but lower doses that still kill some (about 10% or less) GWSS did not significantly reduce flight performance. 2. GFP-mutants of Xylella fastidiosa are useful to track this bacterium's movement and colonization patterns in a variety of plants. Xylem vessel length does not explain differences in susceptibility to Pierce's disease, caused by X. fastidiosa. 3. Studies of where X. fastidiosa occurs in the foreguts of transmitting sharpshooter vectors support the hypothesis that bacteria colonizing the entrance to the insects' pumping chamber are adequate for their vector transmission to plants. This is consistent with previous findings that very few (<200) cells in a vector's foregut are sufficient for efficient transmission.

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) Cell size, minimum cell cycle time and cell doubling time as well as the meristem size of invasive and non-invasive species will be measured. Relationships between genome size, cell cycle time, cell size, meristem size, growth characteristics, minimum generation times, seed mass, and rates of spread will be evaluated. (2) Changes in light environment, soil resources, and composition of native vegetation will be related to frequency, density, and biomass of invasive species. (3) Species diversity of naturalized and invasive species will be assessed based on published records, unpublished data, and herbarium specimens. (4) Data on relationship between eradication

effort and initial size of exotic weed infestations will be evaluated for California and other areas.
Impact: (1) A phylogenetically controlled comparative study of 26 invasive and noninvasive woody angiosperm species revealed that seedling relative growth rates are promising indicators of species invasiveness. (2) Seedling growth analysis of exotic Acacia species cultivated under different moisture/desiccation regimes revealed that, among 12 species commonly cultivated in California, ACACIA FARMESIANA and A. CYCLOPS are most drought tolerant and therefore most likely invasive. These two Acacia species are very difficult weeds in some other countries where they were introduced. (3) In Taiwan, the strong correlation between reproductive traits and invasiveness of five introduced Crotalaria species was found. (4) An analysis of data from 50 US states showed that the total numbers of naturalized plant species could serve as a reliable predictor of the numbers of alien pest species. (5) A general theory of seed plant invasiveness was further elaborated.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.19 Invasive Species
Title: MARINE BIODIVERSITY: IMPORTANCE FOR ECOSYSTEM FUNCTION AND RESISTANCE TO EXOTIC SPECIES INVASION

Description: This project is focused on two related issues: the effects of the loss of biodiversity on the functioning of marine ecosystems, and the causes and consequences of invasion of marine systems by non-indigenous species. First, advisors are manipulating the diversity of intertidal seaweeds at the Bodega Marine Reserve to assess the effect of species diversity on the primary productivity and biomass of the macroalgal community and the diversity, and abundance of mobile and sessile invertebrates. The preliminary findings facilitated the submission and funding of a larger grant funded from the National Science Foundation that began in March 2004. Ongoing work has demonstrated that algal species are complementary in their use of different pools of nitrogen, and increasing algal diversity may increase the productivity of intertidal systems by increasing total nitrogen influx. As an offshoot of this work, we have demonstrated that increasing genotypic diversity in the seagrass Zostera marina enhances the resistance of an entire community to disturbance. Because this seagrass is the only macroscopic plant in the system, the stabilizing effects of seagrass genetic diversity cascade to the variety of commercially and ecologically important invertebrates and fishes that use seagrass beds as a nursery grounds. These results also support theory suggesting that diversity at any level should be effective at providing biological insurance against environmental change. This research has direct application to seagrass restoration efforts currently required as mitigation in dredging and coastal construction. Results suggest that planting a diversity of clones should be important for the long term persistence of the community as well as for the initial success of the transplant. This research on invasive species has also involved the study of specific new invaders that may pose particular threats to native species and timely estimates of their impact and spread are required. For example, in a recent Marine Ecology Progress Series publication, researchers

combined field monitoring and laboratory experiments to examine the population ecology of both the microscopic and macroscopic stages of a new invasion of Undaria pinnatifida in California. The two major findings of this work were: (1) the species shifts from a life history with discrete generations, macroscopic only in the winter, to one with continuous overlapping macroscopic with latitudinal shifts in temperature; and (2) grazing by herbivores, predominately the native kelp crab Pugettia producta can suppress Undaria populations, even when recruitment is quite high. Advisors have worked in conjunction with the harbormaster in Santa Barbara harbor to facilitate the eradication of this potentially destructive invader. They are also involved in a similar project monitoring the recently introduced the sea squirt Didemnum lahellei, that may threaten oyster aquaculture operations in Tomales Bay.
Impact: In other parts of the world, invasive seaweeds and sea squirts have severely hampered aquaculture efforts. Specific information on the environmental limits and growth rates of the invasive sea squirt Didemnum and the seaweed Undaria will allow scientists to predict and mitigate their effects on aquacultured oysters and other commercially valuable species. Understanding the consequences of changing species diversity for ecosystem health will inform managers and decision makers of the costs of diversity loss. In an effort to more explicitly link diversity of marine systems with ecosystem goods and services enjoyed by humans, an advisor helped form a working group at the NCEAS at UC Santa Barbara. A major focus of the group's efforts is the effects of biodiversity loss in estuaries on critical ecosystem services such as water purification and fisheries yields. The group includes two economists and two outreach/communications specialists who help them deliver their findings to stakeholders, decision makers and the general public. Our first products are expected this winter linking declining biodiversity to declines in secondary production and ecosystem stability, ultimately translating into greater collapse of fisheries and slower recovery from collapse. We are finding that diversity can help serve as an insurance policy to buffer marine ecosystems from environmental change. We depend heavily on coastal ecosystems for food and tourism revenues, and enhancing the consistency and reliability of the ecosystems that provide these goods and services will have real economic benefits.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.19 Invasive Species
Title: Plant Growth and Competitiveness in Flooded Environments

Description: The rice-weed competition model (VAMP) was completed. This model simulates stand development and rice grain production in mixed stands of watergrass (Echinochloa spp.) and rice (Oryza sativa) under variable inputs of water depth and fertilizer application, corresponding to pot and field experiments manipulating one or both management variables. The results from VAMP correspond well to experimental results, explaining why neither fertilizer delay nor water depth are effective treatments for watergrass control. While water depth is effective in slowing watergrass growth, it also slows rice; once watergrass emerges, it rapidly reestablishes its competitive advantage and suppresses rice growth. The end result is lack of control. Fertilizer delay has a greater suppressive effect on watergrass and rice. Its effectiveness depends on the fraction of the stand represented by

watergrass, being most effective when the fraction is high, because it curtails the uptake advantage watergrass has. However, the reduction in rice grain is still unacceptably large. The research on perennial pepperweed (Lepidium latifolium) consists of field experiments measuring dispersal of seed, plant community structure, and response to herbicide application. Laboratory experiments were germination trials under different salinities and a pot-based mesocosm experiment measuring germination, growth, and survival under different flooding conditions (daily, weekly), vegetation conditions (typical dominant for a given salinity vs. bare ground) and salinity of tidal water. This research has shown that the spread of this weed throughout wetlands in California will be more rapid in freshwater and slightly brackish environments, where both growth and seed production are strong, but that at aqueous salinities greater than 10 ppt, germination fails and growth is poor. The research has been consistent with field observation in the three salt marshes studied (Delta, San Pablo Bay, S. San Francisco Bay). The physiological limitation by salt has proven to be more important than seed dispersal. Salinity is the major variable associated with germination, growth, and seed production; it suppresses germination, growth and seed production such that perennial pepperweed is not expected to colonize salt marshes very well. Its presence in these systems can only be explained by greater salt dilution following extraordinary freshwater input in very wet years.
Impact: This rice-weed research was intended to define the potential for sustainable low chemical input weed control in rice using manipulation of competition. The results with watergrass suggest that competitive suppression is not possible in stands more than a few days old. However, competition in these very young stands probably is never significant, suggesting that competition does not offer much hope for successful weed control. Techniques for suppressing germination of weeds, such as stale seedbed techniques, appear to offer more potential in this respect. Pepperweed suppression in tidal marshes by herbicides has not proven very effective in trials to date. In part, this is due to the nature of pepperweed (strong rhizomes and deep roots, low herbicide uptake and translocation, poor kill, rapid recovery from the seed bank) and in part because of the side effects (damage to native vegetation). This research has not progressed to the point where feasible control measures are apparent, but our discoveries to date suggest that eradication in salt marshes is likely to be more easily accomplished than in freshwater systems, where prevention by early spot treatment of early invaders may offer the major hope of success. Once established, perennial pepperweed may be virtually impossible to eradicate in less salty systems.

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: Researchers have just begun screening seedlings of Echinochloa oryzoides (early watergrass) and E. phyllopogon (late watergrass) from rice fields in the Sacramento and San Joaquin Valleys 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 herbicide. Herbicide screening is behind schedule because funds originally allocated for the project were withheld as a result of state budget cuts to the agency funding the project, the Statewide UC IPM Program. Funds were obtained from an alternative agency in September 2004 and researchers are now proceeding with the screens for resistance. Once the screening is completed, the incidence and nature of resistance to the five herbicides will be correlated with management practices and cropping areas. We are also currently developing DNA markers, which will be used to quantify the origin and spread of resistance among rice fields in California. This research was also delayed by the failure to receive promised funds.
Impact: The watergrasses, Echinochloa oryzoides and E. phyllopogon, can cause rice yield losses exceeding 50 percent 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, we expect 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: 1.19 Invasive Species
Title: BIOLOGY OF PATHOGENS AND INSECTS IN NATURAL FOREST ECOSYSTEMS OF CALIFORNIA

Description: 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. Their initial work focused on the biology of host pathogen interactions, particularly on the host range of the pathogen. We are now involved in developing models on the epidemiology or the pathogen and on impacts of the pathogen in natural ecosystems. Using both laboratory and field experiments, researchers have shown that 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 spatial distribution and spread over several years. They have established 440 permanent plots in mixed- evergreen (dominated by coast live oak) and redwood-tanoak forests in from Big Sur to the Oregon border. Over13,000 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, 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 2003-2004 was found to be much less conducive to production of P. ramorum spores than the previous year. Collection of spores in rainwater resulted in very low pathogen numbers than in 2002-2003. This resulted in lower numbers of new infections on most host plants.

They have also examined the ecology of two other undescribed species of Phytophthora in the forests of California and Oregon. P. nemorosa is primarily found in tanoak /redwood forests. 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 is almost exclusively found in coast live oak forests. This species has also been reported from Germany. Researchers do not know if P. pseudosyringae is native to California or is an exotic as suspected for P. ramorum.
Impact: The information that has been 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. Our data continues to be used by many national and international government agencies (APHIS, CDFA, DEFRA) to write regulations for quarantines.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.19 Invasive Species
Title: ECOLOGY AND PHYSIOLOGY OF WEEDY AND INVASIVE PLANTS IN WILDLAND AND AGRICULTURAL ECOSYSTEMS

Description: Cynara cardunculus seeds are wind-dispersed and seedlings are often observed close to mature adults suggesting that establishment is influenced by dispersal, adult facilitation, or an interaction between the two. Wind dispersal was quantified using seed traps in areas with and without vegetation. Facilitation was tested by planting seeds up to 2 m from adult plants in the field. Adult rosettes were treated to determine the influence of adults on seedling emergence and survival. The treatments were a) removing dead litter, b) removing live leaves, c) removing both leaves and litter, or d) no removal treatment. Emergence and survival of seedlings were followed for two growing seasons. Most seeds were dispersed within 7 m from adults in vegetation but could travel beyond 40 m without vegetation. Rosette treatments had no effect on seedling emergence but the presence/absence of the live plant influenced survival. Survival, measured by seedling senescence date, increased with live plant removal treatments. The increase in survival occurred at distances up to 40 cm from the rosette, illustrating that seedling facilitation does not occur in C. cardunculus, and that seedling patterns are likely due to dispersal. To quantify environmental variables that correlate with establishment of A. donax in the field, 25 plots were established in three southern California riparian areas and four A. donax rhizomes were planted in each plot. Sites were visited weekly until all A. donax sprout emergence was complete. Environmental variables were recorded including soil temperature, radiation, and community composition. Analyses of variance revealed that environmental conditions and A. donax performance varied significantly across sites. Multiple regression was used to determine the variables that best explain success of A. donax across all sites. Shoot emergence timing was slowed by cool soil temperatures and expedited by large initial rhizome volume; shoot height was negatively correlated with soil temperature and positively correlated with soil moisture; shoot survival was positively correlated with soil moisture. Destructive shoot herbivory by rodents for this species was observed in two sites, and negatively affected shoot survival in one site. The seasonal physiological activity of Arundo

donax and its impact on riparian systems was studied using common garden and field experiments. A. donax and two native species were grown under controlled conditions and with addition of 1.75 mg/L nitrogen as NH4NO3. A. donax produced more biomass than both natives with added N; no plants had altered allocation under control and treatment conditions. A field experiment was conducted along two watersheds in southern California. Six permanent transects were set up perpendicular to the river at each site. Monthly measurements of soil temperature, soil moisture, vegetation cover, and light intensity displayed little difference between points with and without the presence of A. donax. A. donax is able to persist in locations without significantly altering the parameters measured. Research is ongoing to identify its physiological impacts in riparian habitats.
Impact: Results of this research have direct applications for developing ecological approaches for prevention and management of wildland invasive weeds. By understanding seed and seedling shadows in C. cardunculus land managers may be able to predict the areas of greatest recruitment in local populations and modify control efforts accordingly. A. donax establishment in riparian habitats is highly dependent on site characteristics. Determining sites of potential invasion may be possible by quantifying environmental variables including soil variables and herbivory pressure and by monitoring the size and apparent vigor of incoming rhizomes.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.19 Invasive Species
Title: YELLOW STARTHISTLE MANAGEMENT MAKES PROGRESS

Description: Yellow starthistle is the most conspicuous of the noxious weeds that are a serious concern on rangelands and forestlands of El Dorado County. This introduced species significantly reduces biodiversity, recreational opportunities, forage production and the value of habitat for wildlife. UC Cooperative Extension has conducted cutting edge research on various strategies to control yellow starthistle, including burning, chemical control, grazing, mowing, pulling and biological control. CE has worked with the El Dorado County Noxious Weed Management Group and through educational programs to teach landowners and land managers how to control yellow starthistle.
Impact: Research and educational efforts in El Dorado County have had a significant effect on the control of yellow starthistle. In collaboration with the local Weed Management Group, the project has resulted in treatment of over 12,000 acres of yellow starthistle-infested range and forest land. This has significantly reduced the overall population of yellow starthistle in the county, improving forage production, increasing biodiversity and benefitting wildlife habitat and recreational opportunities.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 1.20 Managing Change in Agriculture
Title: ALTERNATIVE STRAW MANAGEMENT PRACTICES ON AVAILABLE SOIL RESOURCES IN FLOODED RICE FIELDS

Description: The agronomic benefits of alternative straw management practices in winter flooded rice fields in the Sacramento Valley of California (U.S.A.) was quantified. The project is focused on the impact of rice straw management on nutrient cycling, and developing improved fertility management guidelines for rice growers. In a survey that was conducted at the 2003 UC Cooperative Extension rice grower meetings, 29% of growers reported reducing fertilizer applications in fields where they regularly incorporated residues, while 9% of growers increased fertilizer rates and 52% reported no change following legislated reductions in burning. Given the reported lack of a clear consensus on the impact of straw management on soil fertility and fertilizer practices, it is not surprising that there is a perceived need among growers for improved fertility management guidelines. In an effort to address that need, researchers began a comprehensive evaluation of current fertility management practices in 2003 to assess the potential for the adoption of recommendations from the long-term straw management trials. The project includes grower surveys, self-reporting and an extensive series of N-rate field trials and associated fertility monitoring in fields throughout the Sacramento Valley. Researchers followed soil nutrient status, plant nutrient uptake, and yield in 38 fields under grower management. The sites include a range of soil types and management practices, and were examined for macronutrients N, P, K, Ca, and Mg, and micronutrients Na, Fe, Cu, Zn and Mn. Yield data were collected from small plot harvests and were grouped by management history for the purpose of analysis. Although some caution should be exercised in the interpretation of a single year's data, the following preliminary observations can be made: 1) midseason plant indicators (color, height, vigor, and tissue N levels) significantly increased with increasing pre-plant N fertilizer applications; 2) neither increasing nor decreasing current pre-plant N fertilizer applications by 25 kg ha-1 produced a significant overall yield effect; and 3) relative yields were significantly greater in reduced N treatments in fields where residue was incorporated compared to fields where it was baled or burnt.
Impact: In a continuing effort, alternative uses for rice residue are being explored now that burning is not an option anymore. One avenue many farmers will follow is to incorporate rice straw and follow the on-site disposal approach. Incorporating large amounts of residue, however, will affect the rate of nutrient cycling. In a series of experiments, the role of residue in the formation of stable soil organic and supplying nutrients to the crop has been elucidated. In general, it can be concluded that farmers can reduce N fertilizer input by 25 kg N per ha per year by using straw incorporation practices. Researchers have been exploring integration of wildlife into rice cropping systems. Wildlife is an important component of the rice cropping system in the Valley, in particular when the fields are winter flooded to increase residue decomposition. However, winter flooding also attracts large numbers of ducks, geese and other water fowl species. We determined the impact of waterfowl on the rate of decomposition of rice straw and nutrient cycling, yield, weed population and the availability of energy for water fowl. An increase in the decomposition of rice residue was observed when wildlife was present. Moreover, the seed bank of grassy weeds was reduced when waterfowl

foraged winter flooded fields and tillage operations could be reduced. Results clearly showed the mutual benefits of an integrated rice/water fowl agro- ecosystem for the farmers and wildlife alike. On a regular basis, presentations on straw management issues at the winter farmer's meetings or state wide meetings are given.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.22 Niche Market
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 which has not traveled hundreds or even thousands of miles will be fresher, riper, tastier and more nutritious.
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: 1.22 Niche Market
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.

Impact: The Mendocino County Promotional Alliance has been formed as a non-profit organization of organizations to promote its 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: 1.23 Organic Agriculture
Title: WHAT PUBLICATIONS ARE AVAILABLE FOR ORGANIC GROWERS?

Description: The fast-growing world organic market and the doubling of California organic acreage since 1998 to over 190,000 acres finds many of the state's more than 2,200 registered organic farmers seeking information on organic production. In addition to information available electronically or through UCCE farm advisors, where can they turn? Not all growers find the Internet "friendly" or useful, and not all counties have extensionists knowledgeable about organic production.
Impact: The Organic Apple Production Manual has been a best seller for two years, with more than 1,200 copies sold. A California Department of Food and Agriculture Buy California Initiative/ USDA grant will help fund organic production manuals for strawberries, olives, winegrapes, vegetables, artichokes and small-scale organic farming scheduled for publication in 2005.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 1.24 Ornamental/Green Agriculture
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 team of California researchers established 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 piñon 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: This 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

Theme: 1.25 Plant Genomics
Title: INTRODUCTION AND EXPRESSION OF TRANSGENES TO IMPROVE QUALITY AND PRODUCTIVITY OF TREE CROPS

Description: This research focuses on understanding the relationship between genes and horticulturally significant traits that regulate fruit quality and productivity. Researchers are utilizing molecular genetic and functional genomic approaches that involve plant transformation and post transcriptional gene silencing (PTGS) to better define gene diversity and gene function. 1) In the area of productivity our focus is on disease and pest resistance. Researchers are evaluating resistance to codling moth and crown gall in walnuts, resistance to Pierces diease (PD) in grapevine and to Citrus Tristeza virus (CTV) in citrus. In all of these cases researchers are currently evaluating resistance in transgenic plants. The therapeutic strategies include expression of specific proteins (codling moth & PD) or by post transcriptional gene silencing (crown gall and CTV). 2) Apple fruit quality is being investigated in transgenic plants to examine the role played by ethylene or sorbitol biosynthesis. In walnut researchers are evaluating the role of hydrolysable tannin synthesis. In citrus researchers are examining the transcriptional profile of fruit specific ESTs.
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 productivity and 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: 1.25 Plant Genomics
Title: GENETIC IMPROVEMENT OF BEANS (PHASEOLUS VULGARIS L.) FOR YIELD, DISEASE RESISTANCE AND FOOD VALUE

Description: Following the completion of the work on introgression of yield factors from wild beans, further attention was devoted on the development and utilization of molecular markers for the characterization of genetic diversity in common bean. AFLP were used to fingerprint a set of 55 domesticated bean lines, of which about half were yellow-seeded beans and the other represented the different eco-geographic races of beans. Fingerprinting was accomplished with amplified fragment length polymorphisms (AFLP). Five EcoRI/MseI and five PstI/MseI primer combinations were used, which revealed 133 fragments. The PstI/MseI primer combinations revealed a three-fold larger number of polymorphic markers than the EcoRI/MseI primer combinations. Most yellow-seeded beans, including the patented cultivar Enola, were included in a tightly knit subgroup of the Andean gene pool. Enola was most closely related to the pre-existing Mexican cultivar Azufrado Peruano 87. A sample of 16 individuals of Enola displayed a single 133-AFLP-fragment fingerprint, which was identical to a fingerprint observed among yellow-seeded beans from Mexico, including Azufrado Peruano

87. Probability calculations of matching the specific Enola fingerprint showed that the most likely origin of Enola is by direct selection within pre-existing yellow- bean cultivars from Mexico, most probably Azufrado Peruano 87.
Impact: Since a 1980 Supreme Court decision, it is possible in the United States to obtain a utility patent for crop cultivars and other life forms. Furthermore, it is also possible to obtain Plant Variety Protection (PVP) for a cultivar. Among the awards of the United States Patent and Trademark Office and the USDA Plant PVP Office are a utility patent and a PVP certificate, respectively, associated with a yellow-seeded bean, specifically the cultivar Enola. These awards have been controversial because of, among several reasons, the perceived lack of novelty of the yellow seed color and the cultivar itself. Research data confirm the lack of novelty of the cultivar Enola. Furthermore, data from other researchers also indicate that the yellow seed coat color is based on previously existing gene combinations. A review of historical data also shows that the yellow seed color had been described in the U.S. repeatedly going back to the 1930s. Thus, these data provide genetic data questioning the award of a patent for the cultivar Enola.

Funding Source: Multistate Research and State
Scope of Impact: AZ, CA, CO, FL, GA, MI, MT, ND, NE, NYC, NYG, OR, PR, WA, WI

Theme: 1.25 Plant Genomics
Title: CONSERVATION AND UTILIZATION OF GERMPLASM AT THE C.M. RICK TOMATO GENETICS RESOURCE CENTER

Description: The C.M. Rick Tomato Genetics Resource Center (TGRC) is a genebank of genetic stocks and wild species of tomato. It is an important resource for genetic improvement of commercial cultivars, as well much research involving tomato. OBJECTIVES: The overall objectives of this project are (1) to maintain, document, and distribute accessions of TGRC stocks, and (2) to conduct related research projects to improve accessibility of this germplasm through incorporation of novel traits from related wild species. The activities of the C.M. Rick Tomato Genetics Resource Center (TGRC) for 2004 are summarized below. ACQUISITIONS: 25 new stocks were acquired, including additional SOLANUM LYCOPERSICOIDES introgression lines in tomato (LYCOPERSICON ESCULENTUM), and a marker stock for chromosome 11. The current total of number of active accessions is 3,600. MAINTENANCE: A total of 2,257 cultures were grown for various purposes, of which 1,544 were for seed increase, 53 for progeny testing of monogenic mutants, including recessive lethals, male-steriles, etc, and 245 for seed germination tests. Seed of over 182 wild accessions were regenerated, including relatively large numbers of L. CHEESMANII, L. CHILENSE and L. HIRSUTUM accessions. As allowed by harvests, large seed lots were submitted to the NCGRP for backup storage. DISTRIBUTION: Over 4,300 seed samples, representing at least 1,410 unique accessions, were sent in response to over 430 requests from 288 colleagues in 40 countries; an additional 42 plus requests were for information only. Information provided by recipients indicates TGRC stocks were used for research on a wide variety of topics. DOCUMENTATION: A large number of mutant stocks were photographed and digital images were uploaded to the TGRC database and website. New accessions were

defined with appropriate genetic descriptors and/or collection site information. Latitude and longitude coordinates for wild species accessions were made available for downloading from our website. Our annual stock list, this year covering wild species stocks, was published in the Tomato Genetics Coop. Report. RESEARCH: TGRC-related research projects focused on genetic strategies for ameliorating the low rate of recombination in L. ESCULENTUM X S. LYCOPERSICOIDES crosses, and transferring the chromosomes of S. SITIENS into cultivated tomato. In addition, genetic diversity within populations of S. LYCOPERSICOIDES and S. SITIENS was evaluated. QTLs for increased fruit antioxidant accumulation in L. PENNELLII were fine-mapped and their epistatic interactions were studied.
Impact: The impact of TGRC activities is demonstrated by a large number of published journal articles which mention use of our stocks. Uses include the study of resistances to diseases, insect pests, and abiotic stresses, and their transfer into tomato. TGRC stocks also facilitate much fundamental research on the biology of tomato. Many other uses are summarized in the detailed annual progress report.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.25 Plant Genomics
Title: CULTURAL OPTIONS FOR INTEGRATED WEED MANAGEMENT IN RICE, WITH EMPHASIS ON HERBICIDE-RESISTANT WATERGRASS

Description: Herbicide resistance- Substantial progress was made in the identification of the biochemical bases of herbicide-resistance in Echinochloa spp. Cytochrome P450 was identified as the mechanism conferring resistance to thiocarbamates and to ACCase-inhibiting herbicides. This mechanism of resistance is also responsible for the lower effectiveness of propanil. This knowledge allowed for the identification of selective synergists to overcome resistance to bispyribac-sodium in late watergrass. Resistance was also identified towards clomazone. Cross-resistance patterns to ALS inhibitors have been characterized for a large collection of Cyperus difformis accessions collected throughout the state, and the molecular bases of this resistance are being identified. A target-site mechanism of resistance to the herbicide quinclorac in Digitaria ischaemum was identified, by which resistant plants fail to increase CN production in response to herbicide treatment. A long-term field experiment on alternative stand establishment techniques for rice aimed at the management of herbicide-resistant weeds was implemented. Results showed effective shifts in weed species. Data are being used for developing a modelling approach for system optimization. Enhancing cultivar weed suppressiveness. Researchers conducted a second season of experiments repeating those conducted in 2003. This project aims at delivering criteria for breeding competitive rice cultivars in order to delay the evolution of herbicide resistance, and reduce herbicide use. a). Competition experiment. A competition experiment was conducted at the Rice Experiment Station near Biggs, CA, in 2004. A total of 39 experimental lines of the population M-202/IR50 plus the two parents were studied. Cultivars were selected to support a complete factorial arrangement of three categories of heading time (early, 90-97 days after planting; intermediate, 99-105; and late 107-112) and

three categories of plant height at maturity (short, 65-75 cm; intermediate, 78-90 cm; and tall, 92-110 cm). Each of the nine treatments was represented by at least two cultivars or a maximum of four. Plots size was 3.3 m2, sub-plots were rice grown with and without watergrass competition. Each treatment was replicated four times. Sampling for growth analysis was conducted at 20 days after seeding (DAS) (to determine plant height and stand), 45 DAS, 75 DAS (to determine leaf area, tiller no., plant height, and total aboveground biomass) and at harvest to measure grain yield, yield components and harvest index. b). Phenotyping and QTL identification of competitiveness-related traits. A set of 138 recombinant imbred lines and parents from the M-202/IR50 population were planted with three replications. Stand, tiller number, plant height, leaf area, specific leaf area and total aerial biomass were measured at three intervals. Genetic studies from this experiment are in progress.
Impact: Development of an understanding of the mechanisms of herbicide resistance in weeds provides the only rational means of conceptualizing management strategies for this problem and to guide the deployment of new herbicides for CA rice for economic and safe weed control. This research is the basis for controlling the overuse of herbicides resulting form the evolution of herbicide resistance in weeds. Competitive rice is a safe, economic and environmentally sound tool to reduce herbicide use and manage the herbicide-resistant weeds that cripple CA rice. Knowledge on the genetic basis of rice competitiveness provides an effective tool for germplasm enhancement.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.26 Plant Germplasm
Title: GENETICS AND VARIETAL IMPROVEMENT OF STRAWBERRIES

Description: This project released the day-neutral strawberry cultivar 'Albion', formerly identified as CN220, to the California nursery industry for propagation and sale within California. This cultivar has superior performance for productivity, fruit quality, harvest efficiency, and environmental tolerance to the 'Diamante' cultivar, which currently is planted on 28% of California's acreage and produces approximately 35-40% of the state's fruit annually. This cultivar has especially high resistance to Phytophthora cactorum and Verticillium dahliae, two faults of the 'Diamante' cultivar. Continued analysis of the polygenic inheritance of long- day flowering (day-neutrality) in strawberry using Complex Segregation Analysis indicated the presence of a major locus that determines 75% of the variation for this characteristic. This finding creates the possibility of developing advanced strawberry breeding populations that are true-breeding for day-neutrality, but variable for the strength of this trait. Infection experiments with for strawberry with V. dahliae indicated that the resistance developed to date by the UC breeding program is stable to inoculum propagule type (conidia and micro-sclerotia). Likewise, variation was detected in the virulence of different V. dahliae isolates, but the resistance developed to date was stable over all isolates tested. A three-year study of the consequences of commercial nursery infection in susceptible and resistant strawberry genotypes was completed, and demonstrated that the most important resistance

mechanism in this population acts by restricting the transfer if infection through vegetative propagules rather than exclusion of the pathogen by the root system.
Impact: Based on information available to date, 'Albion' will likely replace 'Diamante'. The added value to California growers of this cultivar replacement is difficult to predict, but could be near the approximately $140,000,000 per year generated by 'Diamante' when it replaced its predecessor. Demonstration of a major locus affecting the polygenic inheritance of day-neutrality resolves a perennial genetic question. Furthermore, the possibility of developing true-breeding populations for this trait could offer a substantial gains in efficiency for future strawberry cultivar development activities. Together, the research results from studies of V. dahliae suggest the opportunity for developing stable horizontal resistance to this disease, and indicate both the methods and resources that will be required to do so.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.26 Plant Germplasm
Title: PLANT GENETIC RESOURCE CONSERVATION AND UTILIZATION

Description: Progress report: The California Annual Report to the W-6 Technical Committee was presented at the 2004 Annual Meeting at Corvallis OR. The committee toured the facilities of the NCGR Corvallis. A project to characterize pistachio accessions at the NCGR Davis was initiated with repository staff using SSRs identified in a prior study. These SSRs were found to be only marginally useful and other markers will be needed to characterize the plant materials. A complete set of photo documentation was provided to the repository for pistachio accessions 1 through 100. These photos will be added to the GRIN database. Parental and some progeny DNAs isolated from a mapping population of pistachio were screened for polymorphism using AFLP.
Impact: The W-6 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. Molecular markers are used to characterize plant germplasm and help to understand diversity in germplasm collections.

Funding Source: Multistate Research and State
Scope of Impact: AZ, CA, CO, HI, ID, MT, NM, OR, UT, WA, WY

Theme: 1.27 Plant Health
Title: COTTON HOST PLANT RESISTANCE TO SILVERLEAF WHITEFLY IS DISCOVERED

Description: Since 1991, Silverleaf whitefly, Bemisia argentifolii, has caused severe economic losses to cotton and other crops in California and the US. In 1996, 554,215 acres of cotton were reported to be infested in Arizona and California. Lint losses were estimated at 24,891 bales, resulting from reduced yield and contamination of lint with honeydew and sooty

molds. Cotton leaf crumple disease, transmitted by the whitefly and caused by cotton leaf crumple geminivirus (CLCV), can also cause extensive reduction in yield.
Impact: Host plant resistance to whiteflies is clearly offering an economical and non-polluting alternative to whitefly management in cotton. Planting of the cotton varieties DP 5415 and NuCotn 33B, which are less susceptible to infestation by silverleaf whitefly, contributed to a reduction in insecticide use on cotton in Southern California since the early l990s. FiberMax okra-leaf cotton varieties with some whitefly resistance are now being marketed in the US and California, giving growers an additional whitefly management option.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 1.27 Plant Health
Title: NEW COTTON VARIETIES RESIST LEAF CRUMPLE DISEASE

Description: Cotton leaf crumple disease (CLCr), caused by cotton leaf crumple geminivirus (CLCrV) and transmitted by the silverleaf whitefly, can substantially reduce seed cotton yield and has been causing damage in Southern California since the mid- 1950s. Insecticides provide temporary control of the whitefly, but CLCrV still infects cotton. A long-term solution that offers economic and environmental advantages is needed.
Impact: Three CLCr disease resistant varieties have been developed. Our research has given cotton growers in California the option of planting CLCr disease-resistant varieties to prevent yield losses.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 1.27 Plant Health
Title: CALIFORNIA'S CLEAN SEED SWEETPOTATO PROGRAM

Description: Sweetpotatoes are vegetatively propagated. Roots are sprouted and the sprouts are transplanted to the field to produce more roots. True seeds are not used in commercial production because sweetpotatoes rarely flower. An unfortunate consequence of not using true seed, however, is that viruses can accumulate in the plants, greatly diminishing both yield and quality.
Impact: Since these early tests, the benefits of virus-tested material has been well recognized in California and other states. Beginning in the mid 1990's, Louisiana and North Carolina dropped their traditional seed programs and began producing virus-tested material in greenhouses for their farmers, based on the clean seed program developed by UCCE.

Most growers in California now use virus-tested seed for at least part of their production. The process is performed by Foundation Plant Materials Service (FPMS) on the University of California Davis campus, which provides plants to growers for a minimal fee of $1.00 per

plant. The use of virus-tested seed is one of the reasons for the substantial sweetpotato yield increases in the last 30 years. In 1967, average yields were 5 tons per acre; in 2001, 12 tons.

UCCE continues to test and promote the sweetpotato clean seed program. Trials conducted in Merced County in 1999- 2001 showed improved yield, shape, and color in five commercial varieties from using virus-tested plants. The use and acceptance by the industry in California as well as other states demonstrates how UCCE research and extension programs can have long standing positive impact for the industry. Consumers throughout California and the West have also benefited, as the clean seed program gives them a more consistent, high quality potato that is significantly less likely to have internal defects.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 1.27 Plant Health
Title: Characterization of Microbial Microhabitats on Leaves

Description: The spatial organization of cells within bacterial aggregates on leaf surfaces was determined for pair-wise mixtures of three different species commonly found on leaves, Pseudomonas syringae, Pantoea agglomerans, and Pseudomonas fluorescens. The fate of an immigrant bacterium will depend on the nature of the leaf structure on which they are deposited, and apparently indirectly on the amount of nutrients and water available at that site to support the development of bacterial aggregates.
Impact: An understanding of the small-scale spatial structure of bacterial cells on leaves as well as within plants enables us to better understand the potential for cell-cell communication that is expected to regulate expression of genes involved in virulence to pants as well as fitness on and in plants. Knowledge of the spatial structure of bacterial populations also helps explain how biological control of diseases might best be implemented.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.27 Plant Health
Title: SIGNALING PATHWAYS FOR STRESS RESPONSES IN HIGHER PLANTS

Description: In the report period, we have further investigated the regulatory mechanism for a voltage-gated potassium channel; conducted genetic analysis of a calcium sensor and its interacting kinases in stress responses and hormone actions; performed structural analysis of a chloroplast immunophilin.
Impact: A patent "Use of a calcium sensor overexpression to improve crop tolerance to stress conditions" has been filed.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.28 Plant Production Efficiency
Title: ORCHARD OPERATIONS PRUNING TO INDUCE EARLY BEARING IN ORCHARDS

Description: Of the 58,000 acres of fruit trees in Tulare County, more than 47,000 acres are fresh-shipping peaches, plums and nectarines. These orchards are commonly replaced every 8 to 12 years as the varieties become obsolete. Industry observers suggest that this figure has recently fallen to 7 to 9 years of productive orchard life. Because of this short potential market life, it is extremely important for peach and nectarine orchards to reach full production as quickly as possible.
Impact: A verbal survey of growers in the Tulare County area indicates that this technology is now being used by more than 45 growers on a full-scale basis on more than 3,000 acres of trees. Many other local growers are trying the concept on at least a portion of their orchards. Additionally, many growers in other parts of California are using these techniques. Assuming that orchard life before varietal obsolescence is roughly 10-12 years, these techniques have increased productive orchard life by at least 10 to 25%, thereby placing money directly in the growers pockets.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 1.28 Plant Production Efficiency
Title: ANR SCIENTISTS DEVELOP NEW PISTACHIO VARIETIES

Description: The cultivar 'Kerman' is planted on more than 95% of current pistachio acreage. While Kerman has been an extremely successful variety, growers would benefit from a variety that produces a higher proportion of split nuts. Also, although the U.S. pistachio industry prides itself on producing large, unstained nuts, a new selection with even whiter and larger nuts would give the U.S. a further market advantage. In addition, the almost exclusive planting of a single cloned variety makes the pistachio industry genetically susceptible to new plant diseases.
Impact: The pistachio cultivar 'Kerman' has been so successful over the past 30 years that it has been almost exclusively planted by U.S. growers. As a result of ANR development and testing, a contender named 'West Wind' has emerged with the potential of being a viable alternative to Kerman. West Wind matures at the same time as Kerman and appears to have as much as a 10% better nut-split percentage, while producing equal or better yields of larger-sized nuts with less shell stain.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Theme: 1.28 Plant Production Efficiency
Title: NEW HAY, KLEINGRASS, EXPORTED TO FAR EAST

Description: Almost half of arable land in the irrigated Sonoran Desert, including Imperial County, is dedicated to forage production. New forage resources are always of interest to local growers. In the early 90's, grass hay introduction trials were conducted at UCDREC by a area livestock advisor. One of the grasses evaluated was kleingrass (Panicum coloratum L.), a perennial crop that thrives in desert heat and can be grown on less productive soil. Using results of that trial and starting in about 1993, several growers in Imperial County began cultivating kleingrass as an crop for export to the Far East, where milk production practices require forage that is relatively fibrous and will extend productive life of the cow. Once established, kleingrass requires only water, fertilizer and baling costs, thus is inexpensive to produce and economically competitive in Japan
Impact:. In 2001, 10,262 acres of kleingrass hay were grown in Imperial County for export, with a gross economic value of $7,711,000. In the Palo Verde Valley of Riverside County and along the Arizona side of the Colorado River about 15,000 additional acres of kleingrass are grown for export with similar gross economic values.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 1.28 Plant Production Efficiency
Title: SOIL MOISTURE MONITORING IMPROVES IRRIGATION MANAGEMENT

Description: Alfalfa and pasture are the most extensively grown crops in the intermountain region. Irrigation is required for maximum yield and profit but future irrigation water availability in the intermountain area is in question due to competing uses, primarily for endangered species preservation. The region's entire agricultural economy is threatened if water supplies for forage production are reduced.

Agricultural water use has come under increased scrutiny and is often singled out as a primary contributor to the decline in anadromous fish populations in recent decades. The general perception of many non-farmers is that irrigation of pasture and alfalfa is a poor use of limited water supplies. Therefore, it is in the best interest of agriculture to use limited water resources as efficiently as possible.
Impact: This improved method of scheduling irrigations has been adopted by growers thoughout Siskiyou County and other areas of the state. Nearly half of the producers in Siskiyou County's Scott Valley are now using soil moisture sensors.

Educational materials developed during the project are used in irrigation training programs by other agencies such as NRCS, farm advisors in other areas and by irrigation specialists in other states.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 1.28 Plant Production Efficiency
Title: COTTON HARVEST AID - DEFOLIATION

Description: Before cotton can be harvested, the leaves have to be removed from the plants, a process known as defoliation. This is done with harvest aid chemicals. Improper choice of materials or time of application results in poor defoliation. Ideally, the material should defoliate the entire plant with minimal desiccation of remaining leaves. Under the constraints of EPA registration as well as environmental concerns, certain defoliants may not be available in the future. There is need to evaluate alternatives to current programs to insure both effective defoliation and minimum impact on air quality.
Impact: Our research has provided growers with guidelines for (1) selecting the best defoliants under specific crop and weather conditions, and (2) proper timing to protect both yield and quality. This has resulted in improved quality and greater returns to the grower. Another result is that growers have been replacing organophosphate defoliants, which have unpleasant odors, with Ginstar. This has resulted in improved air quality during the harvest period (Oct-Dec). Also, a registered defoliant was taken off the market because our studies indicated that cotton lint from treated fields contained high arsenic levels, preventing its fiber from being used in children's clothing.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 1.28 Plant Production Efficiency
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.
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: 1.28 Plant Production Efficiency
Title: 3 YEAR STUDY EXAMINES MOST EFFICIENT SPRINKLER SPACING

Description: Questions about water and fertilizer use efficiency are major economic and environmental issues for California agriculture. Excess nitrate is an important concern for San Joaquin Valley communities that depend on groundwater for drinking. Vegetable crops such as carrots, onions and potatoes typically require high amounts of nitrogen fertilizer and frequent irrigation, usually by sprinkler. Although sprinkler lateral spacings vary from 30 to 50 feet, no season-long field study had determined the impact of these different spacings on efficiency of water and nitrogen use.
Impact: Most carrots, onions and potatoes in Kern County are now irrigated at 40 or 42-foot lateral spacings with six to 12 hour sets. With this system, this study shows that water use effiency in the 50,000 acres of carrots grown in Kern County is closer to 90% than the 75-80% estimate normally used for hand-move sprinkler irrigation. This high level of efficiency also means that less water is available through "ag conservation savings" than is typically estimated by California water policy makers for these types of systems.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 1.28 Plant Production Efficiency
Title: CROP PHYSIOLOGY OF CALIFORNIA TREE CROPS

Description: In 2004, we 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 resulted in a completely new approach for simultaneously modeling tree architectural growth, source-sink interactions and carbon partitioning in trees. This model is now being used to guide research regarding factors that control dry matter partitioning, tree growth and fruit quality parameters in the field. This work has also stimulated

new research to understand vegetative growth responses to pruning and characterization of the behavior of different shoot types. The evaluation and characterization of size controlling rootstocks for peach and nectarine has also continued. The role of plant water relations in determining the size controlling behavior of experimental rootstocks has been confirmed with controlled laboratory experiments. Additional physiological characteristics that may be involved in the size-controlling behavior are continuing to be investigated. 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 and management factors that influence these interactions are ongoing.
Impact: The modeling project has provided a working model for studying and describing source-sink interactions at the whole plant level and identified key factors controlling fruit tree growth, fruit yield and fruit quality. It has also indicated what growers can do to optimize crop production and fruit quality and was used to explain fruit production responses to unusual weather patterns in 2004. The rootstock research has generated significant grower interest and two rootstocks have been released for commercial use to the California industry. 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: 1.28 Plant Production Efficiency
Title: HORTICULTURE, BIOLOGY AND ENVIRONMENTAL PHYSIOLOGY OF CALIFORNIA STRAWBERRIES

Description: In 2004, more than 13,000 strawberry seedlings resulting from 83 controlled crosses were evaluated at the University of California South Coast Research and Extension Center for agronomic traits and fruit quality during a 28-week fruiting season. Based on performance evaluations, more than 300 seedlings were retained for runner propagation and subsequent evaluations in 2005. In addition, 150 advanced selections from numerous crosses made between 1999 and 2002 were similarly evaluated. A subset of these advanced items was screened for tolerance to Colletotrichum acutatum, and agronomic and horticultural performances of these items were also evaluated in a protected culture system. Ultimately, the goal of these research activities is the development of improved short-day flowering-type cultivars that have broad environmental and disease tolerances, high yields, excellent fruit quality, and improved production efficiencies.
Impact: The continual development of improved strawberry cultivars in the University of California strawberry breeding program has enabled the California strawberry

industry to satisfy the needs of an increasingly sophisticated and competitive marketplace while improving yields, product quality and production efficiency. For example, research in the University of California strawberry cultivar improvement program during the past 15 years has resulted in the development of new varieties that have greatly-extended fruit production seasons, larger fruit size, improved harvest efficiency and disease tolerances, longer shelf life, and improved fruit quality and flavor compared to older varieties. During this same 15-year period, California strawberry acreage increased 150%, while strawberry fruit production and market value tripled. The development of cultivars with larger fruit size has resulted in increased harvest efficiency (fewer berries are needed to fill a box), reduced harvest costs, and improved earnings for fruit pickers. Similarly, the development of cultivars with more compact and open plant canopies assists in prevention of fungal diseases and enables more rapid fruit harvesting. Perhaps most importantly, the development of varieties with extended fruit production seasons and improved shipping and post-harvest quality has resulted in year-round strawberry production, and this has led to increased availability and consumption.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.28 Plant Production Efficiency
Title: ROOTSTOCK AND INTERSTEM EFFECTS ON POME AND STONE FRUIT TREES

Description: Apple: A Fuji rootstock trial was initiated at the UC Kearney Ag Center in 1999 with six single tree reps of 21 rootstocks. Due to various cultural and economic problems, no yield measurements were made in 2004. However, valuable information regarding fireblight was obtained. A total of 14 trees have died so far, presumably from fireblight. Thirteen of those were on the standard rootstocks M9 and M26. Of the experimental trees, only one on Supporter 1 has died. All of the Cornell-Geneva series (which were bred for fireblight resistance) have survived so far. Increased fireblight pressure will be imposed in the next few years to make sure there is strong resistance. A second NC-140 apple planting was initiated in 2003. The scion is Golden Delicious and there are 23 experimental rootstocks. In 2003, nearly 20% of the trees grew very poorly or died. In 2004 they did much better. By 2005 we will have good information on tree size and productivity. Peach: A NC-140 peach rootstock trial was planted in 2001. Fifteen rootstocks were planted in California and about 18 other states for evaluation. The trees in this planting have separated into 3 statistically different tree size categories. The vigorous rootstocks include peach almond hybrids such as BH-4, Cadaman and SLAP, all of which have more vigor than Nemaguard. Of the semi dwarfing stocks, Bailey and Hiawatha looked the most promising. Both had good production and fruit size in 2003 and 2004. Pumiselect had small fruit size and

was not very productive. Of the dwarfing rootstocks several had large fruit size including Jaspi, Julior and VVA-1. An ongoing evaluation program for peach rootstocks is now entering its final stages of evaluation. Initially, over 80 items were evaluated for compatibility, productivity, dwarfism and root sucker production. Ten rootstocks showed promise and were put into a replicated trial at two different spacings with two different scion varieties. Two selections have continued to meet the criteria for commercial peach rootstocks and have been patented. Both are semi-dwarfing rootstocks with no root suckering, compatibility with a range of scion varieties and good productivity. An ongoing breeding program for stone fruit rootstocks will continue with the objective of combining tree size control with resistance to important diseases and pests including nematodes.
Impact: The fruit growers in California have rated dwarfing rootstocks as one of their highest priorities. There is the potential for greatly reducing labor costs and disease resistance rootstocks can also 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: Multistate Research and State
Scope of Impact: AR, CA, CO, GA, IA, IL, IN, KY, MA, MD, ME, MI, MN, MO, NC, NJ, NYG, OH, OR, PA, SC, TN, UT, VT, WA, WA

Theme: 1.28 Plant Production Efficiency
Title: GENETIC IMPROVEMENT OF PEACH AND ALMOND

Description: Almond and peach are major agricultural industries in California with a combined farm-gate value of over $1.6 billion. Continued viability of these commodities is crucial to the economic survival of the mostly family farms involved, as well as the rural communities built around these farming and processing enterprises. Sharka, (plum pox virus), the most serious disease of tree crops in Europe, has recently been found in Canada and Pennsylvania. No resistance has previously been reported for peach, while almond has long been assumed to be a symptomless host. We have now demonstrated immunity for major California almond varieties. Resistance has been identified in several interspecies almond x peach hybrids and in a related advanced peach breeding line. The confirmation of immunity in almond varieties would remove this dominant Central Valley tree crop from possible future quarantine restrictions and would dramatically reduce current mandatory virus testing of California orchards. A candidate for the pollen-specific S-allele function in almond has been identified, representing a breakthrough in efforts to understand self-recognition systems in plants. Knowledge of this pollen-expressed F-box gene is required for understanding its mode of action, including capacity for generating the required polymorphism for haplotype-specific S-allele identity, and for developing self-fertile almond varieties.

Impact: Genetic solutions to problems resulting from the rapid losses in traditional agro-chemicals and honeybee cross-pollinators are essential for continued viability of these industries. New varieties with improved resistance and productivity result in improved production efficiency, reduced agro-chemical contamination of California ecosystems, and provide a safer product to the consumer.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.28 Plant Production Efficiency
Title: GENETIC IMPROVEMENT OF WALNUT

Description: 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 8,300 seedlings derived from controlled crosses or supplemental pollen crosses. Over 5o selections have been made from among the progeny of previous crossings. Three have been submitted for patenting. These are Sexton, Gillet and Forde characterized by an earlier harvest date than Chandler and large, light kernels. Sexton is protandrous and Forde and Gillet are protogynous. Over 1500 selected rootstocks from 17 different clones have been micropropagated and nursery grown for field trials. An additional 1163 have been grown for retesting against nematodes, crown gall or Phytophthora. 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. There is also significant demand for the three recently released cultivars: Sexton, Gillet and Forde.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.28 Plant Production Efficiency
Title: GENETIC IMPROVEMENT OF PISTACHIO AND GENETIC STUDY OF THE GENUS PISTACIA

Description: The project is being closed out although some of the activities that have been

covered under this project title will continue, but will be reported in the future under another project designation. I have continued to participate in the evaluation of nine female and two male pistachio advanced selections. They are being tested at two locations, Kern Co. and Madera Co. Three females and an early flowering male have been identified that continue to show superior performance compared to the current leading cultivar. Release reports have been prepared for two of the female selections and one male. In addition, I supervised planting of approximately 60 additional selections in a maintenance plot at Davis. These items were judged to have superior characteristics compared to the present industry standard and were retained for future advanced selection testing.

Impact: The new advanced selection cultivars being released in 2005 will provide significant direct economic benefit to growers. One of these cultivars has yielded 46% increased grower paid yield vs. the industry standard cultivar in three years of advanced selection trials. In 2004, it yielded 43% more nuts than the leading cultivar; at appx. $3 per lb. (2004 price) this would have amounted to an increased profit of $3740 per acre planted to the new cultivar. 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.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.28 Plant Production Efficiency
Title: USE OF WILD LYCOPERSICON SPECIES IN BREEDING FOR IMPROVEMENTOF CULTIVATED TOMATO

Description: Our tomato breeding and genetics research has focused on the identification and transfer of genes from wild to cultivated tomato (LYCOPERSICON ESCULENTUM) for chilling tolerance (CT), resistance to blackmold (RBM), late blight (RLB) and aphids. The pathogens PHYTOPHTHORA INFESTANS (late blight) and ALTERNARIA ALTERNATA (blackmold) and chilling temperatures can all cause significant yield and fruit quality losses, while aphids reduce yields. 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 . Aphid resistance was assessed in two interspecific inbred backcross line (IBL) populations derived from L. HIRSUTUM and L. PENNELLII, and the most consistently resistant IBLs over two years of field trials were from the HIRSUTUM-derived population. These highly resistant IBLs are a source of aphid resistance for further breeding efforts. An

assessment of cultivated tomato germplasm mainly from California indicated that a minimum of 7 AFLP primer pairs revealed unique banding patterns for all 74 cultivars even though some cultivars were genetically related, indicating the value of the AFLP markers for cultivar fingerprinting.
Impact: Transfer of wild species' genes for resistance to pathogens, pests and chilling to cultivated tomato germplasm using molecular markers as tools for gene transfer can facilitate development of cultivars requiring fewer agricultural inputs. Reduced chemical inputs lessen environmental impacts and production costs for growers, enhancing agricultural production.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.28 Plant Production Efficiency
Title: BREEDING, GENETIC, AND AGRONOMIC STUDIES OF BARLEY IN CALIFORNIA

Description: The 6-rowed feed barley UC 1115 has had good grain yield results in two years of multi-locational trials in the Central Valley of California. The naked-grained (hull-less) barley UC 1134 has also had good grain yields in its first year of multi-locational trials. UC 1135, the full-sib of UC 1134, has been selected for further evaluation in the Klamath Basin on the Oregon border after yielding 7,000 lb./acre at the Tulelake Experiment Station. The emphasis of the barley breeding program at UC Davis is now shifting away from feed barley to the development of malting barley for the Central Valley.
Impact: Seed of UC 1047 are being multiplied for commercialization. During five years of grain trials, UC 1047 yielded 12.6% and 5.5% more than UC 937 and UC 933, respectively in the Sacramento Valley. In the San Joaquin Valley UC 1047 yielded 12.4% and 9.0% more than UC 957 and UC 933, respectively. UC 1047 is a semidwarf barley and would be expected to replace UC 937 and UC 933 in most environments. Where rainfall is limited, UC 933 would be expected to have an advantage because it is several days earlier to head than is UC 1047. On-farm trials of UC 1047 are now under way.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.28 Plant Production Efficiency
Title: CLASSICAL AND MOLECULAR GENETICS OF LETTUCE

Description: This project encompasses both classical genetics and genomic approaches to lettuce improvement. We are introgressing multiple genes for resistance to several diseases, particularly downy mildew, from wild species into romaine and

leafy lettuce types as well as crisphead types. These are being combined with other genes for resistance to corky root and lettuce mosaic. We 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. We have initiated a program to breed for resistance to Verticillium wilt that is potentially devastating to lettuce production. Resistance genes to several diseases are being also mapped; 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. We are also mapping genes of agricultural importance, particularly root, leaf and flowering time traits, to develop molecular markers for marker-assisted selection. We 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: 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, we 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: 1.28 Plant Production Efficiency
Title: ROOTSTOCKS, CULTIVARS, TRAINING AND CULTURE OF MULTI DENSITY DECIDUOUS FRUIT ORCHARDS

Description: The California Pistachio Rootstock Trials, with four locations for different purposes; all four were used for yield, one was used to evaluate Verticillium tolerance, and one one location for salinity tolerance. All were 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. Since 2003 molecular markers have been done of several of the UCB-1 rootstocks in the above trials to identify the more productive and Verticilllium tolerant rootstocks. A commercial nursery is now interested in propagating some of the superior UCB-1 rootstocks. Cherry: Several sweet cherry rootstock trials have been established over the years. We have evaluated about 20 Prunus mahaleb selections at 5 different sites throughout California since 1996. In 2001, we 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 in 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. We are now observing a field trial of some of these rootstocks obtained from tissue culture. The objective will be to provide selected rootstocks produced clonally. Cherry - we 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: 1.28 Plant Production Efficiency
Title: WHEAT BREEDING AND MOLECULAR GENETICS

Description: Variety releases: Foundation seed was produced for the new varieties Clear White (a hard white spring variety) and Oro (a Desert Durum variety). Regional trials: Six common wheat UC lines were evaluated in the field and then tested for breadmaking quality. From these, 150 populations of common wheat and 47 populations of durum wheat were selected.
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 leaf rust, stripe rust, and septoria resistance genes will reduce the requirements of pesticides resulting in a direct benefit to the environment. Oro, the new durum variety released by the UCD breeding program showed average yields that were 560 lbs/a higher than the leading variety in the Imperial Valley and 1,370 lbs/a higher in the San Joaquin Valley, the two main durum regions in California. The variety Clear White is the first hard white spring variety in California with a low level of Polyphenol Oxidase (PPO).

This is an important trait for noodles quality. High levels of PPO produce a discoloration of the noodles, which is an undesirable quality characteristic. Clear White has also excellent breadmaking quality providing the California wheat growers with a new and versatile variety.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.28 Plant Production Efficiency
Title: Cotton Production Practices, Variety Choices for Increased Input Use Efficiency and Productivity

Description: Competition in production, low prices, increasing costs all impact grower profitability. Interest in production system changes has been increasing due to concerns that include production costs, improved yields, reduced water availability. Trials have evaluated systems that include changes in planting patterns (on annual or semi-permanent beds), reductions in number of tillage passes, and use of herbicide-resistant transgenic varieties. A 4-year project evaluated growth, yield, quality impacts of double-row plantings with 2 closely- spaced rows of cotton (8 inches apart) on 30 inch beds in comparison with single row per bed plantings. Data across over 25 locations showed yield increases of 4 to 15 percent with double compared with single row in about one-half tested locations, with no significant impact at remaining sites.Yield increases were consistent only at sites where plant vigor was lower and plant size limited yield potential. Transgenic herbicide resistant varieties combined with more rapid plant canopy closure with double row plantings improved weed control with fewer tillage passes and less herbicide applied, but the double row system also worked with conventional varieties with modified tillage practices.Variety trials were expanded to include different cotton types (Pima, CA Upland, Acala), with evaluations of growth, quality in varieties under development for disease resistance,or newer-generation herbicide or insect resistant transgenics. Research identified yields and fiber quality differences that impact grade and price. Irrigation, planting date, growth regulator studies in Acala, CA Uplands showed mild to moderate mid- and late-season irrigation delays can save water and have little impact on yield in some Upland varieties. A race of Fusarium, which can cause fungal disease in susceptible varieties, was identified as new race with potential to seriously impact susceptible varieties. Disease screenings were done at 2 field sites, 1 greenhouse site. Preliminary information on varietal susceptibility was produced and reported. Data shows existence of highly susceptible and highly-resistant varieties in Pima, but is less definitive in Upland, showing mild to moderate resistance in many varieties. Pima early decline trials showed plants were consistently deficient in multiple nutrients late-season, but severity of symptoms and yield losses were more related to root system limits in depth or density. Evaluations of germplasm for relative tolerance to early decline showed low heritability and limited tolerance even with severe symptoms early to mid-bloom. Over 70 percent of 47 grower field sites in field study of nitrogen (N)

management in Acala cotton showed no yield responses to fertilizer N amounts higher than 100 lbs of N per acre, usually because residual soil N levels were high enough to supply much of crop N needs. Soil test nitrate levels in upper two feet of soil were identified as useful indicators of N needs, while soil test values in the upper 3 to 4 feet in combination with petiole nitrate measurements and fruit load estimates provided even better tools in crop N fertilizer management.
Impact: Grower interest in alternative tillage and planting systems is high due to potential for reduced production costs or reduced potential for dust production. Options tested recently include double-row plantings on narrow beds, transgenic herbicide tolerant varieties that allow acceptable weed control with fewer tillage passes. Trials show that while these system changes can reduce some production costs and tillage passes under many situations, yields and crop earliness were consistently improved only under conditions with less vigorous plants. Reduced costs and desire for reduced tillage must be balanced against some increases in planting, harvest expenses. Residual soil nitrate sampling, crop monitoring provide information to improve N use efficiency and reduce groundwater quality impacts. Data on improved irrigation, growth regulator recommendations and varieties in Acala, Pima, Uplands helps growers with decisions that impact profitability, water and fertilizer use. Problem in Pima called "early decline" in which vegetative growth slows earlier than typical and foliage shows damage similar to potassium or nitrogen deficiency was better defined. Data showed impacts of variety and some measure of root distribution on timing, degree of yield, foliar damage, and lack of consistent role of soil nitrogen or potassium levels

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.28 Plant Production Efficiency
Title: Integrated Canopy Management in California Nut Crops

Description: Objective 1- Final results on high limb pruning were discussed in last year's report and final reports are listed below. New work is being conducted on influence of pruning or non-pruning treatments on growth and productivity of young Howard walnut trees. 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 2004, 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 2004 season. All three deficit treatments led to significantly lower yields in the third year of treatment imposition. However, if yields per unit light intercepted was calculated, all three deficit treatments had significantly higher yields than the control. This suggests

that if deficit irrigated trees had been planted closer together, they might have had higher overall yields compared to the control. Incidence of kernel mold has continued to be 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- The emphasis for this work has shifted somewhat and preliminary work is now being done in studying role of water stress in seasonal variations in plant protective compounds in walnut as well as interactions with mold.
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: 1.28 Plant Production Efficiency
Title: Identifying Cotton Genotypes With Superior Performance In Commercial Production

Description: On March 2, 2004, five new Acala and two new Pima cotton varieties were approved by the SJVCB and released for commercial production in 2004. These varieties were higher yielding when compared to the standards, Maxxa and S-7. Also, many of the varieties offer the added value of pest and weed resistance, bringing new technology to the SJV growers. Acala varieties in 2004: OA-262 is from O&A Enterprises and is a Roundup ready variety. This allows the cotton plant to tolerate Roundup herbicides sprayed on the cotton as well as weeds, without destroying the cotton. OA-265, from O&A, is a Bollgard/Roundup Ready stacked cotton. In addition to Roundup Ready technology, this variety contains a Bt gene to help the plant resist certain insects. OA-265 also was the highest yielding variety in my trials, at 1,685 pounds per acre. OA-270, from O&A, is quite similar to OA-265 with RR/Bt Technology and equal yields. OA-270 is a slightly longer growing variety when compared to OA-265. C-201 is from Cotton Planning Seed Distributors and was released as a replacement to Ultima. This roller-ginned variety can earn a premium of 12-15 cents per pound. C-101 from CPCSD is a nematode resistant variety, replacing Nem-X. Pima varieties in 2004: OA-353 from O&A, out-yielded the standard S-7, by 157 pounds per acre.

OA-354 from O&A, produced yields of 73 pounds per acre higher than S-7. The SJV growers continued to see improved yields and quality because my testing program that holds the bar high for new varieties to be approved. Also, the SJVCB approved the testing of cotton varieties with regulated technology, such as Roundup Ready Flex. These cottons are regulated by USDA. Although regulated trials are more costly and time consuming, testing them will allow these improved varieties to be available to the growers years sooner. Acala varieties up for release in 2005: C-402, from CPCSD, yields well in heavy soils and has very good Verticillium wilt tolerance. C-402, also from CPCSD, has high yields especially in the northern areas, with good quality and lower SCF than Maxxa. Pima variety up for release in 2005: PHY-800, from Phytogen, has high yields across locations, and good fiber and yarn quality as well as Fusarium wilt tolerance
Impact: 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.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.28 Plant Production Efficiency
Title: Potato Variety Selection Evaluation and Development

Description: Emphasis was on specialty potatoes in 2004. Trials conducted in Kern, Tulelake, Davis. Numerous red, purple and yellow flesh were selected. Tubers were chipped, before and after storage. Tubers were evaluated for fresh market appeal, chipping quality, and postharvest quality factors including quantitative colors measurements of L, a, b, Hue and Chroma for skin and flesh, dry matter content, and glycoalkaloid content. Subjective color scale of 1-5 developed, and color cards developed for use by researchers and industry. Completed in 2004 were two student thesis projects, relationships of variety, location, postharvest light on greening and glycoalkaloid content; and relationships of variety, nitrogen fertilizer and location on yield quality, response to fertilizer, plant nitrogen content. New or Salad potato project continued with small, round white and yellow varieties. Spacing and harvest date trials were conducted. Postharvest studies on greening, packaging and quality were conducted. Field days were held in two locations. Progress reports were distributed to the industry via industry research board, university bulletins and field day leaflets. PVPs for two long white varieties were submitted to USDA. Analysis of carbohydrate levels in current and potential varieties was conducted for the industry, in response to anti-potato diets and potential of production and marketing of potatoes with lower carbohydrate.
Impact: The number of growers of specialty varieties and who are marketing through

specialty channels has increased significantly, and continues to increase. Yellow flesh varieties are becoming more conventional. Colored flesh varieties are becoming more common and more known among the consuming public. Industrys knowledge about factors causing greening and alkaloid content of potatoes has increased and postharvest handling practices changed accordingly. More universities are following the lead of UC and devoting increasing effort to breeding, selection and development of specialty varieties. Growers have better information on how to obtain higher yields and to achieve highest quality of specialty varieties as a result of the cultural practice studies conducted in conjunction with the variety selection and evaluation. In a broader context, nearly all varieties currently grown commercially in California have been developed or introduced through the University of California potato variety development project.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.28 Plant Production Efficiency
Title: GENETICS, BREEDING, AND EVALUATION OF CITRUS FRUITS

Description: Evaluation continued of yield and fruit quality of four recently released late-season mandarin cultivars (Gold Nugget, Shasta Gold, Tahoe Gold, and Yosemite Gold mandarin hybrids) and several other mandarins. Hand-pollination tests showed that Gold Nugget pollen will not stimulate production of seedy fruit in Clementine, but some fruit with low seed counts were obtained when Clementine flowers were pollinated by Shasta Gold, Tahoe Gold, and Yosemite Gold. These results confirm patterns seen in previous years. Low-seeded forms of many mandarin cultivars, including W. Murcott (Afourer), Fairchild, Nova, Daisy, and Encore, were identified by selection among trees propagated from irradiated budwood. These selections are being propagated for wider testing to evaluate stability, seediness, productivity when isolated from other cultivars, and other horticultural traits. The first crop from repropagated trees of the first selections was consistently low-seeded in mixed plantings suggesting that the mutations induced are stable during normal propagation. Hybridization to develop new low-seeded triploid mandarin and low-acid grapefruit types continued. Several hybrids appear promising after 2-3 years of fruit evaluation and are being propagated for larger-scale tests. To expand the EST sequence database for citrus, 2 new cDNA libraries were developed and about 40,000 clones from 12 libraries produced earlier were sequenced. Sequences were submitted to GenBank and incorporated into a PC-compatible sequence browser, HarvEST: Citrus. A collaborative project to develop high-density linkage maps of sweet orange and trifoliate orange was initiated with the University of Florida and USDA. Initial efforts emphasized mapping SSRs as anchor markers. Development of new rootstocks through hybridization, selection, and field trial

evaluation was continued with emphasis on selection of rootstocks with good performance on calcareous soils and tolerance to Phytophthora and citrus tristeza virus.
Impact: Development of new citrus cultivars can provide growers with additional market opportunities and consumers with better tasting, more attractive, low-seeded fruit. Development of cultivars with improved pest and disease resistance can reduce production costs and reduce the need for use environmentally damaging chemicals.

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: 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). A study describing the physiological basis for yield maintenance in prunes (dried plums) under regulated deficit irrigation (RDI) was published. This study demonstrated that canopy level photosynthesis can be maintained even when leaf level photosynthesis is declining under RDI, due to a beneficial effect of RDI on leaf orientation and light distribution within the canopy. 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 RDI on walnut growth and yield. In 2002 there was no effect of RDI on yield in either site, but the southern sites (San Joaquin Co.), had about 40% higher yields than the northern site (Tehama Co.), despite experiencing higher levels of tree stress, as measured by SWP. In 2003 and 2004 there have been yield reductions associated with RDI at the northern site, but not at the southern site, which has continued to maintain the highest yields. The physiological basis for the difference in response to RDI at the two sites is currently under study. A large scale almond RDI study (160 acres each of RDI and control) was started with funding from DWR, and after the first year there were no yield differences and RDI had allowed a seasonal water savings of about 10%.
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 in prunes and almonds, especially where it has been demonstrated that irrigation can be reduced with little reductions in SWP, presumably a result of favorable soil conditions. Under these conditions, the use of SWP has enabled growers to take the maximum advantage of soil moisture reserves, and allowed reductions in their use of energy and natural resources.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.28 Plant Production Efficiency
Title: Reducing Barriers to Adoption of Microirrigation

Description: A four-year almond RDI (regulated deficit irrigation) study was completed, and demonstrated the benefits of reducing irrigation during the hull split period to control hull rot disease and improve nut harvest ability with no detrimental effects on overall productivity. In the orchard having the highest hull rot disease pressure, a reduced branch dieback from the disease under RDI had been observed for 3 years, but 4 years of RDI were required to obtain a beneficial yield effect (3,350 lbs per acre nut yield in the RDI treatment compared to 2,870 lbs per acre), because of the long term processes involved in determining almond tree yields. Water savings using RDI were strongly dependent on soil conditions, with a documented water savings, compared to full irrigation requirements, of 65% under deep soil condition. Under shallow soil conditions there were no water savings
Impact: Many almond and prune growers in CA are using plant-based measurements (midday stem water potential) for irrigation monitoring/scheduling, and of these, most are employing RDI to improve the horticultural performance of their crop.

Funding Source: Multistate Research and State
Scope of Impact: AZ, CA, CO, FL, IA, ID, KS, LA, NM, NYG, OH, OR, PR, TX, UT, VI

Theme: 1.29 Precision Agriculture
Title: LEAF COLOR CHART: A COST-EFFECTIVE TOOL FOR NITROGEN MANAGEMENT

Description: Precise application of nitrogen (N) fertilizer based on plant need and location in the field greatly improves fertilizer use efficiency in rice growing. This maintains yield while helping to reduce nitrogen runoff into surface and ground water. Moreover, higher energy costs have increased fertilizer prices. One way to improve the economics of rice production is to estimate tissue N status at critical points in the plant's life cycle. To do this effectively, a rice grower must evaluate large acreages and make management decisions quickly.
Impact: In the Sacramento Valley, over 300 Leaf Color Charts are in use as it has become an integral part of the fertility management program for farm managers and private consultants. The LCC evaluates nitrogen status of a rice crop cost-effectively, avoiding leaf sampling, laboratory analysis costs and time delays in receiving the results. (UC's Office of Technology Transfer has filed for a patent on the LCC concept and the technological innovations used to produce it.)

Funding Source: Smith-Lever 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: Work carried out during this period involved the further development and application of methods for the use of precision agriculture technology for both scientific investigation and crop management. This involves the use of 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. During this period we continued a three year experiment on variable rate application of nitrogen in cotton. This experiment is in its third year and involves replicated experiments in three cotton fields in the San Joaquin Valley. We also continued the development of clustering and CART statistical methods for the analysis of spatiotemporal precision agriculture data.
Impact: Site-specific management 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. The key difficulty is reducing the cost of the technology. This can be done by starting with practices providing the greatest economic benefit, leading to increased adoption.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.29 Precision Agriculture
Title: Precision Technologies for Specialty Crop Production

Description: (1) Real-time nitrate sensors are useful for monitoring ground and drainage water for nitrate contamination, and measuring and mapping soil nitrate content for site-specific nitrate fertilizer application. A mid-infrared (MIR) based soil nitrate sensor was developed that was able to determine nitrate content concentration in soil pastes derived from several different soils. The technique utilizes the MIR response corresponding to four different wavelengths. (2) Weigh buckets are simple and inexpensive alternatives for weigh wagons used for measuring crop yield during fields trials. An impact type electronic weigh bucket was tested during the 2004 tomato harvesting season. This device was lighter and worked well in the field. The unit could be easily retrofitted to the tomato harvester boom

conveyor and allowed the continuous operation of the harvester. (3) A network of water arrival sensors was used in several flood irrigated alfalfa fields to determine wetting front advance rate. Tests were conducted in three different locations (Davis, Woodland, Lemoore) and three different checks at each of those locations to verify if wetting front advance timing can assist in determining advance rate curves. These curves are expected to be useful in implementing cutoff irrigation management scheme. (4) UC Davis compaction profile sensor was tested in two different soil conditions on the UC Davis campus to relate its output to infiltration variability in the field. The field data are currently being analyzed.
Impact: Results lead to economical and environmental benefits since it involves applying 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: 1.31 Risk Management
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.
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 the Imperial County Cooperative Extension website at 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: 1.32 Small Farm Viability
Title: OPEN-AIR CLASSROOM FOR SMALL SCALE GROWERS

Description: Small-scale farmers face many of the same issues as their larger counterparts. But, from pest management to fertilizer application, small-scale growers often have to do it alone--without the benefit of a private consultant. With their limited resources, they have very little chance to get away to attend training sessions and workshops. UCCE Santa Clara County, with support from UC's Small Farm Program and with the participation of several farm advisors from neighboring Monterey and Santa Cruz counties, has launched a program to train a group of Hispanic growers of organic crops on their cooperative farm. The program (Open-Air Classroom) was initiated last fall. UC advisors specializing in various disciplines (entomology, plant pathology, irrigation, fertility, berry and vegetable plant/variety selection, simplified farm management and marketing) visit with the growers and go with them on a tour of the ranch. The series of classes began with two sessions on entomology. Growers collected insects to identify, considered each one's pest/beneficial contribution to the farm, and discussed control strategies. Upcoming sessions will help growers with basic marketing strategies as well as irrigation, fertilizer and other economic inputs. The sessions will continue from late spring through summer 2003.
Impact: With this progam, UCCE is filling a gap by supporting small and limited-resource farms with quality training and timely, needed information. The growers are enthusiastic and thankful to have these sessions offered on their land, addressing their specific problems. The growers desire to learn more has increased several fold and they are eager for additional topics and classes. This program is clearly enhancing their land stewardship and better preparing them to comply with tightening environmental regulations.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 1.32 Small Farm Viability
Title: LIMITED RESOURCE FARMERS LEARN HOW TO SAVE WATER AND ENERGY

Description: Southeast Asian growers are important in the Merced County strawberry industry. Strawberries are so sensitive to water stress that there is a tendency to over-irrigate, wasting valuable water and increasing pumping costs. Using a simple device called a tensiometer which measures soil moisture and is easy to understand and use, we have been helping small Southeast Asian growers learn how to irrigate more efficiently. After recruiting growers to participate in the project, we placed the tensiometers in two locations in each of their strawberry fields. The growers were provided with training in reading and recording the results, and with very simple guidelines for applying water as indicated by the readings. Information demonstrating that tensiometers can be a useful tool for managing irrigation in strawberries also has been shared at meetings in Sacramento, Stockton and Fresno.

Impact: Interviews indicate that growers have used the tensiometers in attempts to cut back on water applications, and believe they have seen some savings in electricity usage. In any case, most of the farmers have learned to wait a bit longer before turning on their pumps. This has saved both water and electricity.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

sults under the same continuous grazing treatments.
Impact: Range and livestock managers can use this information to weigh potential outcomes and meet specific conservation objectives. Removal of cattle grazing from these systems results in increased nitrate levels in the spring waters (ba

Theme: 5.14 Home Safety
Title: NONDESTRUCTIVE EVALUATION OF WOOD AND WOOD-BASED MATERIALS

Description: The drying control project has been concluded with a major publication pending that describes an automatic control program to improve drying time and quality. The first publication has been submitted on seismic testing of plywood and oriented strandboard shear walls that shows substantial performance differences. Fire test protocols are now being written into the building code for the State of California.
Impact: Our seismic work will lead to safer design of housing to withstand large earthquakes. The fire research is expected to greatly reduce the number of homes lost to wildfire throughout the US.

Funding Source: McIntire-Stennis and State
Scope of Impact: State Specific

Theme: 5.17 Jobs/Employment
Title: Immigration Policy and Labor Protections in California

Description: 1) Final revisions were implemented for 'State Structures and Social Movement Strategies' , and the article was published in Politics and Society in September 2004. This article examines the respective contributions of changing state leadership, labor market conditions, and union strategy to the efficacy of California's Agricultural Labor Relations Act. 2) 'The Grassroots Reconfiguration of U.S. Immigration Policy' was accepted for publication by Migration Review and is currently being fine-tuned for publication. This article analyzes and attempts to explain the disparity between federal immigration policy intent and local immigration policy implementation. 3) Research was conducted on the varying ways that the multiple levels and federal

system of the U.S. government, and the ambiguous and often-conflicting prerogatives of each level, have permitted--even encouraged--local-level governments and interest groups to oppose, recast, and compensate for federal immigration policy. Research is being conducted into local non-cooperation ordinances, regionally-specific enforcement protocols, legal challenges to the Congressionally-mandated Department of Labor-INS collaboration, and the immigrant drivers' license issue.
Impact: The UC researcher's evaluation of California's Agricultural Labor Relations Act casts light on why state policies sometimes fail, pointing to the ways that state leadership, interest groups in society, and the structure of the economy, can all play a role. His studies of the local-level recasting of U.S. immigration policy shows how certain features of the structure of the U.S. nation-state permit, even encourage, local challenges to federal policy.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 5.21 Promoting Business Programs
Title: PLANT GENETIC RESOURCE CONSERVATION AND UTILIZATION

Description: University-industry partnerships are proliferating in the United States, as public funding for high-level research continues to decline yet knowledge plays an increasingly important role in industrial processes. The horticulture industry benefits from such arrangements by influencing research directions and gaining access to innovations and complementary research in agricultural biotechnology. Given the nature of this industry, the obstacles to developing effective partnerships are substantial. Private horticulture institutions should form consortia of both small- and medium-sized firms. The empirical results demonstrate that patent statistics are a useful predictor of merger activity; mergers in agricultural biotechnology appear to be partially motivated by difficulties in enforcing patent rights when firms have overlapping technologies; and some of the merger activity may be explained by attempts to reduce spillovers.
Impact: To assist public institutions and private companies in their support of innovation and R&D financing for plant genetic research through innovative contractual commitments.

Funding Source: Multistate Research and State
Scope of Impact: AZ, CA, CO, HI, ID, MT, NM, OR, UT, WA, WY

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 47 peer-reviewed articles to address Goal 2 last year. Three patents were issued to UC researchers 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 2004-2005 Allocated Resources

Extension Federal Funds (Smith Lever 3 b&c)	Extension State Match	Research Federal Funds (Hatch)	Research State Match
$23,561	$23,561	$160,149	$160,149

Extension Total FTE	Research Total FTE
0.80	11.40

Theme: 2.02 Food Handling
Title: POSTHARVEST QUALITY AND SAFETY IN FRESH-CUT VEGETABLES AND FRUITS

Description: Background: Large volumes of w ater are commonly used during the postharvest handling and processing of minimally processed fruits and vegetables. Economic considerations and wastewater discharge regulations make water recirculation a common practice in the industry. Few practices have the capacity of water recirculation to increase the potential risk of food-borne illness by readily distributing a point source contaminant to non-contaminated produce. Disinfection of water is a critical step to minimize the potential transmission of pathogens among produce within a lot and between lots over time. Water-borne microorganisms whether postharvest plant pathogens or agents of human illness can be rapidly acquired. Natural plant surface contours, natural openings, harvest and trimming wounds, and cut surfaces during processing can serve as points of entry for microbes. It is essential, therefore, that the water used for washing, cooling or other postharvest procedures be maintained in a condition suitable for the application, as an important component of a sound postharvest quality and safety program. Progress to Date: Significant progress has been made in manipulating redox potential as a single value measurement of the microbial quality of water in cooling and fresh-cut handling applications. During

this period a new approach, an outgrowth of prior research, was investigated in collaboration with industry. The objective of this research is to evaluate the efficacy of Electrolyzed Oxidizing Water (EOW) as a water treatment for whole system protection in vegetable cooling operations and postharvest ice-making operations. EOW is formed by electrolysis of weak sodium chloride solutions creating a mixed oxidative species, primarily hypochlorous acid, with a high redox potential. Biofilm formation on water conveyance surfaces and waterlines, on ice-making surfaces and reservoir tanks, and other contact or equipment surfaces is a known source of persistent contamination of fresh produce by decay microbes and bacteria of concern for food safety and illness. Other strategies to optimize produce disinfection with aqueous and gaseous ozone are in progress. Preliminary tests with melons and tomatoes demonstrated the potential for disinfection of decay pathogens and pathogens of human food safety concern. In addition, expanded evaluation of biofumigation with Muscodor albus has demonstrated a promising level of reduction of surface populations of Botrytis cinerea as well as Salmonella on tomato and other fruits and fruit-vegetables. This information and related research is helping to define parameters for both design and implementation of Good Agricultural Practices and future research needs to improve microbial food safety programs.
Impact: This research has had a positive effect in building awareness and implementing commodity-specific Good Agricultural Practices. New formulations, interventions, and process recommendations are being broadly disseminated in trade journal publications, workshops, extension bulletins, and electronically.

Funding Source: Multistate Research and State
Scope of Impact: AL, AR, CA, FL, GA, IA, IL, LA, MD, MI, MS, NYG, OK, OR, PA, TN

Theme: 2.02 Food Handling
Title: Assuring Fruit and Vegetable Product Quality and Safety Through the Handling and Marketing Chain

Description: An improved sensing system was developed for the detection of freeze damage in Navel oranges. Improved sensitivity was achieved in headspace sampling using a low-cost ethanol fuel cell sensor with one orange per sealed polyethylene bag. Headspace ethanol levels were significantly different between the partially frozen and unfrozen oranges with no ethanol detected in any of the unfrozen oranges. Instrumented methods for measuring the color and firmness of California cling peaches were evaluated. Two destructive methods and one non-destructive method of measuring firmness were evaluated. The color measurements were conducted using light emitting diode (LED) based technology due to their long life and infrequent need for recalibration. Thirteen thousand peaches were evaluated at two inspection stations. Twenty-four varieties were studied (Andross, Arakelian, Bowen, Carolyn, Carson, Corona, Dee-six, Dr. Davis, Evans, Everts, Goodwin, Halford, Hesse, Klamt, Late Ross,

Loadel, Monaco, Riegels, Rizzi, Ross, Stanislaus, Starn, Sullivan, Tuolumne). Preliminary analysis indicates good agreement between the human inspectors and the instrumented measurements. Visual color inspection and instrument inspection of flesh color were in agreement for 83% of the fruit. Manual firmness inspection agreed with the non-destructive method for 83% of the fruit and with the destructive firmness method for 78% of the fruit. An improved mold biosensor was developed for use in outdoor California processing tomato inspection stations. By reducing the sample size and increasing the reagent concentrations, the binding times and washing steps require less time to conduct without loss of sensitivity. Results indicate that except for the temperature sensitivity of the fluorescent label, the process was relatively insensitive to temperature. If a temperature insensitive fluorescent label is used, the method would be suited for use at inspection stations without temperature control.
Impact: This tool could help keep damaged citrus from entering the retail market, potentially reducing the economic damage caused when low quality freeze damaged fruit are purchased by consumers. An objective method of determining color and firmness in canning peaches and mold in processing tomatoes is important in the commerce of these commodities because it provides a fair method of assessing product value and assures the consumer that the produce meets minimum quality standards.

Funding Source: Multistate Research and State
Scope of Impact: CA, GA, HI, IN, MD

Theme: 2.02 Food Handling
Title: ASSURING FRUIT AND VEGETABLE PRODUCT QUALITY AND SAFETY THROUGH THE HANDLING AND MARKETING CHAIN

Description: Industry sponsored research continued on developing a fast, nondestructive method of determining the presence of freeze damage in oranges. Laboratory tests indicate that headspace ethanol determination using a hand-held sensor effectively discriminates between lots of chilled fruit and lots of freeze damaged fruit. Work continues on determining the sensitivity of the method and comparing it with a magnetic resonance detection technique. Rice value is partially determined by the proportion of whole kernels in a milled sample. FGIS sample milling procedures do not prescribe the temperature of the laboratory mill. We demonstrated that a higher whole kernel yield is produced by cooling the mill with a water-cooled saddle and specially adapted cutter bar assembly.
Impact: The orange study holds promise of developing a rapid, nondestructive method of determining freeze damage to replace the exiting qualitative evaluation method. The new design of the rice mill will allow the industry to obtain more consistent results and results that more closely reflect the milling yields obtainable by commercial mills.

Funding Source: Multistate Research and State
Scope of Impact: CA, GA, HI, IN, MD

Theme: 2.02 Food Handling
Title: POSTHARVEST QUALITY AND SAFETY IN FRESH-CUT VEGETABLES AND FRUITS

Description: Objective 1: 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. a. Impact of 1-MCP treatment of iceberg and romaine lettuce heads in relation to preprocessing handling and storage and to quality of the salad cut lettuce. Research conducted with industry and processor collaboration. b. Storage and conditioning of melons (cantaloupe, honeydew, and specialty melons) for improved aroma and quality. We are evaluating storage conditions, ethylene and 1-MCP applications and other treatments to enhance the overall quality, especially aroma, of cantaloupe and honeydew melons that are fresh-cut. Variety and stage of maturity at harvest are also part of the studies. c. Effect of preprocessing handling of peppers on pepper texture and other quality parameters. Mature-green peppers subjected to various periods of delay to cool and sun exposure and compositional and texture quality of dices evaluated. d. Use of 1-MCP to retard deterioriation of leafy green vegetables (collards, kale, parsley, other herbs). This work done at reasonable storage temperature (5 degrees C) and temperature abuse conditions (10 degree C). Visual quality attributes and compositional quality (sugars, chlorophyll, carotenoids, ascorbic acid, ammonia) evaluated. Objective 3: To develop a better understanding of the physiology of fresh-cut vegetables and fruits in response to processing and during storage and handling. a. As coordinator of an annual Fresh-cut workshop held at UC Davis (Sept 14-16, 2004), I compile and edit materials and recent research findings as well as unpublished data on fresh-cut products. b. Cauliflower intact and floret storage under a range of temperatures and atmospheres. Visual quality attributes, composition, and respiration rates monitored. Research conducted with industry and processor collaboration.
Impact: Our applied studies are of direct relevance to successful pre- and post-processing handling of products by the fresh-cut industry. Our work provides benchmark data on quality changes and compositional changes for fresh-cut products. Some of the studies we have conducted have been specifically requested by fresh-cut processors.

Funding Source: Multistate Research and State
Scope of Impact: AL, AR, CA, FL, GA, IA, IL, LA, MD, MI, MS, NYG, OK, OR, PA, TN

Theme: 2.02 Food Handling
Title: Postharvest Biology of Fruits

Description: Chilling at 6 C caused an immediate cessation of protoplasmic streaming in trichomes from African violets (Saintpaulia ionantha), and a slower aggregation of chloroplasts in the cells (Saltveit and Hepler, 2003). Streaming slowly recovered upon warming to 20 C, reaching fairly stable rates after 4, 15, 25, and 35 min for tissue chilled for 2 min and for 2, 14 and 24 h, respectively. The rate of ion leakage from excised petioles into an isotonic 0.2 M mannitol solution increased after 12 h of chilling and reached a maximum after 3 days of chilling. A heat-shock at 45 C for 6 min reduced chilling-induced rates of ion leakage from excised 1-cm petiole segments by over 50%, i.e., to levels near that from non-chilled control tissue. Heat-shock treatments themselves had no effect on the rate of ion leakage from non-chilled petiole segments. Protoplasmic streaming was stopped by 1 min of heat-shock at 45 C, but slowly recovered to normal levels after about 30 min. Chloroplasts aggregation was prevented by a 1 or 2 min 45 C heat-shock treatment administered 1.5 h before chilling, but heat-shock treatments up to 6 min only slightly delayed the reduction in protoplasmic streaming caused by chilling. Tradescantia virginiana did not exhibit symptoms associated with chilling injury in sensitive species (i.e., cessation of protoplasmic streaming in stamen hairs and increased ion leakage from leaf tissue). The ability of various abiotic stresses to suppress protein synthesis may be more important in increasing tolerance to chilling injury than their ability to induce the synthesis of specific proteins (Saltveit, Peiser and Rab, 2003). Exposure to a chilling temperature of 2.5 C for 96 h inhibited the subsequent growth of cucumber seedling radicles at 25 C by 92%. Exposing seedling with 5 mm long radicles to acetaldehyde vapor (275 ppm) or to an aqueous ethanol solution (0.6 M) for 2 h, or to 45 C for 10 min before chilling, increased chilling tolerance so that the chilling treatment reduced growth by only 47%, 39%, or 36%, respectively. All of these effective treatments induced the synthesis of a number of proteins, and suppressed de novo protein synthesis (i.e., the incorporation of [S]-methionine) by about 70%. In contrast, treatment for 2 h with an aqueous arsenite solution (100 micro M) had no effect on chilling sensitivity or the incorporation of [S]-methionine, yet it induced the synthesis of a complement of proteins that were similar to that induced by the effective heat-shock treatment. A unique protein or set of proteins may be responsible for heat shock induced chilling tolerance, but none was detected.
Impact: The UC basic studies have identified a number of key points in the physiology of chilling injury that may be amenable to manipulation through postharvest practices, conventional breeding, or genetic engineering. Current applications include the development of treatments that reduce chilling injury.

Funding Source: Multistate Research and State
Scope of Impact: CA, MA, ME, MI, MN, NC, NYC, NYG, OR, WA

Theme: 2.03 Food Quality

Title: Postharvest Quality and Safety in Fresh-Cut Vegetables and Fruits

Description: UC researchers evaluated the effects of cutting nad post-cutting handling conditions on concentrations of ascorbic acid, carotenoids, and flavonids in strawberries, pineapples, mangoes, cantaloupes, and watermelons during storage at 5 C and 90 to 95% relative humidity for 12 days. Only small losses in nutritional quality of fresh-cut fruits were noted before the end of their shelf-life based on appearance quality. Treatment of strawberry with 1-methylcyclopropene (1-MCP) after cutting retarded softening and darkening of fresh-cut strawberries kep at 5 C for 9 days (2 days longer than the control). Combining 1-MCP treatment with 1% calcium chloride dip an/or modified atmosphere packaging (2-4 % oxygen + 8-12% carbon dioxide) extended shelf-life of fresh-cut strawberries, pineapples, and mangoes by 2-3 days beyond the control. Although intact pomegranate fruits are chilling-sensitive, the arils are chilling-tolerant and should be kept at temperatures between 0 C and 5 C to maintain their quality and microbial safety. Pomegranate arils that are not damaged or microbally-contaminated can be kept at 0 C for up to 21 days, at 2 C for up to 18 days, or at 5 C for up to 14 days in marketable condition.
Impact: Their recommendations for maintaining quality of pomegranate arils have been used by the three companies in California to produce and market a ready-to-eat pomegranate arils product in 2004.
Funding Source: 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: During this past year, the effects of thermal processing conditions, such as blanching, boiling and retorting, on the degradation of glucosinolates was determined. Glucosinolates are natural compounds commonly occurring in Brassica species vegetables, and they are converted enzymatically to bioactive compounds. UC researchers also worked on a NASA funded project to design a multi-purpose fruit and vegetable processor to be used on the surface of Mars. This year's work involved evaluation of the energy requirements for tomato slicing, dicing, pulping and concentration. Another project focused on the thermal inactivation and reactivation of broccoli peroxidase, an enzyme which catalyzes quality degradation in many vegetables. One other project looked at the effects of low temperature treatments on activation of pectin methyl esterase and subsequent firming of diced tomatoes. Finally, they studied the lycopene content and color of California tomato varieties.
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: Multistate Research and State
Scope of Impact: AL, AR, CA, FL, GA, IA, IL, LA, MD, MI, MS, NYG, OK, OR, PA, TN

Theme: 2.03 Food Quality
Title: Effect of Environmental Variables and Cultural Practices on Phenolic Levels in the Grapevine and Its Relation to Phenolic Levels in Wines

Description: During the reporting period we conducted experiments to determine the relationship between fruit tannin content and the amount of tannin in the resulting wine. The purpose of the experiment was to determine the fraction of the tannin present in the fruit at harvest that is extracted during commercial winemaking. UC researchers extracted skin and seeds separately using 70% acetone and then used a ferric chloride reaction under basic conditions to determine the total amount of tannin in grape berries at harvest. Knowing the average berry weight, and the total amount of tannin in the fruit they were able to calculate the total amount of tannin harvested from each block of Cabernet Sauvignon fruit based on the harvest weight. After the fruit was processed for winemaking they determined the amount of tannin in the wine and measured the total volume of wine from the tank. This enabled us to compare the total amount of tannin in the fruit at harvest with the amount in the resulting wine and calculate the percent extracted. This experiment was conducted on 9 different blocks from two different wineries. They found that the percent extracted varied from vineyard site to vineyard site, ranging from 24% to75 %, with an average percentage extracted of 42%. The results indicate that the amount of tannin in fruit at harvest cannot be used to predict the amount of tannin that will be present in the resulting wine because of the large variation in the percentage of tannin in the fruit that is extracted during winemaking. They estimated the percentage of tannin in grape berries that is extracted during commercial winemaking. We found that the percentage extracted varied more than three fold among vineyards. This result indicates that tannin extractability is a major variable in red wine production. It also suggests that growing conditions that alter tannin extractability might be important but unrecognized viticultural variables.
Impact: Work during the reporting period provides a set of simple assays for determination of the phenolic compounds in grapes and wines. The system relies on the reactivity of iron with phenolics under basic conditions and thus generates little or no toxic waste. The system is simple, easy to implement in winery laboratories and can provide a useful tool for monitoring extraction protocols typically used in commercial wine production.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 2.03 Food Quality
Title: A study of sensory methodology issues in wine and food

Description: Traditional Madeira wines are baked and aged. One of the aging volatiles is sotolon (4,5-dimethyl-3-hydroxy-2(5H)-furanone), which imparts an aroma described as caramel, burnt sugar, "madeirised", "rancio", nutty and curry-like, and which increases in concentration with age. The sensory effect of sotolon on the "perceived age" of Madeiras was evaluated by comparing unbaked wines with added sotolon to traditional wines. Six traditional Madeiras made with Bual grapes (1961, 1968, 1980, 1993, 1996, and 1999), and 3 young, unbaked Bual wines with 0 ppb, 10 ppb and 19 ppb added sotolon, respectively, were compared by sensory descriptive analysis. Sixteen of 19 flavor attributes discriminated significantly among the wines. Principal component analysis showed that the first two PCs accounted for 69% of the variance. The baked and the unbaked wines were located on opposite sides of PC1. Unbaked wines were higher in musty, mushroom and dried fruit flavors, while baked wines had more complexity of flavor and were higher in nutty, citrus, cherry, coffee and brown sugar flavor attributes. Correspondence analysis used to analyze the color data graphically showed a progression of increasing brownness with increasing age up to about 23 years of aging. Although the two unbaked wines with added sotolon seemed to be more complex than the one without, this compound alone did not make them similar to the traditional Madeiras. Therefore, the baking process is important to the flavors of traditional Madeiras and a future modification of this study would be to add the sotolon after baking but before aging. It is commonly accepted that Botrytis wines have a characteristic honey-like aroma, but there are apparently no scientific reports on the differences in sensory perception of dessert wines made from Botrytis infected grapes and those made from non infected grapes, e.g. Ice wines. The purpose of this project was to determine if, by doing a sensory analysis of a number of Botrytis and non-Botrytis wines as determined by immunoassay, of different vintages and from different geographical areas; it is possible to sensorially distinguish between Botrytis and non-Botrytis wines. Wine were analzyed by descriptive analysis and by immuno-assay. In conclusion, despite the high variability in grape variety, wine processes and in wine regions of the wines selected for this study, there is a clear trend showing that wines with high Botrytis antigen values (above 6 BagU/mL) and wines with lower values than 1 BagU/mL do correlate well with the PLS1 model and the Botrytis antigen levels in the wines. The sensory description of wines with higher Botrytis antigen levels (> 6 BagU/mL) are particularly high levels of honey, while those with the lowest levels (< 1 BagU/mL) are described as high in fresh fruit and citrus aromas. Wines with Botrytis antigen levels in the middle of this range showed no correlations. In future studies, it would be interesting to combine sensory descriptive analysis, Botrytis antigen levels and GC-MS in the studying of selected wines, to explore, which specific components that contribute to the Botrytis flavor in the wines.
Impact: In both studies sensory descriptive analysis allowed us to describe the diffrences

among the wines and to explain these differences based on our knowledge of the chemistry and/or micro-organisms involved. In both cases this could lead to the production of more consistent wines.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 2.06 Food Safety
Title: ENHANCING POSTHARVEST QUALITY OF FRUITS WITH REDUCED DEPENDENCE ON CHEMICAL TREATMENTS

Description: Ethyl formate, a generally recognized as safe fumigant, has been tested on a wide range of economically important insect pests. The dosage required for Probit 9 control have been determined. In addition, UC researchers have explored the tolerance of table grapes to ethyl formate treatment. Grapes pretreated with sulfur dioxide show excellent tolerance to the ethyl formate treatment. They 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.
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

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 determine that a variety of environmental hazards create genotoxic risk to Californians that result in cancer and inherited deformities; to know that women report barriers related to their weight, such as disrespectful treatment and unsolicited advice to lose weight, contribute to delay of health care; to learn 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; to asses the impact of agronomic and physical processes on phytonutrient composition of foods provides mechanisms for optimizing the nutritional quality of food; to know that phytochemical-rich plant-based foods incorporated into usual diets have the potential to provide beneficial

cardiovascular effects; to learn that zinc deficiency can have deleterious effects on the nervous system during development as well as in adulthood; to have a better understanding of how and why humans of different ethnicities make food selections; and the nutritional consequences of these behaviors; and to learn that unhealthful habits that can lead to childhood obesity were common in Head Start households underscoring the need to engage parents in changing the home environment.

Thirty-three local extension programs were delivered in this area. In addition, 15 statewide collaborative workgroups and one continuing conference 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 105 peer-reviewed articles and 3 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 2004-2005 Allocated Resources

Extension Federal Funds (Smith Lever 3 b&c)	Extension State Match	Research Federal Funds (Hatch)	Research State Match
$466,208	$466,208	$455,625	$455,625

Extension Total FTE	Research Total FTE
15.83	32.40

Theme: 3.01 Health Care
Title: IMPROVING ACCESS TO HEALTH CARE FOR LARGE-SIZED WOMEN

Description: Overweight women are at higher risk from many types of gynecological cancer,including breast, uterus, cervix and ovary, but they obtain fewer preventive gynecologic examinations, including Pap tests and mammograms. The differences in care persist even after adjusting for other known barriers to care such as age, education and availability of health insurance. This information raises concern about why cancer-screening programs are not reaching obese women who are at an increased cancer risk. The objective of the study is to investigate the factors that contribute to lower rates of gynecological cancer screening as related to women's body size. California researchers sampled 498 women with Body Mass Index (BMI = kg/meter squared) from 25 to 122, including 60 women with BMI greater than 55, were surveyed concerning their access to gynecological cancer screening and potential barriers that could cause delay. Health care providers (N = 129) were surveyed concerning their education, practices, and attitudes about providing care and gynecological cancer screening tests for obese women. The results were that obese women reported that they delay cancer screening tests and perceive that their weight is a barrier to obtaining appropriate health care. The percent of women reporting these statementsincreased significantly as the women's BMI increased. Women with BMI >55 had a significantly lower rate of Papanicolaou (Pap) tests compared to others. The lower screening rate was not a result of lack of available health care since more than 90% of the women had health insurance.

Impact: Women report that barriers related to their weight contribute to delay of health care. These barriers include: disrespectful treatment, embarrassment at being weighed, negative attitudes of providers, unsolicited advice to lose weight, and medical equipment that was too small to be functional. The percentage of women who reported these barriers increased as the women's BMI increased. Women who delay were significantly less likely to have timely pelvic examinations, Paptests, and mammograms than the comparison group, even though they reported that they were 'moderately' or 'very concerned' about cancer symptoms. The women who delay care were also more likely to have been on weight loss programs five or more times. Many health care providers reported that they had little specific education concerning care of obese women, found that examining and providing care for large patients was more difficult than for other patients andwere not satisfied with the resources and referrals available to provide care for them. Since the goal of preventive cancer screening is to improve health outcomes for obese women, strategies must be designed to reduce the weight- barriers to these tests and improve the quality of the health care experience. Providers should receive specific training related to care of large women. The impact of this research is to increase access to health care for obese women and to increase the percentage of obese women who have gynecological cancer screening tests at the appropriate frequency. If cancers are found early, many lives could be saved.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 3.02 Human Health
Title: MOLECULAR GENETICS OF HUMAN CELL RESPONSE TO ENVIRONMENTAL CARCINOGENS

Description: The objective of this project is to characterize the mechanisms of environmentally induced genetic toxicological response. Much of the work has focused on recombinational mechanisms for mutation. The findings have led to the development of a detailed new mechanistic model, which describes recombination-mediated pathways for mutation at chromosomal genes. Recombination-mediated pathways of mutation are frequently observed in human cancer, particularly at tumor suppressor loci. Other work has been ongoing on the characterization of genomic instability induced by very low doses of ionizing radiation, which are consistent with environmental exposure levels. Genomic instability, which refers to an elevated risk of genetic change for many generations after exposure, represents another important but incompletely understood mechanism for environmental carcinogenesis. Recently, California researchers have also initiated an extensive series of experiments designed to test the hypothesis that a mutational signature can be identified at the important tumor suppressor locus p53 by analysis of megabase scale deletions. California researchers are in the process of characterizing the radiation-induced spectrum at p53 by inserting a selectable marker into one of the p53 alleles. Targeting is underway in human lymphoblasts, for direct comparison with existing spectra at model loci, and will also be performed in mouse embryonic stem cells. The targeted embryonic stem cells will enable development of a transgenic mouse system to directly compare mutational spectra induced by chromosome breakage agents with tumors induced by the same agents in the mouse model.
Impact: A variety of environmental hazards create genotoxic risk to Californians that result in cancer and inherited deformities. The work within this project contributes to the identification of risk levels as well as a better understanding of the mechanisms by which genetic damage is induced. This information can ultimately be used in establishing and monitoring safe exposure levels.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 3.02 Human Health
Title: CHROMOSOMAL MECHANISMS IN ENVIRONMENTAL CARCINOGENESIS

Description: Recently the research on chromosomal mechanisms in environmental carcinogenesis has explored the use of chromosomal markers for cancer diagnosis and using DNA polymorphisms combined with cytogenetic endpoints to identify susceptible individuals in the population. A brief description of these studies is described as follows: 1) Using fluorescence in situ hybridization (FISH) with DNA probes for the centromeric regions of human chromosomes 3 and 17, researchers showed that a significant proportion of women diagnosed as human papillomas virus-positive with atypical squamous cells of undetermined significance (ASCUS) had elevated levels of tetraploid cervical cells, a genetic abnormality often associated with cervical carcinogenesis. These results suggest that these women are at an increased risk of developing more advanced cervical lesions and that this FISH technique may be useful as a secondary test in cervical cancer screening. 2) California researchers

examined the effect of UDP- glucuronosyltransferase 1A1 (UGT1A1) genotype on somatic mutant frequency in the HPRT gene in human lymphocytes and the glycophorin A gene of red blood cells, as well as the frequency of lymphocyte micronuclei in 101 healthy smoking and nonsmoking individuals. No associations were seen between the UGT1A1 polymorphisms and micronucleus frequencies. While some associations were found between specific polymorphisms and hprt and glycophorin mutant frequencies, consistent patterns were not seen. The results from this study suggested that UGT1A1 genotype may modulate somatic mutation in some cell types by a mechanism not involving bilirubin antioxidant activity.
Impact: Cervical cancer is the second most common malignant neoplasia affecting women worldwide, with approximately 500,000 new cases diagnosed annually. Screening in the United States has significantly lowered mortality from this disease. However, as part of the screening process, approximately 2 million Pap smears per year are classified as ASCUS, meaning that no clear diagnostic information can be gathered from the smear. As a result, large numbers of women are subjected to additional testing that is emotionally taxing with annual costs estimated in the hundreds of millions of dollars. Having a reliable secondary diagnostic technique such as the FISH technique mentioned above would be a significant advance and substantially reduce these additional diagnostic costs.

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: Chemicals including pharmaceuticals, drugs, food substances, pesticides and other products in commerce are never used with 100% efficiency. In pest management in agriculture and in residential settings, 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 protectedfrom insect pests. Organophosphate (OP) pesticides are the first chemical class 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 CDC biomonitoring data. The results indicate that EPA's screening level assessments of OPs, while being qualitative indicators of the relative importance of various exposure sources, are not good quantitative exposure indicators. California researchers 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 153 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. Sixty per cent of the produce samples contained more DAP residue than parent pesticide. The mole ratios of DAPs to parent organophosphate residues ranged from 0.1 to 73. There can be no doubt that oral or gatrointestinal absorption of nontoxic DAPs contributes to overestimates of absorbed dosage from biomonitoring data reported in CDC National Reports 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 developing principles that guide policy development and day-to-day 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 of organophosphates and pyrethroids in food will inflate exposure assessments, particularly those for children. Measurement of organophosphate metabolites in both produce and human urine is an important for health and epidemiological studies. Urine monitoring of pesticide biomarkers can be used to more accurately establish exposures following a variety of human activities.

Funding Source: Multistate Research and State

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

Theme: 3.02 Human Health

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

Description: The primary goals of this project are to (1) establish relationships between the consumption of specific phytochemicals and whole foods and the activation of key detoxification pathways, (2) develop analytical methodologies for the analysis of flavonoid and flavonoid metabolites in biological tissues, and (3) assess the impact of agronomic and physical processes on the phytonutrient composition of foods in order to ensure quality and develop an analytical foundation for nutritional genomics. The following is a list of key accomplishments from the efforts over the past year: 1. Development of a method for quantifying detoxification enzymes directly in tissue homogentates in response to diet. 2. Development of methods enabling the metabolic profiling of flavonoids and flavonoid metabolites in human tissues in response to diet. 3. Characterization of the polyphenolics in peaches and demonstration that thermal processing canalter their distribution. Characterization of polyphenolic compounds in grape seeds and beer. More importantly, California researchers are in the second year of a three-year study investigating the influence of farming practices on several quality and nutritional characteristics in tomatoes and bell peppers. These studies demonstrate a trend of statistically higher levels of vitamin C and certain phenolic antioxidants in foods grown by organic farming practices as compared to conventional practices.

Impact: Optimizing 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 the nutritional quality of food. Investigating the influence of diet on the regulation of detoxification pathways lays the foundation for assessing how diet alters molecular mechanisms that maintain health and/or modulate disease.

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 overall research program investigates effects of dietary phytochemicals fromfoods such as soy, fruits, nuts and cocoa on lipid and lipoprotein oxidation susceptibility, platelet aggregation, endothelial function and other markers of cardiovascular risk. The major accomplishments during this period relate to the following research questions and interests: 1) Hypothesis: Soy protein and associated isoflavones will provide antioxidant protection in the plasma during the acute phase of 0-7 hours following consumption, as measured by LDLoxidation 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 inpreparation. 2) Hypothesis: Soy protein and associated isoflavones 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. Whole blood plateletaggregation was measured, as well as platelet surface activation markers using monoclonal antibodies and flow cytometry. Data analysis is underway, the first draft of a manuscript is being prepared and submission is planned for the coming year. 3) Hypothesis: Grape Seed Extract (GSE) polyphenols will delay platelet aggregation, decrease blood pressure, and decrease lipid oxidation susceptibility in individuals with the Metabolic Syndrome (a constellation of risk factorsassociated with cardiovascular disease risk). A randomized controlled trial with 36 subjects is underway to evaluate the effects of two doses of GSE consumed twice daily over a period of four weeks. The activities for the coming year on this project include recruitment of the final subjects, completion of biochemical assays and data collection, data analysis and manuscript preparation. 4) A review paper has been submitted regarding soy protein and isoflavones and potential positive health benefits for chronic disease risk reduction. This paper summarizes the current literature and targets practicing clinical nutritionists. It is currently undergoing revisions following peer review. 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 additional measures of cardiovascular risk.

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 are multi-factorial and include antioxidant protection and modulation of vascular endothelial function, in addition to impacting lipid and lipoprotein metabolism. Information regarding physiologic functions of dietary phytochemicals can influence public policy and clinical recommendations.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 3.02 Human Health
Title: ALTERED FOOD INTAKE IN AGE-RELATED ANOREXIA: HYPOTHALAMIC DYSREGULATION

Description: California researchers continue to evaluate the effect of senescence on age-related anorexia by focusing on possible hypothalamic alterations. During the past year, the specific aim was to test the hypothesis that gamma amino butyric acid (GABA), a putative potentiator of NPYs effect on food intake, is diminished. To this end, young and old male F344 rats received injections of NPY, muscimol, (MUS, a GABA A receptor agonist), combinations of these two agents, and vehicle [artificial] cerebrospinal fluid (aCSF)] into the hypothalamic paraventricular nucleus (PVN). Both young and old presenescent rats increased their food intake in response to NPY, MUS, and the combination of the two (in comparison to injections of aCSF). Senescent rats exhibited an attenuated NPY-induced food intake, no increase in response to MUS, and a response to NPY + MUS that was no larger than that of NPY alone. Researchers conclude that PVN injections of GABA as well as NPY are less effective in stimulating feeding in senescent rats and suggest that alterations in their signaling pathways play a role in the involuntary feeding decrease seen near the end of life. The current investigations are focusing on components of the GABA signally pathway in order to evaluate their role in the diminished food intake of the senescent rat.
Impact: Although caution should be used when extrapolating between rodents and humans, the results suggest strongly that neural centers in the hypothalamus are involved with attenuated food intake observed in aging humans. Identifying the precise location of the disruption in neural control of food intake could aid in the development of pharmacological treatments for age-related anorexia.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 3.02 Human Health
Title: OBESE FEMALE RESTRAINED EATERS: TWO TREATMENT OPTIONS

Description: This study was done in collaboration with scientist at the USDA Western HumanNutrition Center. This is a long term study of obese female premenopausal women (n=78, ages 30-45 yrs). This year, in the first published paper, California researchers

examined bone mineral density (BMD) and content (BMC)of the spine and femur in obese women who were restrained eaters, with emphasis on the relationship between bone mineral content (BMC) and determinants of bone mass, and current eating behaviors, dietary intake, physical activity, and indices of calcium regulation, bone metabolism, stress and inflammation. Obese pre-menopausal women are thought to be at low risk for osteoporosis due to increased body weight and estrogen on weight-bearing bone. However, research involving eating behaviors has identified an association between high levels of restrained eating (conscious limitation of food intake) and reduced bone mass. Thirty-one percent of women had osteopenia or osteoporosis (osteo). In osteo women, 87.5% had osteo based on lumbar spine, whereas only 12.5% had osteo based on femur. No significant differences were observed between osteo women and non-osteo women for current eating behaviors, dietary intake, physical activity habits, bone turnover, calcium regulation, stress or inflammation. A significant positive correlation between BMC and energy expenditure (r=0.256), and a significant negative correlation between BMC and number of times on a weight loss diet (r= -0.250) and cognitive restraint (r= -0.239) were observed. In the second paper (in press, 2004), researchers have reported on the two year follow-up of women in the dieting group (diet) and compared them with women in the health at every size non-dieting group (HAES). 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, Interceptive 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. Fifty percent of both groups returned for two year evaluation. HAES group maintained weight, improved in all outcome variables, and sustained improvements. Diet Group lost weight and showed initial improvement in many variables at one year; weight was regained and little improvement was sustained.
Impact: It is important to monitor obese women for osteoporosis/osteopenia. While bone density in weight bearing joints is not compromised, it is in areas like the lumbar spine. Despite the attention to weight and the increase in diet behavior, the incidence of obesity continues to rise. There are little data to show improved long term success for the majority of participants who engage in weight loss behaviors. The second study documented that an approach that emphasizes health at every size did not result in a change in body weight but did 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: 3.02 Human Health
Title: MEDIATING EXPOSURE TO ENVIRONMENTAL HAZARDS THROUGH

TEXTILE SYSTEMS

Description: 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 resulted collaboration with National Personal Protective Technology Laboratory (NPPTL) of NIOSH. In addition, one of the antibacterial technologies resulted from the research is tested by U.S. Air Force for antimicrobial underwear and uniforms. Another technology is applied in production of biocidal hospital linen products.
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: Multistate Research and State
Scope of Impact: CA, CO, IA, IL, MD, MN, NE, NYC, OK

Theme: 3.02 Human Health
Title: FOODS FOR MAINTAINING HEALTH

Description: Studies in human volunteers have demonstrated that the cholecystokinin (CCK)response to meals corresponded to the subjective measure of satiety; however, the pattern of satiety differs between men and women. In women fat in a food structure (whole almonds) induce a lower satiety response than fat incorporated into foods as oil. Additional studies demonstrated that the source of dietary fat (dairy or nondairy) modifies the lipid, insulin and CCK responses to high and low fat meals. Inclusion of dairy fat significantly reduced the insulin response to a high carbohydrate meal and enhanced CCK responses. Based on previous work on food-based dietary guidelines contributions have been made to publications on the role of new technologies to improving health and lowering risk of chronic diseases.
Impact: These studies demonstrate the importance of CCK as a useful biomarker ofsatiety in human volunteers. In addition the studies indicate that the impact of food components on subjective feelings associated with satiety are related to, not only the macronutrient content of foods, but to the form of foods and the source of the macronutrients. These complement earlier studies in which California researchers demonstrated that fiber, the non-digestible carbohydrate fraction of foods, will also enhance the subjective satiety of meals. These results are important for food choices that can help modify food intake behavior.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 3.02 Human Health
Title: EFFECTS OF NUTRIENTS AND TOXICANTS ON HUMAN HEALTH

Description: The research in a UC laboratory focuses on the regulation of neuronal cell signals by nutrients and toxicants. California researchers have been studying the effects of zinc deficiency-induced oxidative stress and cytoskeleton alterations on select neuronal signals whose impairment can affect neuronal proliferation, differentiation and death. An altered synaptic plasticity could explain in part the neurological disorders associated with developmental zinc deficiency. Based on the known increased risk of the elderly to develop zinc deficiency, alterations in synaptic plasticity may also contribute to the age-associated impairment of cognitive functions. researchers are also working on the hypothesis that a combination of marginal zinc deficiency and lead exposure during gestation and infancy will have a serious impact on neurobehavioral and learning capacities later in life. For this purpose, researchers are investigating the potential differential susceptibility of zinc deficient neurons to lead toxicity focusing on the modulation of select cell signals and on the induction of apoptotic cell death. Researchers have found that in neuronal cell cultures, a condition of zinc deficiency leads to a higher susceptibility of cells to lead-mediated activation of select signaling cascades that can result in impaired cell function and death.
Impact: The studies indicate that zinc deficiency can have deleterious effects on the nervous system during development as well as in adulthood. A condition of zinc deficiency during gestation and infancy can increase the susceptibility of an individual to the adverse effects of select neurotoxic metals, that can affect neurobehavioral and learning capacities later in life.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 3.02 Human Health
Title: MODULATION OF CANCER TISK IN COLONIC EPITHELIAL CELLS

Description: Epidemiological data suggest that obesity increases the risk of colorectal cancerin humans. To pursue this observation, a study was designed to determine whether obese C57BL/6J-Lep-ob male mice were at greater risk of colonic cancer than their lean male littermates. Risk of colonic tumorgenesis was assessed by numbers of aberrant crypts, aberrant crypt foci and colonic tumors. Proliferation of the colonic epithelia was assessed histochemically following administration of BrdU. Availability of the procarcinogen, azoxymethane (AOM) to target tissues was assessed by quantifying via HPLC plasma AOM concentrations during the 60 min period following AOM injection. When obese and lean mice were injected with azoxymethane (AOM) at doses calculated to provide equivalent AOM levels per kg lean body mass, obese animals had significantly fewer aberrant crypts/colon and fewer aberrant crypt foci/colon than the lean animals. Tumors were identified in the colonic mucosa of lean (4 tumors in 14 mice) but not obese (0 tumors in 15 mice) mice. Colonic cell proliferation was not significantly different for obese and lean mice. Because

these results were unexpected, plasma AOM concentrations were measured and were found to be lower in the obese than lean mice. When plasma AOM levels were comparable for the lean and obese mice, the obese mice continued to have significantly fewer aberrant crypt foci/colon than the lean mice. Obese Lep-ob mice did not exhibit increased risk of colonic cancer as expected. Instead, Lep-ob mice exhibited equivalent or lower risk of colon cancer when compared to the lean group. These results imply that leptin may be responsible for the increased risk of colon cancer associated with obesity.
Impact: Epidemiological data suggest that persons who are overweight or obese are at increased risk of colorectal cancer. With the increased prevalence of overweight and obesity in children and adults in the U.S. and elsewhere, this increased risk has the potential to greatly increase colorectal cancer incidence within the next 20 years. If leptin is the molecule responsible for this link, intervention strategies should aim to reduce plasma leptin concentrations.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 3.02 Human Health
Title: GENETIC IMPROVEMENT OF BEANS (PHASEOLUS VULGARIS L.) FOR YIELD, DISEASE RESISTANCE, AND FOOD VALUE
Description: Lunasin is present in barley and is bioactive as measured by colony formationassay. This is the first report of the presence of this peptide in cereals. Lunasin was also characterized in Korean soybean cultivars. Lunasin suppresses E1A (a viral protein)-mediated transformation of mammalian cells but has no effect on the growth of normal and established cancer cell lines.
Impact: This is the first report on the ability of lunasin to prevent carcinogenesis induced by a viral oncogene. Lunasin from soybean was completely characterized. The ability of lunasin to suppress skin cancer California researchers reported earlier is confirmed with a stable isotope method. It is shown that dermal application of lunasin slows down cell proliferation of skin keratinocytes. Significant progress continues to be made in providing evidence for the cancer preventive properties of the lunasin peptide. Originally found in soy, it is now found in barley.

Funding Source: Multistate Research and State
Scope of Impact: AZ, CA, CO, FL, GA, MI, MT, ND, NE, MN, NYC, NYG, OR, PR, WA, WI

Theme: 3.03 Human Nutrition
Title: FROM THE FARM TO YOUR CHICKEN TACO

Description: In January 2005, UC Cooperative Extension in Riverside County created aninternship project for a student from Berea College in Kentucky to visit Coachella Valley. Nutrition, Family & Consumer Sciences Advisor, FSNEP Youth Program Rep and 4-H YD Program Rep in Riverside County, and student intern planned an educational display and

hands-on activity to present to elementary school students in an after-school program. They designed a display titled AFrom The Farm to Your Chicken Taco.@ The storytelling and presentation using picture cards and a felt board showed the children how components of a chicken taco can be traced back to the farm, their origin. The presentation was followed with corn tortilla-making demonstration. Students observed the mixing of corn flour and water, and the kneading to make dough. Each student got a small wad of dough to roll into a ball, which they patted down flat to make a tortilla. Afterward they cooked their tortilla on a griddle, then tasted the tortilla. This project was well-received and has been used to launch the 4-H After School Farm-to-School educational program in Riverside County. Four 4-H after-school clubs participated, and the program is being continued during FY 2005-2006.
Impact: The student intern had an opportunity to participate in brainstorming, planning and conducting a project, as well as to teach to a group of Latino children. Twenty-two children in this classroom during after-school program at Valley View Elementary in Coachella learned about cornfields, tomato and lettuce gardens, hen houses, milking cows and making cheese. They learned that a lot of work goes into making a chicken taco and gained a better knowledge of the agricultural side of food production.

Funding Source: USDA Food Stamp Nutrition Education Program, Smith Lever and State
Scope of Impact: State

Theme: 3.03 Human Nutrition
Title: FUNCTION OF THE AMMONIA TRANSPORTER

Description: The most important finding from the previous year was that the largest class ofspontaneous mutants of the green alga Chlamydomonas reinhardtii selected for resistance to the toxic ammonium analogue methylammonium lacked function of its major ammonia gas channel Amt4.
Impact: The green alga Chlamydomonas reinhardtii is one of the few microorganisms known to have both types of biological gas channels that have been described, those for NH3 (called Amt or Mep) and those for CO2 (Rh). C. reinhardtii allowed the clearest distinction between substrates for the two types of channels and provided the first evidence that Rh proteins were CO2 channels. Despite their immunological importance in transfusion medicine in humans, the function of Rh proteins had been unknown for over 60 years.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 3.03 Human Nutrition
Title: NUTRIENT BIOAVAILABILITY B PHYTONUTRIENTS AND BEYOND
Description: California researchers have continued studies on the metabolic and nutritional effects of common polymorphisms in human folate-related genes that have been shown to influence disease risk. researchers have identified a gene-gene interaction that influences the risk of heart disease and are developing cell culture models to mimic this interaction.

Researchers have continued to evaluate two new genetic mouse models to mimic the effects of these polymorphisms and to evaluate their effects on metabolism and how this is modified by nutritional status. These new animal models have gene interruptions that disturb mitochondrial folate metabolism and histone methylation, a process involved in regulation of gene expression. researchers have continued to study one carbon metabolic fluxes and DNA methylation in these animals and in embryonic fibroblasts. The data indicate that disturbances in mitochondrial folate metabolism result in early embryonic lethality. In collaborative human studies with advisor at Florida, researchers have shown that a common polymorphism in the MTHFR gene causes elevated homocysteine prior to defective remethylation in folate-restricted young women. Researchers have continued to evaluate genetic risk factors for neural tube defects.
Impact: Neural tube defects are the most common birth defects in humans and identification of genetic risk factors for this condition will allow screening to identify at risk individuals. Polymorphisms in genes encoding folate-dependent enzymes have been implicated as risk factors for cancer and vascular disease. The studies may indicate whether this risk can be modified by dietary changes.

Funding Source: Multistate Research and State
Scope of Impact: AZ, CA, CO, CTS, IN, KS, MA, ME, MI, NE, NM, OR, WA

Theme: 3.03 Human Nutrition
Title: DIETARY PATTERNS AND NUTRITIONAL STATUS OF VIETNAMESE AND VIETNAMESE-AMERICANS

Description: Research has been completed on the cultural-history of key American foods; seven reports have been published, four remain in-press. Fieldwork has concluded in the United States on identifying traditional dietary practices of Vietnamese-Americans during pregnancy and lactation. Research on food procurement practices of California Hmong has concluded. Fieldwork on edible wild plants in northern Thailand and use in maternal diet has concluded
Impact: A book- length manuscript on themes in cultural nutrition, with special attention to nutritional issues in ethnic minority populations, was published in 2004. Research on medical uses of chocolate continues. Understanding how and why humans make food selections, and the nutritional consequences of these behaviors will permit better nutrition education programs in the 21st century.

Funding Source: Hatch and State
Scope of Impact: State Specific

Key Theme: 3.03
Title: PREVENTING CHILDHOOD OBESITY: A TEAM EFFORT

Description :The issue of childhood obesity has increasingly captured interest and generated concerns among health experts. In September 2004, the Institute of Medicine concluded that Achildhood obesity is a serious nationwide health problem requiring urgent attention and a population-based prevention approach so that all children may grow up physically and emotionally healthy.@ Over the last 30 years, the incidence of obesity has more than doubled for preschool children and adolescents, and it has more than tripled for children ages 6 to 11 years old. Today approximately 9 million children over age 6 are obese. As part of UC Berkeley Center for Weight and Health=s Children and Weight: What Communities Can Do! Project, UC Cooperative Extension in Riverside County initiated a grassroots coalition for the Corona-Norco community in June 2002. The Corona-Norco Children and Weight Coalition (CN-CWC) has brought together agency representatives and people from various backgrounds in the community to work toward raising childhood obesity awareness and prevention. CN-CWC partner agencies include Corona-Norco Unified School District, Riverside County Office of Education Children and Family Services Head Start, Riverside County Department of Public Health Nutrition Services, California State University-San Bernardino, Loma Linda University, YMCA, American Cancer Society and Molina Health Care.
Impact: The coalition conducted a health habits survey of Head Start families during2003-2004. The survey found that unhealthful habits that can lead to childhood obesity were common, and underscored the need to engage parents in changing the home environment. For example, more than 80 percent of respondents said they fed at least one fast food meal to their children each week. Fifty-seven percent of parents said their children spent two or more hours watching TV or playing video games every day.
The coalition received funding from UC-ANR California Communities Program to hire a graduate student intern from Loma Linda University. The graduate student intern worked with the coalition to develop a presentation with educational displays for Head Start parents. More than 90 Head Start parents participated in the childhood obesity awareness sessions. The presentation and displays raised awareness about fast food, soda and unhealthy snacks, and educated parents about healthier options that they could make available to their children at home.

Funding Source: Smith Lever and State
Scope of Impact: State

Theme: 3.03 Human Nutrition
Title: BIOAVAILABILITY OF VITAMIN A & ZINC FROM SELECTED FOODS OF POTENTIAL USE FOR INTERVENTION PROGRAMS IN POPULATIONS AT HIGH RISK OF DEFICIENCY

Description: During the past year, several studies were completed on: 1) the effects of different fortification mixtures on the absorption of iron and zinc from processed food supplements designed for young children, 2) the effects of zinc supplementation alone or with other micronutrients on illness risk, growth and micronutrient status of young children, 3) the effects of infant feeding interventions (varied duration of exclusive breast feeding and

different systems of delivering micronutrients) on infant risk of micronutrient deficiency, and 4) bioavailability of vitamin A from different food sources. The study of fortificant mixtures indicated that iron was absorbed 70% more efficiently from a mixture containing NaFeEDTA than from one containing ferrous sulfate, but the amount of calcium in the mixture did not affect iron absorption; zinc absorption did not differ when zinc was provided as zinc sulfate or zinc methionine, although higher calcium intake had a marginally negative effect on zinc absorption. The study of zinc supplementation found that zinc alone reduced symptoms of infectious morbidity, whereas simultaneous provision of zinc with other micronutrients increased the risk of these illnesses. A study of infant feeding practices indicated that low birth weight (LBW), exclusively breast fed infants who received iron supplements from 4-6 mo and LBW infants who received complementary foods beginning at 4 mo had higher iron status at 6 mo than unsupplemented EBF infants. In another study of complementary feeding practices, mothers were able to implement short-term recommended changes in feeding behaviors, including increasing meal frequency, increasing the amount of food provided, decreasing viscosity and thereby enhancing the energy density of semi-solid preparations and successfully administering different types of micronutrient supplements. The study of food sources of vitamin A showed that both green leafy vegetables and yellow-orange sweet potatoes had a positive impact on vitamin A reserves, with estimated equivalency factors of 10:1 and 13:1, respectively, in relation to retinyl palmitate.
Impact: The results of these studies can be used to formulate appropriate fortified foods for young children, to plan micronutrient supplementation programs, and to develop appropriate recommendations for young child feeding and practical guidelines for satisfying vitamin A requirements
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Funding Source: Hatch and State
Scope of Impact: State Specific

Key Theme: 3.03 Human Nutrition
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 California researchers gain a better understanding of the influence of this disease on mineral metabolism. Researchers 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 researchers 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 research emphasis is the investigation of the effects of zinc and copper deficiency on fetal and early neonatal development. During the period under review, several studies on the effects of zinc and copper deficiency on oxidant defense mechanisms in the developing conceptus were completed. Also studies on the effects of zinc deficiency on cell membrane integrity, and on the activation of certain key regulatory genes were completed. The work provides evidence for the concept that a common cause of pregnancy complications is sub optimal maternal zinc and copper nutrition. In addition, this work supports the concept that a common cause of developmental defects is excessive tissue oxidative damage.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 3.03 Human Nutrition
Title: MEASUREMENT OF CELL PROLIFERATION IN RESPONSE TO NUTRIENTS: ROLE IN CARCINOGENESIS AND ATHEROGENESIS

Description: Substantial progress was made toward the goals of understanding the role of nutrients in modifying cell proliferation and the risk for cancer and vascular disease. First, accurate, high-throughput techniques were developed for measuring the proliferation rates of breast epithelial cells (BEC), colonocytes and skin epithelial cells (keratinocytes), both in rodents and humans. These techniques involve no radioactivity or other risks. Carcinogens increase the proliferation of skin epithelial cells in mice, while anti-mitotic agents such as the soy-derived peptide lunasin reverse this effect. Dietary carcinogens increase colonocyte proliferation in rats, and dietary curcumin or non-steroidal anti-inflammatory agents do not block this. Genistein, a phytoestrogen derived from soy, reduced BEC proliferation in rodents but only when provided in both pre-weaning and adult phases of life. Human BEC proliferation, measured from percutaneous needle biopsies or ductal lavage, exhibited higher values in premenopausal women than post-menopausal women and exhibited considerable variability among women, that could reflect effects of diet. Dietary caloric restriction (30% reduction) reduced the proliferation rate of keratinocytes and MEC in mice. Interestingly, feeding mice three times per week with only 5% caloric reduction reproduced most of the effects on cell proliferation of much more stringent calorie restriction, suggesting that intermittency of feeding may have potent impact on cell proliferation and may provide a feasible practical alternative to severe restriction in the clinical setting. The proliferation rate of cells in human skin was established indirectly by non-invasive sampling of skin keratin kinetics. Finally, high-fat diet interacts with genetics to alter vascular smooth muscle cell

(VSMC) proliferation in the aorta of mice. The combination of apolipoprotein E knockout plus high-fat diet increased VSMC proliferation much more than either alone.
Impact: The ability to measure the proliferation and death rates of cells in vivo in animalsand humans with accuracy and ease opens many research questions to experimental inquiry. The activity of agents proposed to have cancer-protective actions (e.g. estrogen modulators, soy-derived phytoestrogens or mitosis-inhibitors, caloric restriction, Brassica-derived agents) has now been tested in living organisms. Hypothesized health benefits or adverse effects of these factors can thereby be subjected to experimental testing. Improved understanding of the prevention, detection and treatment of disease may result from these new techniques that California researchers have developed.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 3.03 Human Nutrition
Title: CHARACTERIZATION OF THE NUTRITIONAL SENSING SIGNAL TRANSDUCTION PATHWAY OF MYXOCOCCUS XANTHUS

Description: During this period California researchers have focused on the role early developmental mutants and their ability to "predate" or utilize soil bacteria and fungi as sole sources of nutrition. Researchers have demonstrated that many of the early developmental mutants and mutants defective in antimicrobial production are blocked in their ability to act as predators in vitro.
Impact: These bacteria produce many antimicrobials, during the transition from vegetative growth to development. The goal is to understand how to increase and optimize production of these antimicrobials and to determine what role they are playing in nature. Understanding the process by which cells sense and respond to nutrients will lead to a better understanding of how cells regulate the production of these economically important compounds.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 3.03 Human Nutrition
Title: CHEMISTRY OF LIPIDS IN FOODS AND TISSUES

Description: Research in the past year has developed further the understanding of thephysical, chemical and biological properties of dietary lipids and their specific roles in foods and health. The nutritional value of the wide range of lipids from milk has continued to be a source of controversy as the potential beneficial and detrimental properties are explored. Research illustrates that different fatty acids are likely to have disparate effects on different individuals based on their genetic and metabolic status. Therefore strategies to distinguish metabolic differences between individuals were an important outcome of the project this year. Methods were developed to quantify the broad metabolic effects of various dietary

ingredients including but not limited to dietary fats. Since individual metabolism responds to non-essential nutrients International consensus was developed to pursue the means to coordinate research in personalized assessment and dietary intervention. The continuing goals of this research are to provide the analytical tools to enable individuals to routinely monitor their metabolic health and with this information guide their food choices.
Impact: Understanding the role of dietary lipids in health and metabolism will provide the knowledge for the food industry to produce food products for improved health. A scientific consensus to establish the metabolic differences between individuals and their different responses to diet will guide the development of technologies to measure those differences and inform both the consumers and their food providers

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 3.03 Human Nutrition
Title: FAMILY, FOOD, FUN, AND FITNESS: FOOD STAMP FAMILIES TEAM UP FOR HEALTHIER LIFESTYLES (ALSO KNOWN AS EAT SMART. PLAY HARD.

Description: Participants will:

1. Demonstrate a positive knowledge gain regarding healthy snacking and being physically active.
2. More often select fruits and/or vegetables for snacks.
3. Reduce the consumption of sweetened beverages for snacks.
4. Increase the consumption of water during snacks.
5. Set goals for healthy snacking and physical activity

Over the last two years the program has been offered three times in San Luis Obispo County to families who participate in the USDA Food Stamp Program and/or the USDA Free and Reduced School Meal Program. Currently, the program is being pilot tested as a train-the-trainer program with educational and community-based organizations in four counties. Results of the train-the-trainer component will be available July 2006.
Impact: Evaluation data collected over a two-year period indicated that child and adult participants (n=38) showed an average 19 percentage point knowledge gain through pre/post tests (pre= 68%; post=87%). Participants used stickers to identify snacking and activity habits at the beginning and end of the program. The sticker assessment indicated that 98% of participants made at least one positive behavior change regarding healthy snacking or being physically active. Reported healthy behavior change included:

20% drinking less soda for snacks
5% drinking less fruit drinks for snacks
15% drinking less sports drinks for snacks
33% drinking more water for snacks
38% being more physically active.

One and two month in-person, follow-up interviews for the 2005 class (n=19) indicated that all participants continued to use the program in their daily lives. Program participants indicated

continuing to make healthy fruit and vegetable snack recipes and to use physical activity games demonstrated during the program. Additionally, participants indicated walking more and sharing the information with family members.
Funding Source: USDA Food Stamp Nutrition Education Program, Smith Lever and State
Scope of Impact: State Specific

Theme: 3.03 Human Nutrition
Title: PARENT AND HOUSEHOLD INFLUENCES ON CALCIUM INTAKE AMONG PREADOLESCENTS

Description: The research project is specifically looking at the role of parental attitudes and behavior on the consumption of calcium rich foods by preadolescents. To accomplish this goal, interviews of English speaking parents, representing specific ethnic/racial groups of 10-13 year olds are being conducted by each university. During this time period a graduate student interviewed 7 additional parents, meeting the requisite 16 total interviews for the state. California researchers at other institutes reviewed the results of select questions on parent influence and helped develop questions for a parent survey instrument. These were reviewed and refined at the annual meeting in Minnesota and a time line for the next phase of the project was developed. Continuing work is in the early stages of developing a parent/child food preparation project that will be used in the next stage of the project when researchers interview sets of parent and child pairs. This project will feature calcium rich foods prepared by parent child teams. Food safety and food tips will also be included.
Impact: This project will create a new research instrument that links parent and child intake of a major nutrient. This project will identify factors that influence the calcium intake of young adolescents. This information can be used in developing effective, tailored nutrition intervention for young adolescents and their parents and may help reduce the financial burden of osteoporosis.

Funding Source: Multistate Research and State
Scope of Impact: AL, AZ, CA, CO, HI, IN, MI, MN, NM, OR, WA, WY

Theme: 3.03 Human Nutrition
Title: PERCEIVED AND ACTUAL MERIT OF BEER AS A COMPONENT OF THE DIET

Description: The project has commenced with an ongoing literature assessment of the currentglobal understanding of beer in the context of health, nutrition and well-being. A large part of this body of work has been collated into a book (see Publications). Furthermore, an article detailing the status of beer in the context of society has also been published. This literature watch will continue throughout the project. A layman-targeted article on the myth of beer as a high carb foodstuff has been published, as has an article on Light beers in the same context. Bench work on the analysis of non-digestible carbohydrates (soluble fiber plus pre-biotics) has commenced, as have a psychophysical investigations of the perception of beer alongside other foodstuffs and an evaluation of various procedures for assessing the antioxidant potential of beer polyphenolic species.

Impact: The project will provide a body of informed and reasoned data to allow realistic and fair-minded decisions to be made about the place of beer as a part of the adult diet. It will provide brewers with information on the merits and de-merits of their products and the consumer with information to allow them to make logical and thoughtful purchase decisions.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 3.03 Human Nutrition
Title: VALIDATION AND APPLICATION OF HOLOTRANSCOBALAMIN II AS A NEW MEASURE OF VITAMIN B-12 ABSORPTION

Description: California 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, researchers 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 researchers received a new grant from UC Mexus to measure holoTC II in adults. Researchers 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: THE RELATIONSHIP OF POVERTY, FOOD SECURITY, AND FOOD ASSISTANCE TO CHILD NUTRITION IN LATINOS

Description: During the past year, the Principal Investigator continued to analyze data fromhousehold surveys conducted in 1998 and 2001 and conducted a new pilot study among low-income Latino households. Four manuscripts were published this year. In manuscript #1, California researchers examine the relationship between food insecurity and body weight

among adult Latino women. Prevalence of food insecurity and obesity in these low-income Latino women was 60% and 37%, respectively. Controlling for years spent in the U.S., per capita income, and parity, food insecurity with hunger, measured by the 10-item adult scale of the Food Security Supplement was significantly increased the risk of obesity (Odds ratio: 1.98; 95% C.I.1.14, 3.53). However, in the same sample, food insufficiency, measured by a single item, was not related to risk of obesity. In U.S. born Latinas, past food insufficiency was also associated with greater risk of obesity. In the second manuscript, researchers reported that biological and socioeconomic factors are more strongly related to overweight among Latino preschoolers than most of the self-reported child feeding strategies. Notably, participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is associated with lower risk of overweight among preschool Latino children. The third publication indicates that the effect of food insecurity on preschooler food patterns is mediated by household food supplies in Latino households. The fourth publication explores the possible explanations for a linkage between food insecurity and obesity and some strategies for interventions. The pilot study was a follow-up to the focus group research conducted in the previous year. The purpose of the pilot study is to explore the influence of past food deprivation on child feeding strategies. A graduate student, working on this project, developed and cognitively tested instruments to measure level of past food insecurity and child feeding strategies. In addition, she developed a set of food portion photo cards for dietary evaluation. Preliminary findings on the instruments are promising. The set of eight past food insecurity items are internally consistent and reliable (Cronbach's alpha =0.8). Greater past food insecurity is significantly and negatively correlated with mother's education (r=-0.46), indicating external validity. In the analysis phase, researchers will test the hypothesis that mothers who have experienced severe food deprivation in the past use more indulgent child feed strategies and choose larger portion sizes as appropriate for young children, compared to other low-income women who did not experience severe deprivation.
Impact: Current food insecurity is associated with increased risk of obesity in Latino women. In U.S. born Latinas, past food insufficiency is also associated with increased risk of obesity. In food insecure Latino households, lower food supplies are negatively related to preschooler intake of fruits, vegetables, dairy products, meat, and grains. WIC participation is associated with lower risk of childhood overweight. These findings underscore the importance of continuing to monitor food insecurity in the U.S. and to maintain or increase funding for the WIC program as a strategy to prevent overweight in children

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 3.03 Human Nutrition
Title: NUTRITIONAL AND HORMONAL REGULATION OF GENES INVOLVED IN LIPOGENESIS

Description: Understanding molecular mechanisms underlying hypertrophy and hyperplasia ofadipose tissue is the long-term objective. To understand lipogenesis, California researchers have been studying hormonal/nutritional regulation of fatty acid synthase (FAS) transcription.

Upstream regulatory factor (USF) and sterol regulatory element binding protein (SREBP) play key roles in the transcriptional regulation of the fatty acid synthase (FAS) gene by feeding/insulin. Due to the dual binding specificity of SREBP, as well as the presence of multiple consensus sites for these transcription factors in the FAS promoter, their physiologically relevant functional binding sites have been controversial. During the last year, researchers continued to characterize FAS promoter using the various FAS promoter-CAT transgenic mice. In FAS promoter activation in fed states, binding of USF to its - 65 site is constitutive but SREBP binding to -150 increases. Researchers found both USF and SREBP binding are required for FAS promoter activation. Furthermore, researchers detected interaction of these two transcription factors. Researchers are in the process of defining interacting domains as well as examining other factors or co activators that may be present in the USF-SREBP complex. Researchers have also been examining function of Pref-1 and ADSF, two factors that are predominantly secreted from adipose tissue and regulate conversion of preadipocytes to adipocytes. So far, by generating Pref-1 null as well Pref-1 over expressing transgenic mice, researchers unequivocally demonstrate the role of Pref-1 in inhibiting adipogenesis. Researchers started to study signaling mechanisms as well as to attempt to clone the membrane receptor that interacts with the soluble Pref-1. As for the ADSF, researchers over expressed dominant negative form of ADSF and demonstrated its inhibitory role in adipocyte differentiation. The Pref-1 and ADSF transgenic mice made us postulate the importance of adipose tissue in maintaining proper glucose homeostasis and insulin sensitivity: Transgenic mice over expressing Pref-1 has significantly reduced adipose tissue and shows glucose intolerance and insulin resistance with decreased levels of leptin and adiponectin, adipokines that have been shown to improve insulin sensitivity. Conversely, Pref-1 knockout mice and transgenic mice over expressing dominant negative ADSF show increased adiposity but improved glucose homeostasis with increased levels of leptin and adiponectin.
Impact: The function of adipose tissue as storage organ for triaylglycerol as well as secretary organ for adipokines may be critical. During the last year, two enzymes were cloned that are predominantly expressed in adipose tissue. An adipocyte specific triacylglycerol lipase, named desnutrin, is induced by fasting and by glucocorticoids. H-rev107 that contains acyltransferase domain was also identified. Studies of these enzymes will help us to understand triacylglycerol metabolism in adipose tissue and their function during different nutritional status. When there is an excess energy intake, storage of fat in adipose tissue increases and also more adipocytes or fat cells are generated. Studying these processes will guide us to understand obesity and can provide a means of control and treatment of obesity in the future.

Funding Source: Hatch 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. The initial work includes a phase for the development of a nutrition and health policy with selected schools and school districts to encourage the establishment of a healthy school environment. A current challenge that this project addresses is the pressure on the school system to adopt recently established national and state academic content standards in core subject areas, align local curricula and student assessments with the standards, and be accountable for improved student outcomes as measured by standardized state and federal student examinations. Knowledge and skills are often considered appropriate primary outcomes. These include behavioral capabilities or the information and skills needed to eat a more nutritious diet and the critical thinking skills and procedural knowledge needed to analyze and make informed judgments on complex food and nutrition-related issues. Having the appropriate knowledge and skills prepares youth to make informed decisions when they have the opportunity to do so. As part of this project, advisors research group is completing a comprehensive inventory of recommended nutrition competencies for children, preschool through grade 12, in coordination with the California Department of Education, other state agencies, and experts in education and nutrition. California researchers have developed a model program that incorporates agriculture into the school environment. It includes every part of the school environment, from gardens, to the cafeteria, to the classroom, as part of a consistent and repetitive message to students, that healthy eating habits can be learned through participation in the full cycle of life from seed to table and back again. California principals and teachers have been surveyed with respect to their use of gardens as part of the school environment. Results from these studies suggest that fourth grade teachers predominately use school gardens to enhance academic instruction, which is in strong agreement with principal responses obtained previously. It is encouraging that some teachers are using the garden in teaching core subject areas such as science (65%), language arts (42%) and math (46%). This indicates that these subject areas may be taught with linkages to standards in the core academic subjects. In the next academic year, this model program will be implemented and evaluated in selected schools in California and will include teacher and staff training to establish the following program components: 1) salad bars, 2) nutrition and gardening education, 3) composting and waste reduction and 4) development of a school food, nutrition and health policy.

Impact: Agricultural, nutritional and environmental literacy have surfaced as important next steps in creating a community climate that supports the concept of improving children's health. Recent data suggest that teachers perceive nutrition education as somewhat to very important; however they also perceive it to be somewhat to only moderately feasible to incorporate into the classroom. This project will provide the in-service educational training that will allow teachers to appreciate that nutrition and agriculture can be a part of the educational program and actually enhance the Childs ability to meet the state standards for core subject areas. The reduction of childhood obesity requires a multifaceted approach; a coordinated comprehensive school health and nutrition program can help meet this need and provides an effective means for addressing this critical health issue. A district food policy can bring individuals together to support a common vision, therefore facilitating focused efforts on a healthy nutritional environment. The California Superintendent of Public Instruction, Jack

OConnell issued a challenge to all school districts in 2003 to pass and implement a comprehensive nutrition and physical activity policy

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 3.03 Human Nutrition
Title: IMPROVING IRON/ZINC NUTRITION

Description: The model to determine zinc nutritional status by the ratio of retained radioactive/excreted zinc after a minute dose of radioactive zinc is promising. Further studies in animals and humans are set-up to evaluate its sensitivity and precision. California researchers have been successful in setting up a simple method to measure total circulating hemoglobin and total blood volume after the inhalation of a safe dose of carbon monoxide. Both volumes have high correlations with lean body mass and their variation in repeated measurements in adult men is less than 3% and 6% in women during diverse menstrual phases. This method, together with other biochemical and hematological measurements, is allowing us to clarify the meaning of 'low hemoglobin' and 'anemia' in these physiological states where blood dilution is normal, and will also allow us to recommend effective and safe use of iron and other nutrients for the prevention and treatment of anemia without inducing oxidative stress. Researchers have further shown that the addition of a chelate (EDTA) to different iron compounds markedly improves their dialysability compared to ascorbic acid in an in-vitro digestion system, especially in the presence of phytic acid. Researchers are proceeding to study EDTA's effect on other divalent metals, including zinc. The regulation of absorption and metabolism of these chelate-exposed metals is being studied in human intestinal cell cultures made iron-deficient or slightly overloaded. Researchers have been successful in setting up all the necessary methodology for these studies and experiments are already going. These studies are aimed at explaining metal-metal interactions as those researchers have recently observed in the various population studies that follow: Daily iron supplementation to pregnant women, besides increasing the risk of low birth weight, reduces zinc absorption late in pregnancy, increases oxidative stress indicators, reduces serum copper concentrations and several of the infants from this group of mothers show mild defects in neurological development. These last three effects were not observed in intermittently supplemented pregnant women in the collaborative studies in Mexico. In collaboration with colleagues, UC researchers have found that iron bioavailability of beans selected for their high iron and zinc content is low and total absorbed iron is similar to that from common beans but total zinc absorption is higher in the high zinc varieties. Continuing with the interest on the efficacy and safety of iron-folic acid supplementation, researchers have set up the methodology trained a biochemist for measuring exhaled ethane as indicator of body lipid peroxidation in Mexico. Researchers are gathering data in iron-supplemented women that will further substantiate which methods of preventive supplementation are safer. Researchers have found unexpected elevations in red-cell folates after weekly compared to daily folic acid doses and are studying this process. Using both an epidemiological approach

in France and an animal model at UC Davis, researchers are studying if mild-moderate deficiencies of micronutrients affect appetite and increase the risk of obesity.
Impact: Researchers have continued to prove that daily iron supplementation as currently recommended to pregnant women is not innocuous, and that the intermittent administration of iron supplements is safer and effective. Further study on the mechanisms of 'anemia' in pregnancy and the elderly are progressing in order to provide a functional understanding of observed low hemoglobin levels. The studies are providing in depth scientific evidence on which to base agricultural genetic modifications, mineral supplementation and fortification policies and are opening new areas of micro and macro nutrient interactions with emphasis on obesity.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 3.03 Human Nutrition
Title: REGULATION OF VITAMIN A METABOLISM

Description: In this period, advisor lab devised and validated a quantitative assay for atRA and itsisomers in small aliquots of biological samples. Despite the importance of atRA to human and animal health, highly sensitive and specific assays for quantifying its concentrations in limited biological samples have not been developed. The problems have been: 1) low concentrations of atRA in vivo; 2) presence of isomers and other retinoids that confound analyses; 3) the light and matrix sensitivity of atRA, which rapidly destroys it. California researchers have overcome these problems by working out extraction procedures for serum and tissues, identifying an internal standard with chemical properties similar to atRA, and developing a LC/MS/MS assay based on selective reaction monitoring. A researcher bought the instrument (retail $340 K), an ABI3000, with NIH funds from the individual grants. The assay is capable of quantifying 20 fmol and can detect 10 fmol with a signal/noise = 3: this allows sample sizes of 10-20 mg of protein to be assayed. For proof of usefulness, the lab established atRA concentrations in mouse brain sections as (pmol/g tissue +/- SEM): cerebellum 10.7 +/- 0.3; cortex, 2.6 +/- 0.4; hippocampus 8.4 +/- 1.2; striatum 15.3 +/- 4.7. In a related project, researchers established that the N-terminal 22 amino acid residues of the enzyme that catalyzes the first and rate-limiting step in atRA biosynthesis from retinol, namely Rdh1, are necessary and sufficient to direct it to the ER and embed it facing the cytosol. Repositioning two arginine residues from positions 16 and 19 to positions 3 and 5 inverted the topology so that Rdh1 faced the lumen of the ER. Removing the 22 amino acid leader sequence destabilized and inactivated the enzyme. These data provide insight into the features necessary to orient type III (reverse signal-anchor) proteins (such as Rdh1), and demonstrate that Rdh1 and other short-chain dehydrogenases/reductases (SDR), which share similar N-terminal signaling sequences, such as human Rdh5 and mouse Rdh4, orient with their catalytic domains facing the cytoplasm. This is important because it helps establish the structure and function of the metabolon that functions as the atRA biosynthetic apparatus, consisting of Rdh1, CRBP (cellular retinol binding protein), and Raldh (retinal dehydrogenase). In another project,

researchers identified, cloned, expressed and characterized a new member of the SDR gene family and demonstrated that it has no catalytic activity and therefore likely acts as a regulatory protein. Researchers also used site-directed mutagenesis to 'restore' selective catalytic activity (either for retinol or for androgens), and thereby provided insight into the amino acid residues that control substrate selectively and activity in SDR. All these approaches aim to provide precise and detailed insight into the pathway of atRA biosynthesis.
Impact: Understanding the precise metabolic pathway(s) that convert vitamin A into its hormonal form, all-trans-retinoic acid (atRA), and how this conversion is regulated, is essential to human and animal health. Vitamin A is required for the reproduction and growth of all vertebrates, but it doesn't function until it is converted into atRA. In the absence of vitamin A, or with impaired conversion of vitamin A into atRA, humans and animals suffer from sterility, birth defects, immune suppression, nervous system impairment, skin diseases, blindness, bone pathology, and increased cancer risk.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 3.04 Infant Mortality
Title: BIOLOGICAL ACTIVITY OF RECOMBINANT HUMAN MILK PROTEINS

Description: Recombinant human milk proteins are being produced in the milk of transgenicanimals 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. California researchers 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. Researchers have screened a large number of genetic variants (genotypes) for expression of these two proteins by using Western blotting with antibodies researchers have generated. The highest expression genotypes have been selected for further breeding and also for purification of the recombinant proteins. The biological activity and stability of these proteins are now being 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. 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: 3.04 Infant Mortality
Title: DETERMINANTS OF MATERNAL LACTATION PERFORMANCE AND NUTRITIONAL STATUS OF BREASTFED INFANTS

Description: In 2004, several papers on breastfeeding and complementary feeding werewritten, based on data from the U.S., Sweden, Honduras, China, Bangladesh and Ghana. California researchers continued data analysis on the prospective study of California mothers and infants.
Impact: Researchers validated a new instrument for measuring infant fatness, which has many potential clinical and research applications. Researchers demonstrated that infant fatness is a predictor of subsequent linear growth, which is useful in understanding the potential benefits of nutrition interventions. Researchers identified risk factors and diagnostic criteria for breast yeast infection. This will help clinicians to identify and prevent this condition, which is an important factor causing mothers to terminate breastfeeding. Lastly, researchers demonstrated that behavior change trials are a rapid, low-cost tool for evaluating methods to improve complementary feeding practices. There are significant economic, environmental and social benefits of improving infant nutrition.

Funding Source: Hatch 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 435 peer-reviewed articles and 10 extension publications in the areas covered by Goal 4. There were 446 local extension programs delivered in this area. UC ANR funded 16 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 Programs that bring together AES and CE resources and personnel that addressed critical issues in the state that are included within National Goal 4. Four patents were issued to UC researchers addressing this Goal.

FY 2004-2005 Allocated Resources

Extension Federal Funds (Smith Lever 3 b&c)	Extension State Match	Research Federal Funds (Hatch)	Research State Match
$1,575,831	$1,575,831	$1,110,341	$1,110,341

Extension Total FTE	Research Total FTE
53.51	79.00

Theme: 4.01 Agricultural Waste Management

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

Description: Effects of anaerobic digestion and aerobic treatment on the gaseous emission reduction of dairy manure storage were evaluated. The experimental results showed that anaerobic digestion achieved over 95% volatile organic compounds (VOC), 90% volatile fatty acids (VFA), and 75-83% methane reductions in storages and aerobic treatment achieved over 95% VOC, 79% VFA, and 39% methane reductions. In this experimental study, screened dairy manure of about 2% volatile solids (VS) was either anaerobic digested or aerobically treated prior to storage in an air-tight vessel. Anaerobic digestion was carried out by using a mesophilic anaerobic sequencing batch reactor of 20-day hydraulic retention time (HRT) and 1 g/L/day VS loading rate and aerobic treatment was done by using an aerobic reactor of 10-day HRT and 2 g/L/day VS loading rate. The treated manure was put into the storage on a daily basis for a period of 35 days. All the gases produced during this period were captured and analyzed for VOCs, VFA and methane. The liquid samples were also taken from the storage vessels and analyzed for these compounds. The untreated manure was also stored and analyzed in the same way as the treated manure and used as the control for comparison. The experimental results showed that biological treatment methods, such as anaerobic digestion and aerobic treatment, could have significant impact on the reduction of gaseous emissions from manure storages.
Impact: The results of this research lead to 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: 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: EDIBLE COATINGS TO IMPROVE FOOD QUALITY AND FOOD SAFETY AND MINIMIZE PACKAGING COST

Description: The diffusion of potassium sorbate preservative in whey protein film has been found slower than in cheese. Thus, potassium sorbate contained in whey-protein coating on cheese will remain on the cheese surface longer to protect against mold growth, compared to sprayed or dusted potassium sorbate alone. Milk-derived lactoferrin, lactoferrin hydrolysate and lactoperoxidase are also natural antimicrobials. Their inhibition activities against mold are maintained when incorporated into a whey protein film. Thus, they can also prevent molding of

cheese and other high-moisture foods, when incorporated into a whey protein coating. Whey protein oxygen-barrier coatings can be formed on corona-discharge-treated polyethylene, polypropylene and polyvinyl chloride plastic films. The whey protein coatings are totally transparent and highly glossy, add no color, and have excellent adhesion to the plastic films. The resulting films can potentially be recycled more easily than plastic films coated with synthetic-polymer oxygen-barrier coatings.
Impact: Whey-protein coatings can improve food quality as well as reduce packaging requirements. Water-based whey-protein coatings have potential for replacing ethanol-based food coatings and synthetic plastic and paper coatings, thus reducing environmental problems. Utilizing whey protein for these applications adds value to this former waste product and enhances the economic viability of the dairy industry.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.01 Agricultural Waste Management
Title: The Science and Engineering for a Biobased Industry and Economy

Description: Storage of biomass: Long-term storage experiments were completed on baled rice straw. Up to 50% dry matter loss occurred for unprotected bales in open storage, implying 8 to 12% overall loss for typical open stacks in California and higher costs compared to storage under permanent cover. Modeling and experimental efforts are underway to investigate chemical and biochemical mechanisms of spontaneous combustion in stored rice straw and other biomass materials. Properties and utilization of saline biomass: Phytoremediation techniques are being developed for producing large amounts of biomass for bioenergy and bioproducts from agricultural lands that are drainage impaired and have high salt content. Properties of this biomass are being investigated, as are thermo- and biochemical conversion and manufacturing of particle boards and other products. Thermochemistry of ash in biomass combustion and gasification: Mineral phase relationships were explored for wood and straw ash separately and in fuel blends over the temperature range from 500 to above 1300 C. Addition of rice straw to a predominantly wood based fuel caused a marked freezing point depression in the liquids temperature from above 2000 C to below 1260 C. However, fuel blends containing more than 30% ash from rice straw exhibited enhanced retention of potassium in solid slag, reducing the volatile fraction potentially contributing to heat exchanger fouling. Agglomeration of bed media in fluidized beds was restricted for fuel blends containing less than 8% rice straw, allowing use in commercial systems without further fuel pretreatment such as leaching. Coupled thermo-biochemical systems for syngas cleaning and fuel gas enrichment: gas cleaning to remove tars is a limiting step in syngas production from biomass by thermal methods. Experiments are designed to

investigate the impacts of tar and producer gas on digester function and operation. Hydrogen enrichment in biogas resulting from syngas blending could be useful in reducing NOx emissions from combustion engines. Biogas production from organic wastes: Biogasification of various organic solid wastes was studied using an Anaerobic Phased Solids Digester (APS-Digester) at thermophilic temperatures. Digestion of individual waste streams yielded methane production potentials of 292-138 L/kgVS fed and mixed waste yielded 282 L/kgVS fed. The APS-Digester is being scaled up to a pilot scale facility of 3 tons per day capacity and a commercial scale of 25 tons per day. A two-stage anaerobic fermentation process is being developed to produce hydrogen and methane gases from food processing wastes. Transient expression of recombinant protein in biomass: Variables for AGROBACTERIUM TUMEFACIENS mediated transformation, including vacuum application, photoperiod, surfactant and cell density, were investigated for optimizing transient expression of recombinant protein in leaf tissue. The optimal method produced 0.16% recombinant protein based on dry tissue weight, which is 10 times greater than reported levels in transgenic corn seed produced commercially. Protein extraction methods from leaf tissue are being investigated.
Impact: Coupled thermo- and biochemical systems should reduce costs of gas cleaning while potentially improving fuel gas properties and providing additional capacity for waste treatment. Energy and products from biomass produced as part of phytoremediation programs will help offset the costs of remediation. Improved resource assessments are being used to design incentives and policies to enhance sustainable biomass development in California. High rate anaerobic fermentation/digestion systems for waste conversion will reduce the cost of bioenergy production, making distributed energy generation more economically attractive for both rural and urban communities and also reduce the environmental impact by these waste streams.

Funding Source: 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: 4.01 Agricultural Waste Management
Title: STRUCTURE, FUNCTION, AND REGULATION OF CLOSTRIDIUM CELLUVORANS CELLULASE

Description: A large amount of agricultural biomass such as corn stalks, rice straw, and wheat straw is produced annually in the USA. If these agricultural waste products could be converted to utilizable energy and/or organic compounds, it would help to reduce air and water pollution and provide value-added products. Furthermore the amount of energy produced could be substantial and lead to less dependence on foreign energy sources. The UC research research is concerned with studying the properties and functions of cellulases and hemicellulases produced by an

anaerobic microorganism, Clostridium cellulovorans. This bacterium produces an enzyme complex called the cellulosome that is capable of degrading plant cell wall materials very efficiently. The cellulosome contains cellulases, hemicellulases and pectinase that work in a synergistic manner to degrade plant cell walls and produce cellobiose, xylobiose, and organic acids. The researchers are studying the genes that code for these enzymes and the manner in which their expression is controlled. They have found that different plant cell wall substrates induce different levels of expression of specific genes such as cellulases and xylanases. In addition to characterizing the enzymes involved in plant cell wall degradation, we have succeeded in transferring the cellulosome genes to a non-cellulose utilizing bacterium, Bacillus subtilis. This strategy may be used to convert many valuable industrial non-cellulose utilizers that currently use expensive carbohydrate substrates into utilizers of inexpensive biomass. This will reduce the cost of producing valuable organic compounds.
Impact: The conversion of agricultural cellulosic waste to ethanol will have a significant impact on the energy requirements of our state and country. It will also lead to a better environment, since there will be less pollution of streams and the air. The use of enzymes for biomass conversion will benefit farmers as well as the general public.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.02 Air Quality
Title: Mechanisms of Plant Responses to Ozone in the Northeastern US

Description: The California membership of this multi-state project hosted a meeting of all participants at the University of California, Kearney Agricultural Center in Parlier California. Collaboration on the mechanism of ozone action was discussed and considerable progress was reported. In California the role of phloem loading and sugar profiles in sink and source tissues has been described. In temperature controlled greenhouse chambers a clear pattern emerged of a reduced ratio of sucrose to raffinose and stachyose (raffinose series sugars) in both cotton and muskmelon (cantaloupe). However, under field chamber exposure conditions, the variability in sugar concentrations in sink tissue precluded identification of this pattern. Further research is required to determine the reason for the discrepancy. At present an interaction with root temperature is the likely explanation. Under field conditions the soil heats up more than under greenhouse conditions, despite insulating and reflecting pot covers, and respiration may proceed at a more rapid rate. Their results have indicated a positive response of root respiration to ozone exposure of the shoot. This is opposite to the hypothesized effect, which would have been driven by reduced substrate available for transport from the source leaves. The well-documented impacts of ozone on bioproductivity and on the root to shoot

biomass ratio (reduced) were observed in both cotton and melon, and under both greenhouse and field conditions. The consequences of reduced allocation of biomass to root systems has previously been described for hydraulic conductance, and indirectly for shoot gas exchange (photosynthetic) performance. Both are reduced by ozone exposure of the shoot, apparently by direct and indirect mechanisms. They have documented the interaction of ozone on vegetative productivity of tomato and Pima cotton, repeating experiments reported last year. Tomato is relatively ozone resistant, and its competitiveness will respect to the C4 weed, yellow nutsedge, actually increases with increasing ozone concentration, particularly at levels above current ambient concentrations. At lower concentrations the competitiveness of tomato is reduced marginally. In contrast, Pima cotton is sufficiently sensitive to ozone that its competitiveness with respect to yellow nutsedge is reduced further with each increment of ozone exposure, beginning at extremely low ozone concentrations. This demonstrates that higher order interactions of ozone with other stressors, including biotic and abiotic stressors, is difficult to predict in the absence of specific information about the entire system, and more detailed mechanistic information. The outcomes of such interactions may determine such factors as crop loss to weeds, and the costs of vegetation management.
Impact: Using chambered and chamberless exposure designs this group is determining the nature, magnitude and mechanisms of ozone damage to key crop and wildland plant species. This information will allow regulators and land use planners to manage resources more effectively, and with improved awareness of the likely impacts of the ozone air pollution component of ongoing global change. These may be significant as ozone reduces crop yields, alters weed-crop competition, and reduces carbon sequestration below ground.

Funding Source: Multistate Research and State
Scope of Impact: AL, CA, IL, MA, MD, MN, NJ, NYC, PA, VA

Theme: 4.02 Air Quality
Title: Forested Ecosystems and the Atmosphere: Interactions between Atmospheric Chemistry, Ecosystem Processes, and Climate

Description: Ecosystem ozone uptake can occur through stomatal and surface deposition and through gas phase chemical reactions. In a California pine forest, researchers observed that thinning dramatically enhanced both monoterpene emission and ozone uptake. These simultaneous enhancements provide strong evidence that ozone reactions with unmeasured biogenically emitted volatile organic compounds (BVOCs) dominate ozone uptake, and these unmeasured BVOC emissions are approximately 10 times the measured monoterpene flux. Branch enclosure measurements confirm more than 100 BVOCs are emitted but not typically observed above the forest. These BVOCs likely impact tropospheric composition

as a previously unquantified source of secondary oxygenated VOCs, organic aerosols, and OH radicals.
Impact: This research project developed a better understanding of the factors controlling biogenic hydrocarbon emissions and their role in regional ozone and aerosol production, and ozone deposition to ecosystems. This information is crucial for policy decisions attempting to protect the health of our ecosystems through regulation of air quality.

Funding Source: McIntire-Stennis and State
Scope of Impact: State Specific

Theme: 4.04 Biological Control
Title: BIOLOGICAL CONTROL IN PEST MANAGEMENT SYSTEMS OF PLANTS

Description: The goal of this project is to improve biological control programs in agroecosystems through an improved understanding of the ecology of predator-prey and parasitoid-host interactions. Work published during this review period covered a diverse array of research activities. First, working in California cotton, California researchers have demonstrated that large-scale augmentative releases of the predatory mite GALENDROMUS OCCIDENTALIS are ineffective for control of spider mites. This lack of efficacy stems from the inability of GALENDROMUS OCCIDENTALIS to establish and build large populations in cotton, apparently a result of intense intraguild predation imposed by a group of hemipteran predators. Second, working with NABIS, a predator of pea aphids in alfalfa, they have demonstrated that the impact of a predator on the population growth rate of its prey can be generated through two complementary pathways: (i) first, and most obviously, predators eat prey; and (ii) second, and less obviously, predators elicit from prey a variety of anti-predator behaviors, and these behaviors may be quite costly, reducing reproduction. In this system, the relative importance of these two pathways was roughly equivalent, a very surprising result for this terrestrial ecosystem. Third, in papaya grown in Hawaii, biological control of the spider mite TETRANYCHUS CINNABARINUS by the predatory mite PHYTOSEIULUS MACROPILIS was shown to be insensitive to the presence of an intraguild predator, the spider NESTICODES RUFIPES. This spider had previously been shown to disrupt biological control of spider mites by another predator, the beetle STETHORUS SIPHONULUS. PHYTOSEIULUS seems to avoid predation by the spider simply by having a very low level of mobility across the leaf surface. This low mobility is achievable simply because PHYTOSEIULUS is small relative to the body size of its spider mite prey, and therefore it does not need to move much across the leaf surface to harvest many prey. Finally, I constructed a game theory model to explore how the presence of top predators may shape the habitat selection 'games' played by herbivores and their intermediate predators. The model showed that a key prediction of earlier

models, in which the spatial distribution of herbivores fails to match the spatial distribution of their host plant resources, is overturned when the model is expanded to include the top predators.
Impact: In the short term, this work is helping farmers determine when they can rely on effective biological control from naturally-occurring predators, and when they instead need to intervene with other control measures to prevent significant crop damage. On the longer term, the work is helping to produce a solid basic understanding of natural enemy ecology upon which ecologically sound biological control programs can be developed within an IPM framework.

Funding Source: Multistate Research and State
Scope of Impact: AZ, CA, CO, GU, HI, ID, KS, MT, ND, NJ, NM, NYC, OR, SAM, UT, WA

Theme: 4.02 Air Quality
Title: THE NATIONAL ATMOSPHERIC DEPOSITION PROGRAM (NADP)

Description: Atmospheric deposition of nitrogen ranges from about 2 to 5 kg/ha/yr in the western Sierra Nevada Mountain of California. How ecosystems process this nitrogen determines the amount of nitrate leaching from terrestrial ecosystems and nitrogen fluxes in stream water. Temporal patterns of stream water chemistry were analyzed across the Cosumnes River Watershed (area = 1989 square kilometers) for water years 1999-2002 to quantify hydrobiogeochemical dynamics in the last free-flowing watershed draining the western Sierra Nevada. The Mediterranean climate of California produces a distinct annual hydrologic pattern with three seasons: baseflow, stormflow, and meltflow. The baseflow season (July-October) is dominated by groundwater chemistry that primarily originates from high elevations, and thus does not vary much across the basin. During the baseflow season discharge is negatively correlated to ionic concentrations, and sediment and nutrients are generally below detection levels. The stormflow season (November-March) is separated into a flushing period (where discharge is positively correlated to river water conductivity) and a dilution period (where discharge is negatively correlated to conductivity). During average flow years, virtually the entire annual load of nutrients and sediment moves through the watershed during the stormflow season. Because stormflow hydrologically links the land with local waterways, the stormflow season shows the greatest variance among sites across the diverse landscape of the Cosumnes Watershed. Chemistry of the meltflow season (April-June) is dominated by dilute upland snowmelt, and there is little chemical variation across the watershed. Storm-scale analysis revealed that progressive flushing occurs with each storm event and that source area dynamics play an important role in chemograph response. With 19 of the 20 major rivers in the western Sierra Nevada having dams, these data provide scientists and regulators with a valuable reference to address how impoundment affects water quality.
Impact: These data provide important information to assess the potential impacts of

atmospheric nitrogen deposition on sensitive aquatic ecosystems in the Central Valley-Bay-Delta. The fact that most nutrient transport occurs during the cold winter season suggests that elevated stream water nitrogen concentrations do not contribute significantly to the summer period of greatest aquatic primary productivity. These data are useful for scientists and regulators alike for future watershed study and planning.

Funding Source: Multistate Research and State

Scope of Impact: CA, CO, FL, GA, IL IN, KY, LA, MA, MD, ME, MI, NE, NC, NYC, OH, OR, PA, TX, UT, VA

Theme: 4.04 Biological Control
Title: Empirical and Modeling Studies of Olfactory Coding in Insects

Description: This project had two components: an empirical component involving neural recording methods to elucidate the coding properties of olfactory neurons in the American cockroach Periplaneta Americana, and a modeling component that included simulating the firing of peripheral olfactory neurons and the computational properties of the olfactory networks in the insect antennal lobs. In the empirical studies, California researchers found that the pattern of responses of different receptor cells within the class of Type S-I sensilla are much more complicated than previously thought. First, the sensitivities of receptor cells can differ dramatically across concentrations. Second, the degree of specialization varies among individual cells. Third, the tuning spectra among these receptor cells defies a neat categorization of cells into types. Further, an analysis of the coding efficiency of these neurons over the 500 millisecond (ms) stimulis period compared with the peak (50-150 ms) and post-peak (150-250 ms) stimulus periods led us to conclude that the peak period is more efficient in coding odor type at high stimulus concentrations and the post-peak interval is most efficient at1 low concentrations. Follow up studies allowed them to demonstrate that some cockroach olfactory receptor cells are able to resolve stimuli pulsed at 40 times per second. They were also able to demonstrate that inhibitory "cross-talk" among neurons in the same olfactory sensillum plays an important role in the way olfactory receptors respond to mixtures of odorants. and that olfactory information, is best represented by a simple, short time-scale rate code in the olfactory receptor neurons. In terms of modeling, they used neural network to address evolutionary questions in animal behavior. They also modeled the insect antennal lobe and were able to demonstrate that strong inhibitory connections among antennal lobe interneurons promote oscillations in the lobe, while inhibitory feedback from antennal output onto these interneurons improves coding, provided this feedback is not too strong. In modeling single receptor neurons, we found that a single class of receptor proteins expresses approximately 98% of its graded response to ligand concentrations over four

orders of magnitude. This four-decadic concentration range is intrinsic to all homogeneous ligand-receptor systems. Thus if particular cell membranes are adapted respectively to a narrower or wider range of ligand concentrations then they must express multivalent receptors or a heterogeneous population of receptor types. Finally, they investigated the issue of single neuron coding efficiency using a normalized Shannon-Weaver measure of information entropy to represent the efficiency of coding over given concentrations for membranes. The results provide insight into the number of receptor types associated with the membranes of particular cells, as well as mechanisms operating in olfactory sensory neurons and chemical communication among various cells in multicellular organisms. They also provide insight into the biochemical pathways involved with the firing of peripheral neurons when stimulated by odorants.
Impact: This empirical work sheds new light into the functioning of insect olfactory systems; thereby providing knowledge that is useful in using odors to manipulate the behavior of insects with regard to pest management.

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: In 1988, Encarsia aurantii (Howard) (Hymenoptera: Aphelinidae) was introduced into northern California to control an isolated infestation of obscure scale, Melanaspis obscura (Comstock) (Coccoidea: Diaspididae), on native and exotic oaks (Quercus spp.) in Sacramento's Capitol Park. Sixteen years later, there is no longer any need for chemical control of the scale (i.e., complete biological control). During spring of 2004, mean density of female scales (based on 100 twigs per tree) on 12 previously infested oak trees was generally low, ranging from <1 (eight trees) to ~15 (single tree) scales/twig. Mean percentage parasitization (per twig) ranged from ~30 to ~80%, and was density-independent (spatial context) for each of five trees. Two refuges for the scale population were noted: some scale crawlers settled and developed under the parental scale cover (spatial refuge) and some female scales continued to produce crawlers into late summer and early fall, when adult parasites were no longer available (temporal refuge).
Impact: This case illustrates how an introduction strategy (i.e., single-species release of E. aurantii), which was derived from pre-introductory investigations in the native home of the target pest, was executed in the field, and ultimately lead to successful biological control.

Funding Source: Multistate Research and State
Scope of Impact: AZ, CA, CO, GU, HI, ID, KS, MT, ND, NJ, NM, NYC, OR, SAM, UT, WA

Theme: 4.04 Biological Control
Title: BACTERIAL CHEMOTAXIS TO THE HERBICIDE ATRAZINE

Description: In the current reporting period, California researchers generated quantitative data demonstrating the chemotactic response of PSEUDOMONAS sp. ADP to the herbicide atrazine. Quantitative capillary assay results with saturating atrazine, and two atrazine degradation intermediates (15 mM cyanuric acid and 10 mM N-isopropylammelide) indicated that all three compounds serve as chemoattractants for atrazine-grown PSEUDOMONAS sp. ADP. The response to atrazine was approximately 2.5-fold over background and statistical analysis indicated that the results were significant. They consider this to be an important result in light of the fact that atrazine is a man-made chemical that has only been in the environment for 50-60 years. It is likely that the ability to detect and respond to atrazine evolved recently and therefore the response has not been optimized over time. The response to cyanuric acid was similar to that of atrazine, even though a significantly higher concentration was used. The response to N-isopropylammelide was comparable to that of the 0.1% Casamino acids positive control attractant (approximately 6- to 7-fold accumulation over background). Current experiments are being carried out with lower concentrations of these attractants to determine the threshold concentrations detected. Quantitative capillary assays and temporal assays demonstrated that ADP cells grown with ammonium sulfate were also attracted to atrazine, cyanuric acid, and N-isopropylammelide, indicating that the chemotactic response is constitutive and does not require a period of growth in the presence of atrazine. The genes encoding the atrazine degradation pathway in PSEUDOMONAS sp. ADP are carried on the atrazine catabolic plasmid pADP-1, and at least one example of a plasmid-encoded chemoreceptor has been reported. The plasmid has been completely sequenced, but no obvious candidates for typical receptor genes such as those encoding methyl-accepting chemotaxis proteins were found. Using the quantitative capillary assay with the plasmid cured derivative PSEUDOMONAS sp. ADP-M1, we demonstrated a chemotactic response to atrazine, cyanuric acid and N-isopropylammelide, which indicates that pADP-1 does not carry the atrazine chemoreceptor gene. An additional important implication of this result is that atrazine must be detected directly, because ADP-M1 is not capable of atrazine metabolism. This indicates that a specific chemoreceptor in ADP recognizes and binds the man-made chemical and rules out the possibility that an intermediate is the actual attractant. However, because both N-isopropylammelide and cyanuric acid elicited a response in this strain, each of these compounds must also be detected by either the same or an additional constitutively expressed chemoreceptor in ADP.
Impact: Atrazine is a man-made herbicide that is used world-wide to control broad leaf and grassy weeds. Recent evidence suggesting that atrazine exposure has toxic effects on animals has raised concerns about atrazine residues in the

environment. Bacteria that are capable of completely degrading atrazine have been isolated, and the researchers are characterizing the ability of atrazine-degrading bacteria to detect and respond to the presence of atrazine using specific sensory systems.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.04 Biological Control
Title: Production and Delivery of Microorganisms for Biological Control of Plant Pathogens and Insects

Description: EUTYPA LATA causes a chronic grapevine disease worldwide that results in cankers on cordons and trunks. California researchers analyzed wood in the region of the advancing canker margin by culturing and by real-time PCR. A commercial kit marketed for stool samples yielded template DNA from discolored wood that was free of detectable PCR inhibitors and suitable for quantification by PCR. Using three primers of varying levels of taxonomic specificity, estimates of DNA concentration within the canker were reasonable in that E. LATA DNA was less than or equal to the fungal DNA which was less than or equal to the eukaryotic DNA. The 95% confidence interval of detransformed log E. LATA DNA in Chardonnay grapevines was 0.2 to 5.8 ng/g dry wt wood in symptomatic samples 6 cm from the lesion margin. Although E. LATA was detected by PCR in the phloem-enriched inner bark, the data do not support the hypothesis that E. LATA colonizes the phloem in advance of the xylem. In the discolored region and at the canker margin, detection of E. LATA with the species-specific primer was as or more sensitive than detection by culturing. In contrast, culturing was more sensitive than PCR for detection of E. LATA in advance of the canker margin. Both real-time PCR and culturing indicated BOTRYOSPHAERIA OBTUSA is an important primary colonizer in some grapevines with wood symptoms typical of Eutypa dieback. In grapevines in which B. OBTUSA and/or E. LATA were detected in asymptomatic wood in advance of the canker margin, they were at 3.8 plus or minus 0.8 (SE) cm and 3.1 plus or minus 0.4 cm, respectively.
Impact: One of the most significant pathogens of the grapevine industry is the pathogen E. LATA. Yield losses from this disease can range from 19 and 94% depending on the severity of the symptoms and can cost California growers upwards of $1 billion per year. This research progress has significant economic implications on the prevention of E. LATA in grapevine.

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: California researchers continue to evaluate the efficacy of several METAPHYTCUS species as augmentative biological control agents for release against citricola scale, COCCUS PSEUDOMAGNOLOIARUM (Kuwana), in San Joaquin Valley citrus. Citricola scale remains a key pest of citrus in this region where over 50% of the citrus is now grown in California. They are also continuing to evaluate the parasitoid complex attacking black scale, SAISSETIA OLEAE (Olivier), in southern California citrus. When pesticide applications cease in San Joaquin Valley citrus groves, citricola scale re-emerges as a key pest requiring chemical control. To evaluate the parasitoid complex on soft scale in southern California citrus groves, including METAPHYCUS species, and its phenology, they are conducting a year round survey of soft scale parasitoids. They place scale infested plant material in untreated interior southern California citrus groves and replace them bi-weekly. The exposed plant material is returned to the laboratory for parasitoid rearing and identification. This information provides a base line with which to evaluate the species complex of parasitoids and its phenology on soft scales in San Joaquin Valley citrus groves. We plan to expand the survey into the San Joaquin Valley by placing scale infested plant material in organic citrus groves this next season. They are now able to mass rear several METAPHYCUS species and are continuing to evaluate their efficacy as augmentative biological control agents. They are continuing to sample glassy-wing sharp shooter (GWSS) HOMOLADISCA COAGULATA populations in commercial citrus groves to evaluate the efficacy of the introduced and endemic egg parasitoids. During the course of the last three years the immature spring populations of GWSS on Valencia oranges have declined from 6000 adults per tree in 2002 to less than 400 per tree in 2004. Similar results have been obtained for the immature spring populations of GWSS on lemons in 2004.
Impact: The researchers continue to develop an understanding of the relationships between the soft scale hosts and their parasitoid complex and the impact that glassy winged sharp shooter populations (GWSS) will have on citrus. With this understanding they will be able to develop an ecologically based IPM program for California citrus. This research with citrus pests has led to the development of an ecologically based pest management program that has reduced pest control costs and pesticide use in California citrus groves.

Funding Source: Multistate Research and State
Scope of Impact: AZ, CA, CO, GU, HI, ID, KS, MT, ND, NJ, NM, NYC, OR, SAM, UT, WA

Theme: 4.04 Biological Control
Title: BIOLOGICAL CONTROL IN PEST MANAGEMENT SYSTEMS OF PLANTS

Description: In calendar year 2004, California researchers continued to rear host plants and the pest whitefly, ALEURODES DUGESII, in sufficient numbers to feed into our colonies of the two parasitoids from Central America, ENCARSIELLA NOYESII and IDIOPORUS AFFINIS. From these colonies, they continued to make releases, both with their own personnel and via the Extension agents and home gardeners in Orange, Los Angeles, and Ventura counties. The distribution of these natural enemies now extends to the limits of the distribution of the infestation in California or the pest whitefly.

Impact: This project concentrates on reducing or eliminating the damage caused by pests, specifically by employing natural enemies that are both adapted to high efficiency in the Californian environment and are highly efficacious against the pest insect we are focused on. This past year the researchers continued the distribution of the highly efficacious parasitoids ENCARSIELLA NOYESII and IDIOPORUS AFFINIS, both parasitoids of the aggressive giant whitefly, ALEURODICUS DUGESII. Distribution through Orange, Los Angeles, San Diego and Ventura counties has now extended the initial distribution of parasitoids to cover the entire initial Californian distribution of the pest whitefly. In the areas of earliest parasitoid releases, the pest is under complete control.

Funding Source: Multistate Research and State
Scope of Impact: AZ, CA, CO, GU, HI, ID, KS, MT, ND, NJ, NM, NYC, OR, SAM, UT, WA

Theme: 4.04 Biological Control
Title: BIOLOGICAL CONTROL IN PEST MANAGEMENT SYSTEMS OF PLANTS

Description: APHELINUS are parasites of aphids, and in particular California 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 prefererences 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. Plans are in progress to collect critical species in India. 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 had 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 were successful in using 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, the eulophid parasitoid (CIRROSPILUS COACHELLAE) of the citrus peelminer (MARMARA GULOSA), were reared in our lab and 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 are reducing pesticide applications in citrus. The work on APHELINUS kis having an immediate impact on surveys and biological control efforts aimed at pest moths, whiteflies and aphids across the southern U.S.

Funding Source: Multistate Research and State
Scope of Impact: AZ, CA, CO, GU, HI, ID, KS, MT, ND, NJ, NM, NYC, OR, SAM, UT, WA

Theme: 4.04 Biological Control
Title: THEORY AND PRACTICE OF BIOLOGICAL CONTROL

Description: The parasite guild associated with small and medium-sized larvae of beet armyworm (Spodoptera exigua [Hubner]) are exploited by a complex of natural enemies on hay alfalfa in northern California. The parasite guild consists 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 non-treated fields ranged from 25 to 60%. Cotesia marginiventris (Cresson), a major parasite of S. exigua in the southeastern U. S. that also occurs in California alfalfa, was not reared from S. exigua. Late season decline in parasitization by H. exiguae was correlated with incidence of an ascovirus. Relatively few S. exigua larvae were infected with nucleopolyhedrovirus (NPV). Predation on sentinel egg masses in non-treated fields ranged from 50-90%. However, rate of predation per egg mass was independent of host density (eggs/mass). Major predators include lygus bugs (Lygus hesperus Knight and L. elisus Van Duzee), pirate bug (Orius tristicolor [White]), damsel bug (Nabis americoferus Carayon), big-eyed bugs (Geocoris spp.), and convergent lady beetle (Hippodamia convergens Guerin).
Impact: Beet armyworm is under good natural biological control in 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: 4.04 Biological Control
Title: POPULATION BIOLOGY OF NEMATOPHAGOUS FUNGI: MORTALITY, EFFICACY, AND FORMULATION

Description: Researchers have proposed that the nematode-trapping fungus Arthrobotrys oligospora and related fungi capture soil nematodes to obtain nitrogen and thereby compete saprophytically for carbon and energy in nitrogen-poor environments, including litter and wood. Two hypotheses were tested concerning this model. The first was that wood decomposition would be enhanced if both large numbers of nematodes (a potential nitrogen supply) and A. oligospora (a cellulolytic organism that can use that supply) were present. The second was that A. oligospora trapping activity would increase if large numbers of nematodes were added to soil containing abundant carbon (a wood dowel or chip). Although the first hypothesis was supported by an in vitro experiment on agar (A. oligospora degraded much more wood when nematodes were present), neither hypothesis was supported by an experiment in vials containing field soil. In soil, wood decomposition was unaffected by the addition of A. oligospora or large numbers of nematodes. And whereas A. oligospora trapped virtually all nematodes added to agar cultures, it apparently trapped no nematodes added to soil. Given that the fungal isolate was obtained from the same soil and that the fungus increased to large numbers (more than 103 propagules g- superscript 1 soil), the failure of A. oligospora to trap nematodes in soil is difficult to explain. Soil nitrate levels, however, were high (71 mg kg- superscript 1), and it is possible that with lower nitrate levels, trapping in soil might be stimulated by wood and nematodes.
Impact: Plant-parasitic nematodes are important pests of crop plants. These pests were controlled by chemicals in the past, but the chemicals are increasingly unavailable because of environmental and safety problems. To control plant-parasitic nematodes, farmers need new tools, and one potential tool is the use of natural enemies, including nematode-trapping fungi. The nematode-trapping fungus Arthrobotrys oligospora occurs in many soils and has been widely studied. Nevertheless, its biology in soil and its effect on plant-parasitic and other nematodes in soil remains unclear. On agar, A. oligospora rapidly traps and consumes nearly all nematodes present, but this is not the case in soil. Some researchers have suggested that A. oligospora only traps nematodes when it is competing for carbon and energy in nonliving organic matter. Others have noted that the sexual stage of A. oligospora grows on decaying wood and that A. oligospora produces enzymes that degrade wood. These observations and findings suggested the following two hypotheses: 1) A. oligospora should become a more effective biological control agent if carbon, in the form of wood, is added to soil, and 2) A. oligospora should degrade more wood when nematodes are abundant rather than scarce. Hypothesis 2 was supported by data from agar

but neither hypothesis was supported by data from soil. The biology of this common nematode-trapping fungus in soil remains a mystery. Understanding this biology remains important because it could suggest new ways to control plant-parasitic nematodes.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.04 Biological Control
Title: DEVELOPMENT, EVALUATION AND SAFETY OF ENTOMOPATHOGENS FOR CONTROL OF ARTHROPOD PESTS

Description: A Korean isolate of Steinernema carpocapsae was evaluated against the fungus gnat, Bradysia agrestis, in the laboratory and propagation house. In the laboratory, the infective juvenile nematodes infected third and fourth instars and pupal stage at a high rate. Second instars were infected at a low rate (was less than 35%), and the egg stage and first instars were immune to infection. Adult fungus gnats dispersed the infective juveniles from treated areas to non-treated areas. In the propagation house experiments with watermelon seedlings, S. carpocapsae significantly reduced B. agrestis larval numbers in comparison with the controls. When watermelon seed was treated with nematodes at sowing, the number of fungus gnat larvae ranged from 4 to 8 and from 5 to 8 in the nematode treated plots compared with 26 and 30 in the control plots on the 17th and 34th day post-treatment, respectively. In another project, the entomopathogenic fungi,
Beauveria bassiana and Metarhizium anisopliae, have been isolated from soil from organic citrus groves and were tested against glassy-winged sharpshooter adults. These isolates required high conidial concentrations to infect thesharpshooter adults.
Impact: The use of entomopathogenic nematodes to control the fungus gnat for seedling production in propagation house will reduce the amount to chemical pesticides in the environment. Entomopathogenic fungi have the potential to control the glassy-winged sharpshooter, a devastating insect pest of grapes and other crops.

Funding Source: Multistate Research and State
Scope of Impact: AL, AR, AZ, CA, CTH, CTS, DE, FL, GA, IL, KY, LA, ME, MN, NJ, NYC, NYG, OH, PA, SC, VT

Theme: 4.04 Biological Control
Title: Development of plant pathogens as bioherbicides for weed control

Description: Transition from conventional to organic vegetable production is associated with an increased soil carbon/nitrogen ratio (C:N), due to reduced fertilizer input and use of organic amendments such as compost and cover crops. We tested the hypothesis that addition of organic amendments to the soil may induce higher microbial activity and predation of weed seeds or weed seedlings. When no other nutrient source is available for soil microbes, weed seeds are attacked for their

carbon content, and in turn this reduces the weed seedbank content. We have modified the carbon/nitrogen (C:N) ratio of soil and soil amended with 10 percent compost to obtain C:N ratios of 40:1, 25:1, 13:1 or 10:1 (control with or without compost addition), and 8:1. Nylon mesh bags containing shepherds-purse (Capsella bursa-pastoris) and burning nettle (Urtica urens) seed were placed at depths of 1 and 3 cm in 250 ml sterile jars that contained the above soil mixtures. The jars were moistened to 80 percent of field capacity and incubated for 1, 2 and 3 months. Soil microbial activity (respiration) was monitored regularly by headspace analysis of CO2 content with a gas chromatograph; weed seed viability was tested at the end of the incubation. Nettle seed viability was reduced rapidly; in soils with C:N ratio less than 25:1. In both natural soil and soil amended with 10 percent compost, viability was reduced up to 60 percent from the initial nettle seed viability within the first 2 months of incubation; but no additional decrease in seed viability was observed in the third month of incubation. No reduction in shepherds-purse seed viability was observed in this experiment. Respiration rate peaked on the third day of incubation, and soils with and without compost had the same respiration temporal pattern (dynamic). The highest respiration rates were observed at C:N ratio of 25:1, with and without compost amendment, similar rates were observed at C:N ratio of 40:1, while respiration rates were negligible at C:N ratios of 10:1 or 13:1 (controls) and 8:1 in soils with or without compost. The seed viability and microbial data found in this study suggest that when the soil microbes have no alternative source of readily digestible carbon, microbes can feed on burning nettle weed seeds and reduce seed bank densities. At C:N ratios of 25:1 and 40:1, the system is not carbon limited as evidenced by both the high microbial activity (respiration rate) and higher viability of weed seeds in these soils. At C:N ratios of 13:1, 10:1 and 8:1 the system is carbon limited, and microbial activity is reduced as is weed seed viability. The long-term effects of organic amendments on weed seed viability are unclear and will be the subject of future research.
Impact: The long-term profitability of the $5.3 billion California conventional and organic vegetable industries is threatened by high weed control costs and potential loss of older herbicides (conventional only). Sustainable weed management inputs such as organic amendments may stabilize or reduce weed control costs.

Funding Source: Multistate Research and State
Scope of Impact: CA, FL, IN, MA, MT, NC, NYC, PR

Theme: 4.04 Biological Control
Title: DEVELOPMENT, EVALUATION AND SAFETY OF ENTOMOPATHOGENS FOR CONTROL OF ARTHROPOD PESTS

Description: To overcome the high costs of bacterial insecticides in comparison to chemical insecticides, strategies have been developed to increase the level if insecticidal proteins produced per cell and per unit of fermentation medium using

recombinant DNA technology. The basic strategy combines proteins with different insecticidal properties in the same bacterium, and enhances synthesis of these proteins using genetic elements that improve transcript stability and protein yield with chaperone-like proteins. These new strains combine mosquitocidal Cry and Cyt proteins of BACILLUS THURINGIENSIS with the binary toxin BACILLUS SPHAERICUS, improving efficacy against CULEX mosquito species, and greatly reducing the potential for resistance through the presence of Cyt1A. Intensive use of B. SPHAERICUS against CULEX populations in the field can result in high levels of resistance, but most of this can be suppressed by combining Cyt1A with the binary toxin of B. SPHAERICUS. Cyt1A enables the binary toxin of this species to enter midgut epithelial cells via the microvillar membrane in the absence of a midgut receptor. Even more importantly, we have determined that combining Cyt1A with the B. SPHAERICUS toxin delays the development of resistance to the latter toxin in mosquito populations. Thus, combining these toxins in a single bacterial strain yields a strain that is at least tenfold more toxic than wild type strains to many mosquito species, including the vectors of West Nile virus, yet is much less prone to mosquito resistance. Although our best current recombinant strains are most effective against CULEX species, these should also be very effective against all mosquito species highly sensitive to the B. SPAHERICUS binary toxin, which includes species such as ANOPHELES GAMBIAE and AN. ARABIENSIS, both of which are major vectors of malaria in Africa.

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, and possibly for other major vector species such as the mosquitoes that transmit malaria and filariasis.

Funding Source: Multistate Research and State
Scope of Impact: AL, AR, AZ, CA, CTH, CTS, DE, FL, GA, IL, KY, LA, ME, MN, NJ, NYC, NYG, OH, PA, SC, VT

Theme: 4.04 Biological Control
Title: BIOLOGICAL CONTROL AND ECOLOGY OF ARTHROPOD PESTS ATTACKING AVOCADO

Description: Significant results have been achieved in the seventh year of work on the biological control avocado pests in California. First, the overwintering ecology of OLIGONYCHUS PERSEAE has entered the fourth year of fieldwork. Outbreaks of this pest are related to leaf retention rates by avocado trees in spring when new flush growth begins and leaves from the previous year defoliate. The pest

thrips SCIRTOTHRIPS PERSEAE, a species new to science at time of discovery in California, has been subjected to augmentative releases of a mass-reared predatory thrips, FRANKLINOTHRIPS ORZIABENSIS and commercially available green lacewings, CHRYSOPERLA CARNEA. The searching behavior and prey preferences of green lacewing larvae have been studied, and the attack rates of the three larval instars towards SCIRTOTHRIPS PERSEAE larvae have been quantified. Work investigating the suppressive activity of composted organic mulches under avocados for control of pupating SCIRTOTHRIPS PERSEAE is ongoing in the field and laboratory. An economic analysis determining the impact of SCIRTOTHRIPS PERSEAE on California avocado production was completed. Work has started on a new avocado pest that invaded California in late 2004, the avocado lacebug, Pseudacysta perseae.
Impact: Growers, grower cooperatives, and insectary managers are using the results of this research for managing pests with reduced insecticide reliance. Mulching of avocado orchards has been adopted by several prominent growers and this is creating much interest amongst the grower community. The ineffectiveness of green lacewings for thrips control in avocado orchards, while controversial, will save growers money and preserve the reputation of biological control.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.04 Biological Control
Title: Invasive insect pests and biological control agents in California: Impact on agriculture and conservation

Description: A number of new projects on the use f molecular markers for distinguishing different biotypes and species of parasitoids used in biological control have been started. In particular we have done work on the parasitoids that are used for the biological control of the Glassy Winged Sharp Shooter, the insect vector of the Pierces Disease. This work showed that most of the North American strains of the species Gonatocerus aschmeadi belong to the same species and are reproductively compatible. UC researchers have continued their work on the invasive Avocado Thrips and have developed an identification key using molecular markers for the pest species in the genus Scirtothrips. In the work on trying to identify the area of origin of the Citrus Peelminer in the central valley of California, they have developed several molecular markers that show that the Peelminer from the central valley is very similar to the peelminer found in Northern Mexico, the area from which the peelminers are thought to have invaded the central valley. Both Mexican and the central vally peelminer differ from the Citrus Peelminer found in the Coachella valley. This year they will determine if the peelminers found in Arizona resemble the ones form the central valley. If that is the case than it will be difficult to make a definitive statement about the origin of the central valley peelminers, however if the Arizona peelminers resemble the Coachella

peelminers then it becomes more likely that the central valley peelminers originate from Mexico. In addition they have continued their work on the influence of symbiotic bacteria on the life history of pest insects and their parasitoids. they are now involved in determining if Wolbachia has a negative impact on the biological control agent Aphytis melinus, used for the control of the Citrus Red scale.
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. In addition it also helps in identifying areas where natural enemies can be collected. The key of thrips species for California will allow fast and unambiguous identification of these difficult to identify insects. The studies on the Wolbachia may help in creating more efficient biological control agents once the researchers can infect uninfected species; their work has shown that horizontal transmission is possible but is more difficult between 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.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.04 Biological Control
Title: MANAGING PLANT-MICROBE INTERACTIONS IN SOIL TO PROMOTE SUSTAINABLE AGRICULTURE

Description: Fusarium crown and stem rot of lisianthus, caused by Fusarium avenaceum, is a destructive disease in California. The pathogen produces large masses of orange-colored macroconidia on stem lesions that extend up to 35 cm in length from the soil surface. An above-ground life stage for a soilborne pathogen could serve as a source for acquisition and aerial dissemination by adult shore flies, fungus gnats, and moth flies. The results provide evidence that these three insects are attracted to and readily acquire (either externally and/or internally) macroconidia of F. avenaceum produced on naturally-infected lisianthus stems and then disseminate acquired macroconidia to healthy plants. The high percentage of transmission, as evidenced by the number of plants infected (75% within 4 days), reflects the efficiency of these insects as vectors. A strain of Beauveria bassiana (Bb), isolated from a shore fly cadaver, was evaluated as a biopesticide for the control of shore flies. Bb was grown on autoclaved millet seed for 2 weeks, air-dried at 24C for 7 days and stored in paper bags. Dried Bb-colonized millet seeds were broadcast on the surface of pots containing potting medium naturally-infested with larvae and pupae or pots infested only with adult flies. Controls consisted of insect-infested pots amended with autoclaved millet seeds. Pots of the same treatment were placed in insect-proof screen cages. At daily intervals for 15 days, adult fly populations were recorded in each cage. In cages initially containing only larvae and pupae, adult fly populations in the control (no Bb) treatment reached a final population of 70 adults on day 15. In

contrast only two adult flies were observed in the Bb-treatment on day 15. In cages containing only adult shore flies, the entire population was dead within 10 to 12 days in the Bb-treatment. In the absence of Bb, 65% of the initial population of adults was still alive on day 12.
Impact: Data supports the researchers' hypothesis that certain greenhouse insects are involved in the transmission of certain soil-borne plant pathogenic fungi and that these insects are susceptible to an entomopathogen (Beauveria bassiana) which, formulated as a biopesticidal bait, could be used for controlof these vectors.

Funding Source: Multistate Research and State
Scope of Impact: AK, AZ, CA, ID, IL, MT, NM, NYG, OR, WA

Theme: 4.04 Biological Control
Title: BIOLOGICAL CONTROL OF WORMS IN WINEGRAPES

Description: Most winegrape growers must control worms from time to time. The most common worm pest of the grape bunches is the omnivorous leaf roller. Another occasional pest is the grape leaf folder. Traditional control of these pests is with insecticides. However, growers are always looking for more environmentally friendly ways to control vineyard pests. Cooperative Extension has been working on biological control of pests in grapes for over 25 years. The latest technology for controlling worm pests in the vineyard is mating disruption. Growers are beginning to place dispensers in the field that release a pheromone which interferes with the mating process. If no mating occurs, no eggs are laid to hatch into the larvae that cause the damage. A less expensive alternative to hanging individual dispensers is to squirt onto the arms of the vines a paraffin emulsion that slowly releases the pheromone. A California Advisor has conducted four experiments to test the effectiveness of this technology. In trials with Chardonnay and Grenache grapes, the paraffin treatment was shown to be very effective in preventing damage from the omnivorous leaf roller. In all cases damage was reduced to the level achieved by an insecticide used for comparison
Impact: A chemical company is now in the process of bringing this technique to market as a commercial product that growers can purchase and use. Thus, growers now have another non-pesticidal, biological control to use in California vineyards.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 4.09 Forest Resource Management
Title: NUTRIENT RELEASE AND ORGANIC DECOMPOSITION IN FOREST SOILS

Description: This project examines the roles of climate, forest community and other factors in determining phosphorus dynamics of decomposing forest litter. Forest soils and

litter from different regions may contain different P forms. Climate may control soil P forms, because more complex P forms have been seen in forests from regions with higher her rainfall and cooler temperatures. The role of climate and decomposition on phosphorus cycling was studied in forests of two climatic regimes: the Sierra Nevada, California, with warm, dry, oxidizing conditions; and the Olympic Peninsula, Washington, with cooler, moister, reducing conditions. Small-diameter branch samples of California red fir decomposed on the forest floor over a 17 year period showed that total dry mass of bark decreased by 62%, bark Carbon(C)/Nitrogen(N) ratio decreased from 72 to 48, and bark concentrations of Nitrogen and Manganese(Mn) increased, but bark Phosphorous(P) concentration decreased. For the wood portion of the samples total dry mass decreased by 37%, wood C/N ratio decreased from 217 to 177, concentrations of N and Mn increased, and P concentration decreased. Thinning and N-fertilizer treatments did not affect decomposition after 17 years. White rot fungi require Mn to decompose lignin and maintain high levels of Mn in decomposing bark and wood. The temporal separation of warm and moist conditions in California limited microbial activity during the periods of summer drought, thereby reducing decomposition rates. The results suggest that climate may not be the most important factor controlling phosphorus forms; tree species and possibly mycorrhizae may also be important. 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: 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. Woody debris in the form of wood and bark returns nutrients to the soil. In the environment of California red fir, with cold winters and dry summers, decomposition can be quite slow. Silvicultural treatments did not affect decomposition after 17 years. Some nutrients are retained or even accumulated in the woody material during decomposition, especially Mn which is required by white-rot fungi. Results of this study are being incorporated into improved forest management strategies.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.09 Forest Resource Management
Title: Management Methods for Forest Soil Carbon Sequestration

Description: California’s forest/urban interface is an explosive zone of high fuel loadings, droughty conditions, seasonally stressed vegetation, and extensive human impact and population. Dwellings often are interspersed in dense thickets of

shrubs growing beneath an open canopy of pines. Fuel loadings may approach 100 Mg/ha with a potential combustible energy of 1.7 billion Btu. Correcting the problem with prescribed fire is politically impractical because of possible litigation. Fire also is ecologically undesirable because of degraded air quality, noxious weed invasion, and fire-induced loss of ecosystem carbon and nitrogen. Lacking management intervention, these sites eventually will ignite. Thus, managers need practicable and cost-effective alternatives to prevent certain catastrophe. The ongoing experiment at four sites is set up to compare alternative fuel treatments relative to their costs, efficacy, and impacts on sustained fuel conditions, residual trees, and soil quality. Treatments include an untreated control, manually removing understory shrubs, masticating all understory fuels, and mastication followed by incorporating residue chips into the topsoil. A fifth treatment, mastication followed by drying and prescribed fire, is planned for spring 2005. California researchers have concentrated their efforts into collecting baseline data to determine the direction of change seen in soil and tree productivity following the implementation of the treatments. One of their goals is to examine changes in soil C, which greatly affects nutrient availability, soil structure, and water retention, and provides for an excellent parameter to assess site productivity. A surface layer of masticated residues reduced growing season soil temperatures between 4 degrees and 6 degrees C. Soil respiration, a measure of carbon loss,was not affected appreciably by mastication, but increased when residues were incorporated. Nitrification, a measure of both potential N availability and loss, depended on site quality. Rates were greatest in manual removal plots on the site with highest precipitation. Nitrification was least on droughty sites where materials had been masticated and incorporated, indicating that treatment responses are site dependent. To explore the effects of litter interactions on nutrient dynamics in in the various understory removal treatment described above, a laboratory incubation of soils with 13C15N-labeled residues of Pinus ponderosa, with and without the N-fixing shrub Ceanothus integerrimus to compare the effects of changing litter input to soil on soil C dynamiccs. Pinus-Ceanothus mixtures showed a net increase in soil C of 2.8%. In contrast, soils amended only with Pinus showed a net loss of 1.9%, due to a greater loss of both litter and soil C as CO2-C coupled with lower accrual of litter-derived C in soil organic matter pools. The results indicate that removal of understory may impact long-term soil C accumulation.
Impact: Prescribed fire is often used to reduce fuel buildup, however the loss of soil carbon and nutrients may impact forest productivity. Alternatives to prescribed fire in reducing fuel buildups and improving soil quality were examined. This information is being incorporated into effective site-specific forest management practices that reduce wildfire risk and enhance long-term forest productivity.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.09 Forest Resource Management
Title: PHOTO-ECOMETRICS FOR NATURAL RESOURCES MONITORING

Description: UC researchers have been continuing our work on the development of photo-ecometrics. The emphasis has been placed on the detection of individual tree tops of conifer forest with high resolution remotely sensed imagery. This is attempted in order to save cost of forest sampling. They derive individual tree-crown boundaries and treetop locations under a unified framework involving a two-stage approach with edge detection followed by marker-controlled watershed segmentation. Their initial results show that the computer based method is comparable to manual identification but saves a significant amount of time.
Impact: The UC researchers' results along the line of developing the field of photo-ecometrics will considerably improve the accuracy and efficiency in forest inventory. The algorithms developed in their research can potentially be widely commercialized. Their burned area mapping algorithm has improved mapping accuracy in comparison to other burnt scar mapping algorithms in California. This is helpful for the study of global carbon cycling. Their land cover mapping algorithms made innovative contribution to the use of texture with high spatial resolution images.

Funding Source: State and McIntire-Stennis
Scope of Impact: State Specific

Theme: 4.09 Forest Resource Management
Title: Mixed-Conifer Stand Development and Stocking Control in Even-Aged and Multiaged Stands in California

Description: UC researchers' work in California's mixed-species conifer stands has integrated studies on forest stand dynamics with management implications. They used these data to develop stocking guidelines for multiaged, mixed-conifer stands in the Sierra and redwood stands on the north coast. Additionally, a light model has been developed for the Sierra Nevada forests that displays light levels at different canopy heights for forest of different structure. In redwood forests, the stocking guideline provides a tool to assist land managers with designing multiaged stocking prescriptions for redwood/Douglas-fir mixtures. They have also documented projected leaf area indices of over 14 in two separate locations in coast redwood stands. A separate study examined the development of 'sudden oak death' in redwood/tanoak stands. One segment of this work looked at spatial patterns of disease spread and another at the effects of 'sudden oak death' on changes in forest structure. We have also attempted to quantify the error associated with aging redwood trees from increment cores due to a discontinuous ring pattern. Pruning studies in sugar pine have yielded initial indications that they may reduce susceptibility to white pine blister rust.
Impact: These guidelines will provide the technology to managed complex structures in the Sierra mixed-conifer and coastal redwood forest types. The UC activity related to

exotic pests (sudden oak death, white pine blister rust) will help in the development of suitable management for forests affected by these pathogens.

Funding Source: State and McIntire-Stennis
Scope of Impact: State Specific

Theme: 4.10 Global Change and Climate Change
Title: Benefits and Costs of Natural Resources Policies Affecting Public and Private Lands

Description: Substantial progress was made in assembling relevant data and carrying out estimations of the potential impacts on agriculture in both California and the United States of predicted changes in global climate, in particular warming and associated changes in patterns of precipitation. With regard to the non-irrigated regions of the US, it appears that farming in these areas will be negatively affected by the predicted changes in temperature and precipitation coming from the most recent general circulation models (GCM), with potential reductions in farmland value amounting to 10-25% in the near-term (2020-2049), depending on the emission scenario, and substantially larger than this later in the century. Irrigated areas need to be treated separately, as impacts will depend on regional patterns of precipitation and water flow, infrastructure, and associated water rights. The most recent GCM models suggest very substantial reductions in the California water supply, with reductions in the Sierra Nevada snowpack amounting to 25-40% in the near term and as much as 70-90% by the end of the century. Spring and summer stream flow is projected to decline by 10-25% in the near term and 40-55% by the end of the century. Changes on this order of magnitude would have serious economic impacts for both urban and agricultural water users as well for in-stream environmental uses of water in California.

Impact: These findings are crucial to the policy debate on how to respond to the threat of global warming, at both the state (California) and federal levels, since they quantify the losses to the vulnerable agriculture sector that can be expected to result from warming.

Funding Source: Multistate Research and State
Scope of Impact: AL, AZ, CA, CO, CTS, GA, IA, KY, LA, MA, MD, ME, ME, ND, NH, NYC, OH, OR, PA, TX, UT, WA, WVA, WY

Theme: 4.10 Global Change and Climate Change
Title: Carbon, Water Vapor and Energy Exchange over Grassland and Tree/Grass Ecosystems

Description: For the past five years California researchers have been conducting a comparative study on the carbon and water exchange over a deciduous oak/grass savanna and an annual grassland in the foothills of the Sierra Nevada Mountains. At the grassland study site, net carbon uptake occurs during the winter/spring wet season and net carbon loss occurs during the dry summer period. Daily photosynthesis commences after the first significant rain in the autumn. Its seasonal variation corresponds with changes in leaf area index, which in turn are governed by soil moisture, available sunlight and the timing of the last frost. During most of the winter daily photosynthesis is constrained by short days and cold nights. Photosynthesis, and growth, accelerates after the last frost and ceases after the soil moisture profile becomes depleted. Soil respiration varies in response to changes in soil temperature, soil moisture, phenology, and growth. Occasional rain events during the summer stimulate microbial activity and produce huge releases in CO2. The grassland was a moderate carbon sink during the first three years (150 gC/m2/y). A shorter growing season, due to a late start of the rainy season, was responsible for the lower photosynthesis and less net carbon uptake during 2002. And the grassland was a net carbon source (102 gC/m2/y) in 2004, when winter rains stopped around day 80, about 50 days sooner than in 2003. At the savanna site, leaf-out and the onset of photosynthesis by the blue oaks corresponds with the time when soil temperature approaches the mean annual air temperature, which is around day 80. Consequently, the oak trees are only physiologically active during a short period when the soil moisture profile is full. The remainder of the photosynthetic period occurs through the hot and dry summer period and under conditions of soil moisture deficits and physiological stress. The oak-grass savanna ecosystem was a moderate carbon sink during 2002 and 2003 (271 gC/m2/y). Net carbon uptake was severely inhibited in 2004 (18 gC m2/y) by the early cessation of spring rains. Simultaneous measurements of canopy photosynthesis and soil respiration under oak trees and in the open grassland, during the summer when the grass was dead, allowed us to explore the biophysical controls on autotrophic and heterotrophic respiration. Soil respiration in the open grassland varied with temperature (respiration rates approximately doubled with a 10C increase in temperature) and the basal rates diminished as the soil dried. Soil respiration rates under the trees were decoupled from the diurnal variation in soil temperature. Instead, they were coupled with canopy photosynthesis, but experienced a lag due to the 7 to 8 hour transit time from the leaves to roots. With regards to ecosystem water exchange, 368 +/- 67 mm/y of moisture evaporated from the savanna system, on average. In contrast, evaporation at the grassland site averaged 310 +/- 28 mm. Differences in the physical water holding characteristics of the soils at the two sites partially account for this difference in evaporation.
Impact: Field measurements of carbon and water exchange are submitted 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 and the feedbacks due to environmental perturbations in soil moisture and temperature. Such information on carbon and water exchange of an oak savanna is crucial for managing oak savanna woodlands and predicting how this ecosystem will respond to climate change.

Funding Source: McIntire-Stennis and State
Scope of Impact: State Specific

Theme: 4.10 Global Change and Climate Change
Title: Ecosystem-Atmosphere Exchange of CO2 in California and Its Role in the Global Carbon Cycle

Description: Projections of future climate depend on the rate of atmospheric CO2 increase, which depends in turn on the efficacy and stability of the carbon sinks. Over the past several decades, photosynthesis has exceed respiration globally, so that terrestrial ecosystems, together with the oceans, have acted as repositories (sinks) for the CO2 emitted by fossil fuel combustion and land cover modification. Both photosynthesis and respiration are modulated by climate, and the sensitivity to climate perturbations (e.g. El-Nino's) yield information about how these ecosystem processes may respond to long-term climate change. Photosynthesis and transpiration are both regulated by stomatal conductance. Using results from a global carbon-climate model, California researchers developed the relationship between gross primary productivity (GPP) and diurnal temperature range, and the relationship was validated at Harvard Forest where CO2 fluxes and climate variations have been measured for nearly a decade (Bonfils et al. 2004). They then used the historical climate record to reconstruct the regional scale productivity of the US from 1970's onwards, and find that summer GPP variability is modulated by precipitation, and that there is no significant secular trend in GPP, suggesting that CO2 fertilization, urbanization and other direct and indirect anthropogenic effects are not detectable in the data (Bonfils et al. 2005). The eruption of Mt. Pinatubo in 1991 presented a case study of the competitions among factors influencing photosynthesis: increased the fraction of diffuse radiation versus decreased total radiation and temperature. THey tested the hypothesis using the seasonal cycle of atmosphere CO2 at Mauna Loa, Hawaii, a record of northern hemisphere photosynthesis and respiration. The observed decrease in seasonal CO2 amplitude after Pinatubo could not be explained by an increase in photosynthesis, which would enhance the summer drawdown of atmospheric CO2 and increase the summer-winter difference. The cooling and drying after Pinatubo, however, not only decreased photosynthesis, but also retarded decomposition and heterotrophic respiration; both acting in concert to decrease the CO2 amplitude (Angert et al. 2004). The extended drought since 2000 presented another case study. Their analysis has found the effects of water stress on photosynthesis are on a continental scale, evident in the satellite NDVI data

(Angert et al. 2005) and in the amplitude of the CO2 seasonal cycle at Mauna Loa Observatory, Hawaii (Buermann et al. 2005). The summer 'greening' trend of the 1990's in the satellite NDVI data halted in the middle 1990's. The results re-emphasize the need to measure soil moisture in addition to temperature and solar irradiance in field experiments. They have carried out the first network analysis of respiration using the night-time measurements of net ecosystem exchange (NEE) made at the flux towers of the European Flux Tower Network (EuroFlux). What is new is the residual NEE unexplained by temperature and moisture, with peak fluxes at the beginning and end of the growing season, related to the autotrophic respiration in the spring, and litter quantity and quality in the fall.
Impact: These studies provide a systematic framework for an observations program to advance our predictive capability of the future of climate and ecosystems. The work has the spatial scale of California and the continent, and the time scale of seasons to decades. This work complements local field studies wherein the sensitivities of photosynthesis to various climate processes are separated articulated. The evidence of water stress on ecosystem function on continental and decadal scales emphasizes the importance of changing hydrologic regimes, especially for California ecosystems. We expect that there would be varying degrees of water stress across the State of California. As is recognized, planning for climate change and/or carbon sequestration must look beyond temperature effects.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: MORE EFFICIENT MOSQUITO CONTROL

Description: The impending introduction of West Nile (WN) virus into California has heightened the need to improve control of mosquito disease vectors in the state. Since the virus was first detected in New York in 1999, it has spread rapidly westward across the USA. Vertebrates susceptible to the virus become infected via the bite of mosquitoes. In 2002 in the U.S., 201 humans and over 13,000 birds (mainly crows) died and over 3,300 humans and 9,000 horses became ill from WN virus infections. No vaccine is available for humans, and our best line of defense against this virus is by control of mosquito vector populations. A California researcher at UC Davis led research that detected resistance in California mosquito populations to currently used pesticides. Mosquito abatement personnel are now aware of this and have focused more on applications of rotations and mosaics of pesticides to mitigate further spread of resistance. The researchers designed a Geographic Information System (GIS) interface for control of mosquitoes in mosquito
abatement districts.
Impact: There have been no further reports of resistance spreading since the discovery

of resistance to currently used pesticides. This is testament to the Mosquito Abatement District's use of better resistance management and mitigating strategies. Since evaluation and use of the GIS interface in Fresno County, a mosquito abatement district manager is convinced that GIS use will mitigate the effects of future budget cuts his district may have to face. He predicts that the district will save a conservative $138,000 per year -- 15 percent of the current budget -- beginning in 2008-09 and that GIS will improve services.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: ORGANIC CONTROLS FOR WALNUT HUSK FLY DEVELOPED

Description: In the Central Coast, walnut husk fly has been a major roadblock to converting conventional walnut orchards to organic production. (Gross returns are as much as 50% higher for organic walnuts.) Husk fly damage can approach 100% in unsprayed orchards but no effective organic controls have previously been available. Other pests such as walnut blight and codling moth already have adequate organic controls.
Impact: More walnut growers in California's Central Coast already have or are planning to convert to organic production because organic walnut husk fly controls developed by UCCE are available. Walnut growers in the Central Coast have a competitive advantage because of very high quality and less codling moth damage than many other growing regions in California. However, they suffer from lower yields and higher land and production costs compared to the Central Valley. Conversion to organic production helps to maintain a walnut industry in an area that has been increasingly converted to houses or row crops.

Although walnut production already is a relatively "clean" agricultural industry, reduced impacts on the environment such as less ground water contamination by nitrates and pesticides, reduced pesticide runoff to the Monterey Bay Marine Sanctuary, and increased farm worker safety also are potential benefits of conversion to organic production.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: CITRUS PROGRAM PROTECTS HEALTH OF STATE'S TREES

Description: California citrus growers often want to import foreign citrus varieties to develop new product lines and extend growing seasons. To protect the state citrus

industry from devastating diseases, all foreign budwood entering California must go through an official inspection service, which will quarantine, test, and, if necessary, cleanse the citrus tissues to ensure that they contain no pathogens. Also to protect the industry, the state requires that nurseries and commercial growers propagate new trees either from their own state-registered trees or from budwood increase blocks grown from buds from a registered source. The Citrus Clonal Protection Program at the University of California, Riverside has operated since 1958 to import citrus varieties and to maintain a collection of true-to-type, disease-free registered trees that serve as the primary source of budwood for the state's nurseries and commercial growers. The program holds one of only two federal permits in the western United States for the importation of foreign budwood, and it assisted the second agency, the USDA National Clonal Germplasm Repository for Citrus & Dates, also located in Riverside, to obtain its permit in 2002.

Impact:

California, with a $800-million-a-year citrus industry, has the lowest disease incidence and the highest fruit quality of any citrus-producing area of the world. While a large part of the credit belongs to the state Department of Food and Agriculture for enforcement of regulations, the Citrus Clonal Protection Program also has served a significant role in ensuring that the state industry has a reliable disease-free source of budwood. It maintains more than 1,000 trees at the UC Lindcove Research & Extension Center as budwood sources, and it routinely quarantines and cleans diseased foreign budwood. During the past five years alone, the CCPP has released 69 new varieties--including the popular Cara Cara navel and several Clementine tangerine varieties--and sold more than 110,000 buds.

Funding Source: Hatch 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: 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. This project focuses on the development of novel assays to assess both the acute and sublethal impacts of new generation pesticides on some of the natural enemies that are present in western orchards. As model natural enemies for this study we have selected the green lacewing, Chrysoperla carnea, an important predator of lepidopteran eggs, and mealybugs, and Mastrus ridibundus, an introduced parasitoid of the codling moth. California researchers have developed laboratory assays to determine both acute (48 h) toxicity from topical exposure, and the lethal and sublethal toxicity of combined topical, residue and oral exposure to a set of seven

new insecticides. The products tested include three neonicotinyl insecticides (Actara, Assail and Provado), three insect growth regulators (Esteem, Intrepid and Novaluron) and one fungal metabolite (Success). Each product was assayed at full (100%) and 10% field rates in comparison to controls. The assays were developed to determine the impacts of these products on eggs, young larvae and adults of C. carnea, as all three of these life stages are vulnerable to orchard spray treatments, but only to the adult stage of M. ridibundus, as its juvenile stages are not vulnerable to orchard sprays within codling moth cocoons beneath the bark of the orchard trees. The three neonicotinyls (Actara > Provado > Assail) showed acute toxicity to both larvae and adults of C. carnea even at the 10% field rate, but only at the 100% field rate for M. ridibundus. Success at the 100% rate reduced survivorship of C. carnea adults, but not larvae, and reduced survivorship of M. ridibundus even at the 10% rate. The insect growth regulators had no impact on the survivorship of either C. carnea or M. ridibundus adults. Important sublethal effects for C. carnea occurred with Success and Novaluron (reduced fecundity and egg hatch) and to a lesser extent with Actara and Assial. For M. ridibundus, sublethal effects occurred with all products, with the exception of Provado, including a reduction in fecundity (Assail, Actara, Novaluron and Success) and a reduction in sex ratio (percent female) of progeny produced (Esteem and Intrepid). As the impacts of these seven products affect different life history parameters of the two model natural enemies, stage structured matrix population models have been developed for both natural enemies to facilitate interpretation of the assay data. The models will be used to generate indices of population recovery time for each natural enemy that can be used comparatively across a spectrum of insecticides and natural enemy species.
Impact: This project harvests the benefits of enhanced biological control of primary and secondary pests through the identification of new generation insecticides that are selective enough to be compatible with natural enemies in western orchards.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: PREDATOR AND PARASITOID BIOLOGY AND THE ECOLOGY OF BIOLOGICAL CONTROL

Description: The goal of this project is to develop a fundamental understanding of plant-insect, predator-prey, and parasitoid-host interactions, and to apply this knowledge to the development of sound pest management practices. During 2004 work was conducted in two systems. First, California researchers worked on developing a sound management program for an invasive pest of papayas grown in Hawaii, the papaya rust mite CALACARUS FLAGELLISETA. They developed a basic understanding of the spatial distribution of the mite within the papaya canopy, and how that distribution changed with seasonal fluctuations in overall mite

density. These results are crucial to developing a sampling plan for the mite. Second, we demonstrated that neither the rust mite nor other key exploiters of papaya (the spider mite TETRANYCHUS CINNABARINUS and the powdery mildew OIDIUM CARICAE) generates induced resistance in its host plant. Finally, long term manipulative field experiments have demonstrated that both rust mites and powdery mildew have significant impacts on vegetative growth and fruit yield of papaya, and that these impacts are very nearly additive when both plant exploiters are present on the same host plants. <p> Second, theyhave worked on understanding the impact of LYGUS HESPERUS on California cotton. The interaction of this pest with the host cotton plant remains highly enigmatic and controversial. During 2004 they analyzed data from 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 several 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, although commercial field scouts do grossly underestimate the density of LYGUS nymphs in the field. Second, we found that the basis for the enigma may lie more with the cotton plant than with the behavior of the LYGUS bugs. 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. Third, they discovered two important correlates of variation in cotton plant sensitivity to LYGUS feeding: (i) younger plants were more sensitive than older plants and (ii) plants with higher petiole phosphate (PO4) concentrations were more sensitive than plants with lower phosphate levels. Field experiments are currently being planned to explore each of these correlations. Finally, a manipulative field experiment demonstrated that a dominant early-season omnivore, GEOCORIS PALLENS, does feed on cotton squares, but generates very little damage and no detectable level of square shed. Future work will explore plant reproductive biology to examine the possibility that plants employ facultative strategies to abort damaged squares under certain conditions, but retaining damaged squares under other conditions.
Impact: This work on cotton should provide a better understanding of the impact of LYGUS on cotton plants, reducing the need to control this pest at very low densities, when it is unlikely to generate economic damage. This information provides for very substantial reductions in pesticide use.

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: 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, greenhouse whitefly TRIALEURODES VAPORARIORUM and Lygus bug (LYGUS SPP.). Research led to registration of the neonicotinoid insecticide imidachloprid for whitefly control, and to a risk assessment model for whitefly feeding. Tomato research focused on the consperse stink bug EUSCHISTUS CONSPERSUS and the potato aphid MACROSIPHUM EUPHORBIAE. 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. Dose responses were established for organophosphates and pyrethroids for a susceptible stink bug population. 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, but that the addition of a buffering agent can mitigate part of the observed effect. 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, and that buffering can mitigate the effect. Pyrethroids and insect growth regulators were shown to provide equivalent control of ANARSIA LINEATELLA to the organophosphates diazinon and chlorpyriphos in a 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 also suggested that citrus is a major reproductive host. Research on the exotic olive pest BACTROCERA OLEAE continued in 2004 and included monitoring of 25 sites in 15 California counties. Flies were caged on olives and fruit quality parameters evaluated 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 affords economical pest control.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: NEMATODE POPULATION BIOLOGY

Description: California researchers continue to research the use of the nematode fauna as an indicator of the structure and function of the soil food web. Having developed the basic principles, they are now exploring the relationships between soil disturbance, for example tillage and fertilizer application, and fooweb structure. Also, the relationships between foodweb structure and foodweb functions, including decomposition, mineralization and suppressiveness to pest species. At the population level, we are screening chemicals of plant origin, primarily flavonoids and phenolics at this stage, as attractants and repellents of plant-feeding nematodes, with the objective of developing baited traps and confusant signals. 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 of candidate rootstocks is underway.
Impact: The contributions towards a more sustainable agriculture include identification of soil management practices that are beneficial to maintaining and improving soil health and those that are not. They developed the protocols and rationale for reducing reliance on soil tillage, mineral fertilizers and synthetic pesticides. These 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 are now in the field test phase and will provide important non-chemical nematode management options for the grape industry.

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: A series of studies were completed by UC researchers. Their work focused on the development of new chemistries for use in IPM of vegetable crops and a study of behavioral
responses of an exotic insect to chemicals and tomato plant resistance factors. 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. Several materials appear to offer significant advantages in IPM

programs for control of key insect pests and for maintenance of beneficial species. Studies on interaction of plant resistance and insecticides on behavior of the tomato psyllid have provided an explaination of why some compounds work against psyllids with some cultivars but not with others.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: Management Strategies for Arthropod Pests and Natural Enemies on Citrus and Avocados in California

Description: 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 since 1994 has been ca. $18.6 million. Research with the Medfly examined sterile fly recapture data for a 3-year period in comparison with climate, host plant in which traps were hung, and fly quality control data. Avocado arthropod pest management in California prior to the 1990s emphasized biological control with minimal pesticide use. Persea mite and avocado thrips which are native to Mexico, were discovered in California in 1990 and 1996, respectively. These two pests have changed California avocado pest management. Research is continuing to develop effective, selective, and economical means of managing field populations of avocado thrips and persea mite. A degree-day model was developed for the egg stage of the glassy-winged sharpshooter, HOMALODISCA COAGULATA, which might be used to predict the timing of egg hatch and to assist in research with egg parasitoids. These parasitoids appear to be the only significant natural enemies of this pest in California.
Impact: 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: INTEGRATED PEST MANAGEMENT OF SAN JOAQUIN VALLEY

CITRUS THROPODS

Description: Research was conducted to advance the integrated pest management (IPM) program for citrus arthropods in the San Joaquin Valley. 1) Various rates and lure types of a synthetic pheromone were tested and found to effectively monitor flights of the citrus peelminer (MARMARA GULOSA). Citrus peelminer was successfully reared using zucchini squash, however, one of its parasites (CIRROSPILUS COACHELLAE) could not adapt to peelminer reared on this host plant. 2) Large-scale field plot and laboratory experiments revealed that the neonicotinoid insecticide acetamiprid suppresses thrips but has little effect on other citrus pest populations when utilized at low rates. At higher rates, acetamiprid suppresses citricola scale (COCCUS PSEUDOMAGOLIARUM), but appears to disrupt natural enemies and repeated use may actually increase armored scale pest problems. 3) Field sampling demonstrated that there are three generations of cottony cushion scale in San Joaquin Valley citrus. Increasing densities of cottony cushion scale were demonstrated to increase the incidence of sooty mold reduce the yield of citrus. 4) Mature citrus tree and nursery tree treatments with various acaricides nearing registration demonstrated efficacy against citrus red mite (PANONYCHUS CITRI) and two-spotted spider mite (TETRANYCHUS URTICAE). Registration of one or more of these acaricides will help manage resistance to older acaricides. 5) Nursery citrus trees infested with California red scale (AONIDIELLA AURANTII) were treated with various insecticides in an effort to find a replacement for chlorpyrifos for nursery stock shipped to Arizona. 6) Monitoring of California red scale resistance revealed that populations maintain their resistance to organophosphate insecticides even in the absence of treatments. Monitoring for insect growth regulator (pyriproxifen) resistance was initiated, but has not yet demonstrated any resistant populations. 7) Ten commercial orchards in the Tulare County area were sampled for pests and natural enemies as a demonstration of citrus IPM tactics. Growers in the project applied 1.0 treatments for thrips (SCIRTOTHRIPS CITRI) and katydids (SCUDDARIA FURCATA), 0.5 treatments for scale insects, 0.2 treatments for worms and 0.2 treatments for mites (a total of 1.9 treatments per orchard). Three of the orchards released APHYTIS wasp parasites. 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. 8) A web site was updated to keep citrus growers informed about 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. 9) A brochure was produced and an education program was conducted to teach citrus growers and nurserymen about the potential threat of the Diaprepes root weevil which is currently not found in California. 10) ArcIMS software was used on the Kearney Ag Center web server to create an interactive web site designed for citrus growers to enter data about the presence and severity of citrus peelminer in their orchards.
Impact: Currently, key pests of San Joaquin Valley citrus include California red scale,

citrus thrips, citricola scale, cottony cushion scale, citrus red mite, katydids and citrus peelminer. Research is being conducted to find suitable biological control agents. An effective pheromone trap was developed for citrus peelminer and knowledge of moth flights is improving control methods. The study of the impact of cottony cushion scale on sooty mold and yield of citrus has re-emphasized the need for keeping this pest below an economic threshold. Studies of vedalia beetle population dynamics emphasized the need for biological control of cottony cushion scale during the spring months (Mar-May). Studies of the effects of insecticides and acaricides on citrus pests and natural enemies will help growers attain California registration of these products, integrate them into their IPM program, and manage resistance to older products. The Tulare County IPM demonstration program documented that citrus growers treat with pesticides an average of 2 times per year and biologically-based IPM tactics are as effective as conventional pesticide practices for producing a high quality crop.

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: Under this reporting period, a UC researcher focused on three major research areas: (1) continue to developing and evaluate layering of various techniques to minimize Glassy-winged sharpshooter (HOMALODISCA COAGULATA) and Pierce's disease (XYLELLA FASTIDIOSA) incidence in vineyards, (2) continuing our efforts to develop a standardized treatment protocol to eliminate this insect in commercial nursery stock, and (3) develop techniques to manage this insect in commercial nursery plantings. 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. The researchers concluded that under high vector densities, no combination of existing treatments will control Pierce's disease. Carbaryl, fenpropathrin, deltamethrin and acetamiprid were field evaluated for their ability to kill glassy-wing sharpshooter nymphs emerging from the egg mass under standard commercial nursery operations. Carbaryl provided 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 difficulty in achieving adequate coverage of the insecticides on these types of plants. 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). To date, none of the products we tested achieved high mortality against both adult and juvenile sharpshooters. With the possible exception of rotenone and pyrethrins (PyGanic), conventional pyrethroids, organophosphates, and chloronicotinyls were more effective than all other compounds tested. Large screen barriers used to prevent immigration of sharpshooters into commercial nurseries were partially effective. Barriers significantly reduced the number of immigrating insects into the nursery. To be effective, barriers must completely surround the nursery or completely isolate the nursery from the source of infestation. They demonstrated that barriers not only physically prevent immigration, but also function as a visual deterrent to this insect; they fly away from the barrier if given a choice. Upon landing on the barriers, we demonstrated sharpshooters were more likely to fly away from the nursery as than climb over the barrier.
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. They continue to provide and update to state agricultural authorities a working list of biorational pesticides that should not be considered for use in urban eradication efforts for the glassy-winged sharpshooter. Their recommendations to the California Department of Food and Agriculture regarding modified quarantine treatments of ornamental nursery materials was submitted and accepted. As a result of this work the state of California is changing the quarantine requirement for shipment of nursery materials resulting in a savings of potentially millions of dollars in inspection and tracking costs.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: SUSTAINABLE PEST MANAGEMENT IN CITRUS: EXPLOITING NATURAL ENEMIES AND SELECTIVE PESTICIDES

Description: California researchers continue to evaluate the efficacy of several METAPHYTCUS species as augmentative biological control agents for release against citricola scale, COCCUS PSEUDOMAGNOLOIARUM (Kuwana), in San Joaquin Valley citrus. Citricola scale remains a key pest of citrus in this region where over 50% of the citrus is now grown in California. They are also continuing to evaluate the parasitoid complex attacking black scale, SAISSETIA OLEAE (Olivier), in southern California citrus. When pesticide applications cease in San Joaquin Valley citrus groves, citricola scale re-emerges as a key pest requiring chemical control. They are now able to mass rear several METAPHYCUS species and are

continuing to evaluate their efficacy as augmentative biological control agents. To evaluate the parasitoid complex on soft scale in southern California citrus groves, including METAPHYCUS species, and its phenology, They are conducting a year round survey of soft scale parasitoids. We place scale infested plant material in untreated interior southern California citrus groves and replace them bi-weekly. The exposed plant material is returned to the laboratory for parasitoid rearing and identification. This information provides a base line with which to evaluate the species complex of parasitoids and its phenology on soft scales in San Joaquin Valley citrus groves. We plan to expand the survey into the San Joaquin Valley using the same protocol and by placing scale infested plant material in organic citrus groves this next season.
Impact: The researchers continue to develop an understanding of the relationships between the soft scale hosts and their parasitoid complex. With this understanding they will be able to develop an ecologically based IPM program for California citrus. Their research with citrus pests has led to the development of an ecologically based pest management program that has reduced pest control costs and pesticide use in California citrus groves.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: NATURAL PRODUCTS CHEMISTRY AS A RESOURCE FOR BIORATIONAL METHODS OF INSECT CONTROL

Description: By bioassay-guided fractionation using Aedes aegypti larvae, four novel mosquito larvicidal saponins, pachyelaside A - D, were effectively isolated from the root bark of Pachyelasma tessmannii (Leguminosae) using recycling high pressure liquid chromatography. The structure of cinnamoyl saponins were established on the basis of extensive NMR spectroscopic and matrix-assisted laser desorption/ionization time-of-flight mass spectrometric studies. These new saponins possess the most complex sugar chains among the saponins characterized from Pachyelasma species, and were found to exhibit potent mosquito larvicidal property against A. aegypti larvae. In addition, the same saponins were found to have potent mosquito larvicidal activity against Culex tarsalis, the principal vector of the Western equine and St. Louis encephalitis viruses common throughout the Western US. Despite their excellent mosquito larvicidal activity, these triterpene saponins are difficult to obtain in quantities and complex molecules to synthesize. To cross these hurdles, a series of aliphatic primary alkanols was tested as a model for their mosquito larvicidal activity, since saponins are usually considered as surface active agents (surfactants). The alkanols tested show activity against C. tarsalis larvae. Alkanols are among the most versatile of all organic compounds; free and esterified alkanols occur widely in nature, and more importantly, they are stable, colorless, inexpensive,

biodegradable, and essentially nontoxic to humans. The fact that they are already approved for use in food products at concentrations comparable to the doses found may facilitate their approval as insecticides. Continuing to search for alternative insect control agents, novel limonoids were characterized from the methanol extract of Croton jatrophoides (Euphorbiaceae) as potent antifeedants against the second-instar larvae of Pectinophora gossypiella and Spodoptera frugiperda. The structures were determined mainly on the basis of extensive nuclear magnetic resonance (NMR) spectroscopic analyses. There is no doubt that many plant secondary metabolites affect insect behavior, development and reproduction. Identifying these substances is an important first step in understanding the effect of plants on insect life at the molecular level. Information about growing environment of living plants, including defenses against insects often provides hints for the choosing bioassays. However, there is usually no such information available when the plants are sold at market places. The methanol extract of the dried flower of Heterotheca inuloides (Compositae) was found to exhibit insect growth inhibitory activity against the second-instar larvae of P. gossypiella using an artificial diet feeding assay. The bioassay guided fractionation led to isolation of the active principle, a sesquiterpenoid, inuloidin.
Impact: The results obtained may provide more scientifically sound and environmentally acceptable species specific insect control agents.

Funding Source: Multistate Research and State
Scope of Impact: AZ, CA, CO, FL, NV, PA, TX

Theme: 4.12 Integrated Pest Management
Title: Selective Management of Lepidopterous Pests in Orchard Ecosystems

Description: 1. Development of programs that use pheromones as supplemental treatments to existing programs provided mixed results. The addition of sprayable pheromones to existing insecticide programs did not result in enhanced performance for walnut orchards with low pressure from codling moth (e.g. less than 0.5%). However, increased performance was noted as codling moth pressure increased, yet the results were inconsistent between orchards. Suggestions for program improvement including early season suppression are made for 2004. 2. The sprayable formulation of the codling moth pheromone under light exposed conditions does not appear to provide adequate protection of the codlemone. Use of an electroantennogram to detect potential pheromone emissions from treated discs over time suggested that the sprayable pheromone provided reduced, but detectable emissions after 6 weeks for discs placed in darken environments. Discs exposed to full sunlight did not produce detectable signals after 7 days for a trial conducted in August 2002. A repeat of the study could not show statistically detectable signals by day 11 in a study conducted later in Oct. 2003. The superior results obtained in walnuts for trap suppression of codling moth compared to pears appear to be related to the more closed canopy

structure of mature walnut orchards compared to pome fruit. These data suggest that the majority of pheromone in the orchard after 2 weeks stems from shaded capsules in more protected locations. However, these data have yet to be replicated using standard air-blast sprayers. These data also suggest that sprayable applications to orchards with less mature or open canopies would have less effective suppression of codling moths. 3. Applications of sprayable DA (pear ester) as part of a preliminary effort to develop an "attract and kill" program did not produce any significant change in egg laying at the rates used in the trial using single-tree applications. 4. Positive results in attractancy trials were obtained for trials using "NoMate" fibers from Scentry. Traps baited with Scentry fibers that were allowed to age continued to provide similar attractiveness compared to non-aged fibers. The positive results obtained in 2003 suggest that further development is warranted despite difficulties with specialized application needs. If issues of limited aircraft with the more specialized application equipment can be resolved, then the potential for aerial application to larger walnut canopies may prove promising.
Impact: Criteria were established for acceptable codling moth population pressure and tree canopy development to predict successful management using pheromone mating disruption in large canopied walnut ecosystems. Collaborative studies across multiple regions in California were developed to evaluate sprayable formulations of codlemone for control of codling moth in walnuts in 2004.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: Small Molecules and Metabolic and Regulatory Networks Mediating Plant-Pathogen Interactions

Description: Arabidopsis isochorismate synthase 1 (AtICS1): California researchers discovered that the AtICS1 protein is imported to the chloroplast stroma and overexpressed, affinity purified AtNHisICS1 exhibits ICS activity. Using a newly developed HPLC assay that allows us to detect salicylic acid (SA), chorismate (CA, the substrate) and isochorismate (IC, the product) in the same run, we found that AtICS1 converts CA to IC, but not SA. [Yersinia Irp9 appears to convert CA directly to SA.] Detailed biochemical characterization of AtICS1 is now in progress. To understand controls over SA biosynthesis in planta, they analyzed AtICS1 expression in response to chemical treatments, abiotic and biotic stress, and development by Northern analysis and RT-PCR. We found that ICS1 is induced by UV-C, indicating that ICS1 (and SA biosynthesis) may respond to ROS, consistent with reports of SA accumulation in response to ozone. We also generated stable Arabidopsis transgenic lines harboring AtICS1::GFP/GUS promoter-reporter constructs to assess expression at the cellular level. Stable Arabidopsis transgenics expressing AtICS1 Cterminal V5-His (AtICS1 native promoter and genomic sequence) in an ics1 background were

also created; they express the epitope-tagged AtICS1 protein in response to pathogen and have restored defense-gene induction. To further define the SA biosynthetic pathway from IC in Arabidopsis, we are looking for AtICS1 interactors using the epitope-tagged AtICS1 lines and using a candidate gene approach. AtICS2: They isolated a full-length AtICS2 cDNA, determined that AtICS2 is imported into the chloroplast stroma (K. Inoue), and that overexpressed AtNHisICS2 has ICS activity. Arabidopsis transgenics harboring AtICS2::GFP/GUS constructs were created to assess expression at the cellular level. AtICS2 is not induced by pathogen but is expressed during chloroplast biogenesis. In bacteria, a dedicated ICS is used to make menaquinone used in anerobic electron transport. Perhaps AtICS2 is required for phylloquinone biosynthesis in Arabidopsis; phylloquinone is an electron carrier associated with photosystem I. We have isolated homozygous null ics2 mutants and characterization is underway. Regulatory Circuitry of Arabidopsis response to powdery mildew: They applied the MB-statistic, a new algorithm developed by a collaborator to identify genes with the largest differences in temporal expression patterns between wild type and ics1 mutant over the time course of powdery mildew infection. This led to the identification of a number of transcription factors associated with different stages of the Arabidopsis response. They are currently exploring high throughput methods to rapidly experimentally test transcription factor activity for the purpose of deriving defense response circuitry. In addition, they developed a new method and markers for laser microdissection (LMD) of epidermal and mesophyll cells from mature Arabidopsis leaves. By profiling distinct populations of cells over the time course of infection using LMD, they can better resolve transcriptional, metabolic, and functional responses.
Impact: Elucidation of the SA biosynthetic pathway in plants is critical to an understanding of plant defense responses and systemic acquired resistance. Knowledge of the location and biochemical activity of both AtICS1 and the other Arabidopsis isochorismate synthase AtICS2 allows us to better understand the regulation and function of these enzymes. AtICS2 is likely required for phylloquione biosynthesis. These two ICS genes/enzymes appear to parallel the roles of these genes/enzymes in bacteria in which one is involved in siderophore biosynthesis (e.g. SA and pyochelin) and one is involved in menaquinone biosynthesis used in anerobic electron transport. Methods for modeling and experimentally testing the regulatory circuitry of the plant defense response to pathogen are being developed. An important tool for this work is the application of laser microdissection (LMD) to collect populations of individual cells associated with particular infection stages. The use of LMD on plant tissue is still in its infancy, and therefore, the methodologies we develop are of use to a large community of researchers.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: Alternative Approaches to Control Varroa destructor (Formerly, Varroa jacobsoni), An Ectoparasitic Mite of the Honey Bee

Description: 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 California 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. In 2004, they collaborated with USDA laboratory to investigate several formulations of H. thompsonii in laboratory cage experiments. The experimental results 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
Impact: The results of the experiments report 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: 4.12 Integrated Pest Management
Title: HERBIVORE-HOST INTERACTIONS AND INTERACTIONS BETWEEN HERBIVORES MEDIATED THROUGH THEIR HOSTS

Description: Previously a California researcher showed that tobacco plants growing near clipped sagebrush neighbors experienced less damage than tobacco near unclipped neighbors. This airborne communication only occurred when plants were within 15 cm. Since most plants grow farther apart this phenomenon is not ecologically very important. Recently he found that sagebrush also suffers much less herbivory when growing near experimentally clipped neighbors. This communication extended over much greater distances, probably about 60 cm; most plants have several neighbors at this distance suggesting that communication can be more important in nature. Communication was blocked when plants were clipped in plastic bags supporting the view that the effect requires airborne contact between plants.

Impact: Communication between plants opens up many possibilities for ecological interactions and pest management. Once the researchers have identified the cues that plants use to control their levels of resistance and understand the process they will have a powerful tool to manipulate plant-insect relationships.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: REFINEMENT OF ARTHROPOD ECONOMIC THRESHOLDS ON FIELD CROPS CALIFORNIA

Description: A new challenge arose for arthropod pest management in San Joaquin Valley cotton in 2001 and research has continued to address this situation. Sticky cotton, arising from honeydew from the silverleaf whitefly, Bemisia argentifolii, and cotton aphids, Aphis gossypii, became an issue in SJV cotton. Environmental conditions conducive to honeydew deposition on exposed lint, the lack of fall precipitation, a long, warm fall, and expanding populations of these pests all contributed to the occurrence of sticky cotton. In much of the SJV, both of these pests occur simultaneously and furthermore the management strategies differ between the two pests. This situation has certainly placed added importance on efficient IPM of arthropods in cotton, particularly aphids and whiteflies. The pre-harvest intervals of many insecticides and senescent cotton plants, which may inhibit translaminar movement of many insecticides, make control at this time particularly challenging. Research concentrating on management of late-season infestations of silverleaf whitefly and cotton aphids and mitigation of sticky cotton was conducted in 2002 and 2003 and continued in 2004. One key question was the number of cotton aphids required to cause cotton lint contamination, i.e., sticky cotton. In 2002, results suggested a threshold of 5 to 10 aphids per fifth main stem node leaf whereas in 2003 even 4 to 5 aphids per leaf resulted in sticky cotton. One difference between the two years was that a low level of silverleaf whitefly nymphs also infested leaves in 2003 whereas this pest was absent in 2002. In 2004, studies were designed to examine the aphid threshold and to evaluate the influence of a combination aphid and whitefly infestation. At the onset of exposed lint, treatments were applied at weekly intervals to either control cotton aphids or to increase aphid populations; six application timings were used with the last one being concomitant with defoliation. Silverleaf whiteflies were controlled in all these plots. One additional treatment approach was used where whiteflies were either controlled at the onset of the study or left uncontrolled and the aphid treatments were superimposed on this. Aphids and whitefly populations were monitored with leaf samples once per week. Lint samples were collected by hand and evaluation of stickiness is underway. Aphid populations peaked at 10.4 per leaf and whitefly levels were 2.2 nymphs per leaf. The treatments and population manipulations generally

functioned as planned.
Impact: Honeydew, excrement produced by sucking insects such as aphids and whiteflies, can contaminate cotton lint in the field prior to harvest. This creates a condition known as sticky cotton and greatly reduces the value of this commodity. Sticky cotton creates difficulties in ginning and processing lint. Insecticides are available to mitigate populations of cotton aphids and silverleaf whiteflies in cotton fields but criteria for use of these materials must be developed. My research is designed to provide these decision guidelines.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: MOLECULAR GENETICS OF CALIFORNIAN ARBOVIRAL VECTOR MOSQUITOES

Description: Comparative vector competency assays between northern and southern California populations of Culex tarsalis revealed similarities in vector competency for Western Equine encephalomyelitis virus. Therefore, higher virus activity in the southern portions of California (South of the Tahachapi Mountains) could not be accounted for by possible populational genetic differences between southern and northern Culex tarsalis populations. Populations genetic studies using iso-enzymes including enzymes that metabolize organophosphates , Wolbachia pipientis infection rates, and morphology indicated that there is genetic introgression between northern Culex pipiens pipiens and southern Culex pipiens quinquefasciatus populations. Central San Joaquin valley Cx. pipiens/ quinquefasciatus hybrids breeding in dairy lagoons do not disperse far from the dairies (< 1.5 miles) and are opportunities blood feeders. Interestingly, the dairy populations fed more on cows (74%) than on birds (10%) in 1998 and then in 1999 the reverse happened when 54% fed on birds and 9.3% on cows. The dairy populations will blood feed on humans as well at dusk and one hour after dusk if given the chance. In rural Sierra Nevada foothills Cx pipiens/quinquefasciatus hybdrids and Cx. tarsalis blood fed respectively three to five times more frequently on birds than mammals. Most urban Cx. pipiens quinquefasciatus and Cx. tarsalis in Los Angeles blood feed on birds with few feeding on humans and cats and dogs. High levels of resistance to the insect growth regulator methoprene was found in Fresno county populations of Ochlerotatus nigromaculis. Based on bio-assay susceptibility profiles and with and without synergists the mode of resistance appears to be controlled by a single dominant gene that codes for a protein that is not affected by mixed function oxidase and esterase inhibitors. Use of Bacillus thuringiensis israelensis effectively controls the methoprene resistant populations. Insecticide resistance tolerance surveillance conducted in California indicated that most populations of Culex tarsalis and Culex pipiens sensu latu were tolerant to the organophosphates

malathion and temephos. All populations of Culex tarsalis and Culex pipiens sensu latu were highly susceptible to pyrethroids. One exception occurred where a population of Cx. p. pipiens var. molestus in Marin county were tolerant to pyrethroids. Interestingly this population unlike all other populations of the Cx. pipens complex members were highly susceptible to the organophosphates malathion and chlorpyrifos.
Impact: Resistance to several currently used mosquitocides occur in California mosquito populations. Culex pipiens sensu latu and Culex tarsalis feed predominantly on birds and occasionally on man in urban and rural environments suggesting that these mosquitoes will likely act as vectors of West Nile virus acting as a bridge between the bird zoonotic cycle and humans.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: CHARACTERIZATION OF GENE CONFERRING NEMATODE RESISTANCE TO PLANTS

Description: The tomato gene Mi-1 confers resistance against three of the most damaging species of root-knot nematodes as well as to some isolates of potato aphids and white flies. This gene was previously cloned in a UC laboratory. The researchers have used in vitro mutagenesis on the cloned gene to identify amino acid residues that are important for its function. In addition they have made several versions of the gene that are under regulation of different promoters and are preparing to introduce these into plant cells. They have explored the role of specific signaling molecules in the resistance pathway by using transgenic roots and Mi-mutants that constitutively trigger a hypersensitive response. They have evidence that the signaling molecules salicylic acid, nitric oxide and ethylene play a crucial role in triggering resistance. Mi-1, like many other plant disease resistance genes occurs as a clustered family of similar genes in the plant genome. They have cloned the DNA containing these homologs from resistant and susceptible tomato and have compared the sequences and genomic organization of the genes to better understand how resistance genes evolved. Currently Mi-1 is the only nematode resistance gene available for cultivated tomato and variant nematode strains and species that infect Mi-1-bearing tomato have been found in California and other parts of the world. They have identified a new root-knot nematode resistance gene, Mi-3, in the wild tomato species Lycopersicon peruvianum that confers resistance against nematode strains that infect tomato with Mi-1. They have obtained a 40 kilobase DNA clone that, according to their genetic analysis, should carry Mi-3. Subclones of this DNA have been introduced into susceptible tomato and L. peruvianum, and assays of this material for resistance against nematodes have produced promising results. These results, if confirmed, will indicate that they have cloned Mi-3.

Impact: Root-knot nematodes cause considerable damage to thousands of crops worldwide. Host resistance reduces damage caused by these parasites and reduces the need for use of chemical pesticides. This research should result in a better understanding of how resistance genes work and may allow us to design novel resistance genes. In the short term they have produced additional DNA markers that are useful for incorporation of new natural resistance genes that are genetically linked to Mi-1.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: Resistant Host Plants and Cover Crops for Management of Plant-Parasitic Nematodes in Sustainable Cropping Systems

Description: Research was conducted on the bacterium Lysobacter enzymogenes strain C3 as a potential biological control agent for plant parasitic nematodes. California researchers changed the culture production medium from a chitin medium to a nutrient broth and found that the in vitro activity of the bacterium against a range of plant-parasitic nematodes was enhanced. Experiments were conducted to assess the influence of immersion of nematodes in cultures of the bacterium and cell-free cultures of the bacterium. The nematodes Heterodera schachtii, Meloidogyne javanica, Aphelenchoides fragariae, and Pratylenchus penetrans were assessed. Exposure to cultures derived from full-strength nutrient broth cultures resulted in the striking effect of complete dissolution of nematodes within 3 days. Although their previous research on C3 production in chitin medium revealed that C3 could exert a lethal effect on M. javanica and H. schachtii, this lytic action was not observed when the bacterium was cultured in a chitin medium. Thus, it is clear that the medium in which the bacterium grows has a strong influence on its biological control potential. The death and disintegration of juvenile nematodes suggests activity of proteases and lipases as has been reported for this strain. We continue to evaluate strain C3 for biological control of plant-parasitic nematodes. The host status of thirteen different potential cover crop cultivars for Heterodera schachtii management in California was determined in greenhouse experiments. Two experiments were conducted to determine the host status of 13 cultivars of mustard and oil seed radish. Nine cultivars of Brassica juncea were evaluated, including the following: ISCI 20, ISCI 99, ISCI 61a, ISCI 61b, Pacific Gold, Green Wave, Southern Giant, Red Giant, and Horned Green. Two varieties of Sinapis alba were investigated: Ida Gold and Martigena. The Humus and Erika cultivars of Brassica napus were also included. Sugarbeet was used as a control. Plants were inoculated with infective juveniles, and a single generation of progeny was counted to assess the host status of the different plants. The results varied between experiments, but all plants did support some reproduction by the nematode. Martigena, Humus, Pacific Gold, and ISCI 20 supported the

least reproduction among the cultivars in one experiment, while in the other experiment southern giant supported only limited reproduction. This research is being continued.
Impact: The bacterium Lysobacter enzymogenes strain C3 shows strong potential as a biological control agent for plant-parasitic nematodes, with activity against four plant-parasitic nematodes of importance to field and ornamental crops. The use of cover crops to shorten rotations for management of sugarbeet cyst nematode is an important alternative, and these results have been communicated to clientele in California. The fact that some nematode reproduction is supported by these cultivars raises concerns about use of these in California as part of a sugarbeet cyst nematode integrated management strategy.

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: Ethyl formate, a generally recognized as safe fumigant, has been tested on a wide range of economically important insect pests. The dosage required for Probit 9 control have been determined. In addition, California researchers have explored the tolerance of table grapes to ethyl formate treatment. Grapes pretreated with sulfur dioxide show excellent tolerance to the ethyl formate treatment. They 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.
Impact: The deadline for the phase out of methyl bromide was 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 non chemical 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: Integrated use of prescribed burning and clopyralid for yellow starthistle

control and optimum rangeland health

Description: 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). Repeated use of either technique can be impractical or may select 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 (percent 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 percent. In Yuba County, this treatment increased medusahead (Taeniatherum caput-medusae) cover from 12 to 19 percent. 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. The 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 percent cover in both sites. This combination also reduced ripgut brome and medusahead cover in Yuba County. Prescribed burning stimulates yellow starthistle germination the following winter, thus rapidly reducing the starthistle seedbank and increasing the efficacy of a subsequent clopyralid treatment. In 2001-2002 Califoria 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 percent compared to the adjacent untreated plots. 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. Monitoring of clopyralid drift following aerial application demonstrated that 30m 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. Finally, the researchers showed that when the herbicide clopyralid is used properly, toad toxicity and drift potential for clopyralid are minimal.

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 objective is to develop improved weed management options for vegetables. The project is focused on two principal areas: (1) development of season-specific weed management programs for vegetables, and (2) evaluation of methods to improve weed control in lettuce with herbicides and soil fumigants. Season-specific weed management. The project goal is development of season-specific vegetable weed management programs. Seasonal patterns of burning nettle (Urtica urens) development were monitored for three years. A 5.1 deg. C growing degree day (GDD) model was developed to quantify the time from watering to emergence, flowering and first seed set. Seasonal mean time from watering to emergence, flowering and first seed set was 99.5, 342.5 and 429.0 GDD (5.1 deg. C). These data will be used to develop weed management recommendations for organic and conventional vegetable producers. Irrigation strategies for pronamide activation. Heavy irrigation can push pronamide below the weed germination zone in soils important for lettuce production in Yuma, AZ, such as the Indio silty clay loam soils. The result of this is poor weed control in lettuce. Some suggest that pronamide activation by intermittent initial irrigation improves weed control compared to continuous irrigation. However, to the best of our knowledge no one has verified that intermittent irrigation reduces pronamide soil mobility. UC researchers conducted a series of soil column leaching studies, to compare effects of intermittent and continuous irrigation on pronamide mobility in soil. Soils used in the studies were Chualar sandy loam soils from Salinas, CA and Indio silty clay loam from Yuma, AZ. Soil columns were packed with 10-inches of untreated soil, and pronamide treated soil was added to the top of the soil column. The continuous irrigation treatment was 12 acre inches of water applied continuously over 24 hours. The intermittent treatment received 1-inch of water in 2 hours, followed by a 12 hour dry period, followed by 12-inches of water in 24 hours. Results indicated that the continuous and intermittent irrigation both readily move pronamide through the Indio silty clay loam, but the Chualar series soils impeded pronamide movement. The results indicate that intermittent irrigation does not improve pronamide retention in the upper soil layers any better than continuous irrigation on Indio silty clay loams from Yuma. The data also indicated that the pronamide did not move readily in Chualar soils. Nutsedge management. In 2003 they found that applications of 1,3-dichloropropene plus

chloropicrin (1,3-D/Pic) at 28 gallons/A (GPA) followed by EPTC at 7 pts. /A to fallow ground in the Coachella Valley, resulted in good nutsedge control in the following lettuce crop. In 2004 we evaluated 20.5 and 26 GPA of 1,3-D/Pic applied by shank injection. Following fumigant applications, 7 pts./A EPTC was applied. Again in 2004 nutsedge control was excellent with 1,3-D/Pic followed by EPTC treatment.
Impact: California vegetable producers sold over $5.3 billion in produce during 2003. 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: CULTURAL OPTIONS FOR INTEGRATED WEED MANAGEMENT IN RICE, WITH EMPHASIS ON HERBICIDE-RESISTANT WATERGRASS

Description: Herbicide resistance. California researchers made substantial progress in the identification of the biochemical bases of herbicide-resistance in Echinochloa spp. Cytochrome P450 was identified as the mechanism conferring resistance to thiocarbamates and to ACCase-inhibiting herbicides. This mechanism of resistance is also responsible for the lower effectiveness of propanil. This knowledge allowed for the identification of selective synergists to overcome resistance to bispyribac-sodium in late watergrass. Resistance was also identified towards clomazone. Cross-resistance patterns to ALS inhibitors have been characterized for a large collection of Cyperus difformis accessions collected throughout the state, and the molecular bases of this resistance are being identified. A target-site mechanism of resistance to the herbicide quinclorac in Digitaria ischaemum was identified, by which resistant plants fail to increase CN production in response to herbicide treatment. A long-term field experiment on alternative stand establishment techniques for rice aimed at the management of herbicide-resistant weeds was implemented. Results showed effective shifts in weed species. Data are being used for developing a modelling approach for system optimization. Enhancing cultivar weed suppressiveness. The researchers conducted a second season of experiments repeating those conducted in 2003. This project aims at delivering criteria for breeding competitive rice cultivars in order to delay the evolution of herbicide resistance, and reduce herbicide use. a). Competition experiment. A competition experiment was conducted at the Rice Experiment Station near Biggs, CA, in 2004. A total of 39 experimental lines of the population M-202/IR50 plus the two parents were studied. Cultivars were selected to support a complete factorial arrangement of three categories of heading time (early, 90-97 days after planting; intermediate, 99-105; and late 107-112) and three categories of plant height at

maturity (short, 65-75 cm; intermediate, 78-90 cm; and tall, 92-110 cm). Each of the nine treatments was represented by at least two cultivars or a maximum of four. Plots size was 3.3 m2, sub-plots were rice grown with and without watergrass competition. Each treatment was replicated four times. Sampling for growth analysis was conducted at 20 days after seeding (DAS) (to determine plant height and stand), 45 DAS, 75 DAS (to determine leaf area, tiller no., plant height, and total aboveground biomass) and at harvest to measure grain yield, yield components and harvest index. b). Phenotyping and QTL identification of competitiveness-related traits. A set of 138 recombinant imbred lines and parents from the M-202/IR50 population were planted with three replications. Stand, tiller number, plant height, leaf area, specific leaf area and total aerial biomass were measured at three intervals. Genetic studies from this experiment are in progress.
Impact: Herbicide-resistance is currently one of the most critical constraints to rice production faced by growers. The researchers' development of an understanding of the mechanisms of herbicide resistance in weeds provides the only rational means of conceptualizing management strategies for this problem and to guide the deployment of new herbicides for CA rice for economic and safe weed control. Their field project on alternatives for stand establishment is the first true approach to implement an IPM-based strategy for weed management in CA rice. This research is the basis for controlling the overuse of herbicides resulting form the evolution of herbicide resistance in weeds. Competitive rice is a safe, economic and environmentally sound tool to reduce herbicide use and manage the herbicide-resistant weeds that cripple CA rice. Knowledge on the genetic basis of rice competitiveness provides an effective tool for germplasm enhancement.

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 soil fumigant methyl bromide (MeBr) is applied extensively to suppress soil-borne fungal pathogens and weeds in many crops. Methyl bromide is a potential ozone depleting substance and is scheduled for phase-out by 2005. 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. Three field research experiments and Four demonstration projects were initiated to test and optimize chemical alternatives to MeBr for strawberry and cut flowers production in California. Research Experiments: The objective of this study was to compare the efficacy of several alternative fumigants applied through drip irrigation systems for strawberry production in CA. Four research plots were initiated in Watsonville, Salinas, and Solidad. The alternative chemicals tested were

chloropicrin (200 lbs/ac), Inline (300 lbs/ac), Midas (200 lbs/ac), and KPam (30 gal/ac). This research found that crop quality and yield under the alternative fumigants to be equivalent to those grown under MeBr/chloropicrin fumigated soils. Growers Demonstration Project: Four demonstration plots (each approx. 1 acre) were established on growers' fields in Watsonville, Santa Maria, Oxnard, and Carlsbad between July and November, 2004. Chloropicrin, Inline, and Midas were applied at 200 lbs/ac under standard mulch and Vertually Impermeable film (VIF). Metam sodium was applied at 45 gal/ac to one-half of the treatments. The purpose of this project is to demonstrate drip fumigation to strawberry and cut flower growers and to evaluate reduced rates of fumigants under VIF for different soil types. Results suggest that reduced rates (less than 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 (strawberry and cut flowers) losses from soil-borne pathogens and weeds. This project evaluates alternative chemicals and practices for crop production. Our research effort resulted in the development of techniques to apply alternative fumigants through drip irrigation systems for crop production (strawberry, cut flowers, and vegetable crops). 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 35% of the strawberry land was fumigated with the alternative fumigants in 2004.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: Horticultural crop genomics: genetic resources diversity and integrated pest management

Description:: A project to develop a biocontrol yeast for control of Aspergillus flavus in pistachio was continued. Tests were conducted to determine the persistence of the yeast in the field and to determine whether the yeast had any significant phytotoxicity on pistachio. Morphological evaluations were taken and nuts examined for reduction in nut size, splits, etc. No differences between treated and control treatments were observed. Collection of data was continued on three pistachio genotypes identified for cultivar release and presently under advanced testing. The two females continued to out produce the leading cultivar used by the industry. Documents have been prepared for their release.
Impact: The development of biopesticides can reduce the use of hazardous chemicals for the control of plant pathogenic fungi. Use of these biopesticides may also contribute to food safety by reducing the level of aflatoxin in pistachio. The new pistachio cultivars being released are expected to provide growers with improved marketable yield and profitability compared to the present cultivar grown by the

industry. Earlier harvest will also help growers manage a heretofore short harvest window.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: Disease Management in Ornamental Crops

Description: Over the past year, California researchers have continued work on alternatives to methyl bromide for field-grown ornamental crops in coastal production areas. Research comparing butyl-, benzyl-, ethyl-, and phenylethyl-Isothiocyanate (ITC) showed that LD50 (to Fusarium oxysporum) differed by soil type. Ethyl-ITC was consistently the most efficacious in all soil types. Benzyl-ITC was generally the least efficacious, and butyl- and phenylethyl-ITCs were variable, appearing relatively efficacious in some soils, and relatively non-efficacious in others. ITC persistence in the different soils also varied, and both persistence and LD50 were influenced by soil pH. Differences in ITC species produced and differences in soil properties degrade the reliability and reproducibility of biofumigation using Brassica species. Our research on water treatments to eliminate fungal pathogens from recycled irrigation water has emphasized ozone treatments over the past year. They have initiated a large-scale field trial at a commercial nursery comparing the root health and survival of container-grown plants irrigated with fresh water, recycled water, and ozone-treated recycled water. A split-plot design includes fungicide treatments on either a scheduled basis, or on an as-needed basis. The purpose of this trial is to test the long-term efficacy of ozone, and to compare plant quality and production costs under different scenarios. Finally, they have begun research 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. One of their study sites has been Monrovia Nursery in southern California, where a serious disease outbreak occurred in the spring of 2004. They have conducted soil-baiting trials to determine survival of propagules, and have been baiting out of the San Gabriel River to check possible avenues of entry into the nursery. This work is ongoing.
Impact: Flower growers in coastal regions of California urgently need alternatives to methyl bromide and there has been great interest in biofumigation as an environmentally friendly approach. Our experiments have shown that biofumigation with Brassica species is not reliable and that growers should explore other means of soil treatment.

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: Salinas Valley, the nation's salad bowl accounts for nearly 60 percent of total lettuce production and soilborne diseases are a major impediment to production. Lettuce drop caused by Sclerotinia minor and S. sclerotiorum is one of the most important disease throughout California. Despite Sclerotinia minor being the dominant species in the Salinas Valley, losses caused by it are more predictable and at least one effective fungicide is available for managing it. In contrast, the more dramatic losses are caused by the airborne phase of S. sclerotiorum that hitherto was restricted to the central and desert valleys in California with limited management options. This decades-old geographic delimitation is likely to be altered by the evolving production practices such as the 80 inch bed configuration largely being driven by the consumer preference for ready-to-eat salad mixes. This in turn has the potential for the establishment of the explosive airborne phase of S. sclerotiorum in the Salinas Valley. California researchers have conducted extensive field surveys and the data support that this is highly likely. Over the past year, they conducted controlled field experiments comparing the effects of 40 inch and 80 inch beds on lettuce drop caused by both S. minor and S. sclerotiorum in isolated locations. Data obtained from the spring and fall seasons suggest that lettuce drop caused by both species is significantly greater on 80 inch beds than on 40 inch beds; the aerial infections from S. sclerotiorum are at least 50 percent higher on 80 inch beds and the pathogen adds significantly greater inoculum than on 40 inch beds. These studies are being continued and will have both short- and long term impacts with clearly measurable deliverables. Another aspect of our work on this disease has been to develop new methods of managing this disease. As part of this, they evaluated several biocontrol treatments along with the standard fungicide in the desert production areas and have identified one product that essentially obviates the need for fungicides. These studies are also being repeated to confirm results. Over the past year, the spread of Verticillium wilt on lettuce to new areas of production was documented in coastal valleys. The seedborne nature of this disease in lettuce and the contribution of certain weeds in spreading the disease were fully documented. We are now critically assessing the role of infested seed in establishing the pathogen in soils that lacked it in controlled microplot studies. They also evaluated several fumigants for their efficacy on Verticillium dahliae in lettuce and identified at least two that can serve as clear alternatives to methyl bromide. The efficacy of methyl bromide + chloropicrin at different soil depths and the rapidity of recolonization of fumigated soil is currently being explored.
Impact: Because of the applied nature of this work, the results always have a direct impact on disease management in many vegetable crops. The researchers have identified the production practices that would have a major impact on soilborne diseases on lettuce in the Salinas Valley. A number of lettuce breeding lines with resistance to S. minor and V. dahliae have been developed and being evaluated. 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. 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: Roses: A phytoplasm specific PCR test was used to screen rose varieties in the FPS collection that showed phyllody symptoms. We tested 10 rose selections that have demonstrated phyllody symptoms: Centennial Star, Earth Song, Kordes Perfecta, Michelangelo, Perfume Delight, Pink Grootendorst, Rouge Royale, Toulouse Lautrec, and two seedlings. Despite repeated testing, no phytoplasma were detected. Apparently most cases of rose phyllody seem to be associated with a physiological phyllody which is not uncommon in garden roses. We suspect that actual phytoplasma infection of roses is relatively rare; numerous past attempts to inoculate modern roses with phyllody-type phytoplasmas have failed (Golino, unpublished). Although reports exist of rose phyllody diseases which may be caused by phytoplasma, they are infrequent and the association with phytoplasma is poorly documented. A careful literature search was combined with this study and supported our conclusions. Syrah Decline: Leaf reddening, swollen graft unions, and stem necrosis symptoms have been reported from California Syrah vineyards, symptoms often associated with genetic incompatibility and/or virus infection. Further, there is widespread grower concern that these vineyards may be showing symptoms of the disease known as Syrah Decline in France, a disease of unknown causes. Vineyards in 11 California counties where Syrah was reported by vineyard managers to be exhibiting symptoms similar to Syrah Decline were surveyed. Symptoms observed included mild and severe vertical cracking on the trunk, interveinal burgundy red leaves typical of leafroll virus symptoms, leaf margin reddening and necrosis, and swelling at the graft union. Over 1500 PCR tests were completed on 133 samples from 78 problematic vineyards surveyed. Infection with known viruses did not seem to be a common factor in the symptoms that concerned growers. Approximately 95% of the samples tested negative for viruses typically associated with graft union disorders. Selected samples (where virus symptoms were characteristic) were chosen for further testing for dsRNA. These RNA fragments were cloned and sequenced and found to be variants of the standard GRSPaV. Work on these variants continues. Field indexes have been established using Syrah clones known to exhibit symptoms of Syrah Decline

under French conditions.
Impact: Roses:The UC research is reassuring to both rose nursery producers and home rose growers who have expressed concern that phyllody symptoms are the result of a phytoplasm infection. Several rose nursery growers have had difficulty explaining to customers that phyllody is not normally a symptom of disease in roses; our work should be reassuring to them and their clients. The publication in American Rose Magazine has made information about rose phyllody and its symptoms available to the large number of home gardeners who grow roses. Syrah Decline: Rumors of an epidemic in California of the French Syrah Decline disease have been addressed. If this disease exists in California, it is rare. During the course of this two year study, no vineyards have been identified with typical symptoms of French Syrah Decline. Most Syrah vineyard problems around the state could be attributed to management or environmental explanations. The important exception is vineyards in the Central Coast which have demonstrated a problem distinct from Syrah Decline that we are now calling Syrah Disorder. There is strong evidence that this is a regional problem, unrelated to virus, Syrah Decline, and/or source of propagating materials, and possibly correlated with site and water stress.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: ISOLATION, CHARACTERIZATION AND USE OF PLANT AND OTHER GENES FOR RESISTANCE AGAINST PLANT VIRUSES

Description: UC researchers (1) examined COWPEA MOSAIC VIRUS (CPMV) and the cowpea (VIGNA UNGUICULATA) gene Cpa, which confers extreme resistance against CPMV, and (2) created a synthetic gene for resistance to TOBACCO ETCH VIRUS (TEV). Various nearly isogenic pairs of cowpea lines were created, one member of each pair having the Cpa/Cpa homozygous resistance genotype and the other member homozygous for susceptibility to CPMV (cpa/cpa). Cpa/Cpa seedlings develop no symptoms and accumulate no recoverable CPMV when inoculated with CPMV at 10,000X a concentration that uniformly infects cpa/cpa seedlings. However, CPMV is not without effect in Cpa/Cpa cowpea. Co-inoculation to Cpa/Cpa cowpea of CPMV and any of certain other viruses (challenging viruses) capable of infecting Cpa and cpa cowpea results in interference with challenging virus accumulation. This phenomenon is designated concurrent protection. The association of extreme resistance and concurrent protection is perfect for all cowpea lines tested. This result suggests that a CPMV factor (an elicitor) is recognized by Cpa cowpea and activates a mechanism effective not only against CPMV (extreme resistance) but also the challenging virus (concurrent protection). They seek to identify the CPMV-encoded elicitor and isolate the Cpa gene and its cpa allele. They demonstrated that CPMV particles encapsidating one

of the two genomic RNAs of CPMV, RNA1, are sufficient to mediate concurrent protection, thereby mapping the elicitor to RNA1. They expressed segments of RNA1 by inserting them into TOMATO BUSHY STUNT VIRUS (TBSV) and POTATO VIRUS X (PVX) vectors. PVX with inserts infected cowpea only poorly; TBSV with RNA1 inserts infected well and gave a weak differential result between Cpa and cpa cowpea that allowed us tentatively to identify elicitor activity associated with the VPg-24Kprotease encoded in the RNA1 central region. Other vector systems are being tested to confirm this result. By screening for, and not finding, recombinants out of cowpea crosses, they showed that Cpa probably is allelic with a local lesion resistance gene, Cpi. They previously had mapped Cpi to linkage group 3. They prepared a bacterial artificial chromosome library of cowpea, have identified markers close to Cpa and allelic Cpi, and are performing chromosome walking to get closer markers. TEV is a member of the potyvirus genus, which includes many of the most economically important plant viruses. In previous work, we designed an ESCHERICHIA COLI system to select, from random, 10-amino-acid peptide libraries, inhibitors of the TEV 27K protease, an essential enzyme of the virus. Selected peptides were expressed as displays on thioredoxin in E. COLI and tobacco. IN VITRO inhibition of the 27K protease activity was demonstrated, and some progeny tobacco plants were identified that expressed thioredoxin with peptide insert and did not develop symptoms or accumulate TEV virions after inoculation with low concentrations of TEV that routinely infected control plants. The results suggest that the selected random peptides function as TEV 27K protease inhibitors in the intact plant and effect resistance. A publication describing these results is in preparation.
Impact: The robust resistance against CPMV that is mediated by the Cpa gene, when activated by CPMV, acts against several other viruses as well in the phenomenon of concurrent protection. Thus isolating and understanding this resistance gene could form the basis of resistance strategies that would be effective against other viruses. Having approaches to engineered resistance, such as protease inhibition, in addition to the widely practiced coat protein expression approach, is valuable because deploying two or more resistance genes that act by distinct mechanisms is likely to increase the durability of resistance.

Funding Source: Hatch and State
Scope of Impact: State Specific

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. Leaf wetness, 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 was 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 tomato powdery mildew was developed and added to the UC IPM 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: Analysis of Disease Resistance in Rice

Description: Systemic acquired resistance (SAR) is an important defense response in plants. SAR induces expression of pathogenesis-related (PR) genes (Ryals et al., 1996) and confers lasting broad-spectrum resistance to viral, bacterial, and fungal pathogens. In dicots, such as Arabidopsis and tobacco, the phytohormone salicylic acid (SA) as well as the synthetic chemicals 2,6-dichloroisonicotinic acid (INA) and benzothiadiazole (BTH) is potent inducers of SAR (Friedrich et al., 1996). In monocots, SAR was shown to be induced by BTH in wheat (Gorlach et al., 1996) and by Pseudomonas syringae in rice (Smith and Metraux, 1991). BTH can also induce disease resistance in rice (Schweizer et al., 1999; Rohilla et al., 2002) and maize (Morris et al., 1998), although it is not clear whether the resistance was SAR. The NPR1 (also known as NIM1 and SAI1) gene is a key regulator of the SA-mediated SAR pathway in Arabidopsis (Cao et al., 1994; Delaney et al., 1995; Glazebrook et al., 1996; Shah et al., 1997). Upon induction by SA, INA, or BTH, NPR1 expression levels are elevated (Cao et al., 1997; Ryals et al., 1997). NPR1 affects the SAR pathway downstream of the SA signal. Arabidopsis npr1/nim1 mutants are impaired in their ability to induce PR gene expression and mount a SAR response, even after treatment with SA or INA. Over-expression of Arabidopsis NPR1 or the rice NPR1 homologue 1 (NH1) in rice results in enhanced resistance to the pathogen Xanthomonas oryzae pv. oryzae (Xoo), suggesting the presence of a related defense pathway in rice. We investigated this pathway in rice by identifying proteins that interact with NH1. Here we report the isolation and characterization of a rice cDNA encoding a novel protein, named NRR (for Negative Regulator of Resistance), which negatively regulates resistance to Xoo when over-expressed in rice. NRR interacts with NPR1 in the NPR1-interacting domain (NI25) consisting of 25 amino acids. NRR also interacts with NH1; however, NI25 was not sufficient for a strong interaction, indicating a difference between the rice and Arabidopsis proteins. When constitutively over-expressed in rice, NRR affected basal resistance, age-related resistance and Xa21-mediated resistance, causing enhanced susceptibility to Xoo. This phenotype was correlated with elevated NRR mRNA and protein levels and increased Xoo growth. Over-expression of NRR suppressed the induction of defense-related genes. NRR:GFP protein was localized to the nucleus, indicating that NRR may act directly to suppress activation of defense genes. NRR is the first gene demonstrated to compromise Xa21-mediated resistance, indicating cross-talk or overlap between NH1- and Xa21-mediated pathways.
Impact: Why would plants want to suppress defense responses? Programmed cell death or hypersensitive response normally accompanies defense responses. Mutants and transgenics with mis-regulated, untimely, or over-active defense responses tend to lead to a lesion mimic phenotype (reviewed by Lorrain et al., 2003; Yin et al., 2000; Chern et al., submitted). Rice contains unusually high basal levels of SA (Silverman et al., 1995). Keeping defense responses in check in rice may be

especially challenging. The presence of NRR and related proteins may serve the purpose to keep defense responses in check, which is essential for normal plant development. Cereals such as rice, maize and wheat provide most of the calories consumed by humans and animals. These crops are therefore the worlds most important, from both a humanitarian and an economic standpoint. Of these cereals, rice provides the most amenable system for molecular genetic studies because of its small genome size, extensive genetic map, large sequence databases, and relative ease of transformation. Therefore, knowledge gained about plant defense signaling pathways in rice will be applicable to many other cereal crops.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: Disease Mechanisms and Management Strategies for Pierce's Disease

Description: During 2004 UC researchers continued basic and applied research on Pierces disease (PD) of grapevines, which is caused by the bacterium, Xylella fastidiosa (Xf). Their second screening of 1,000 random Tn5 mutants showed that approximately 30 percent of the inoculated vines remained non-symptomatic. The Xf DNA flanking the Tn5 insertion was sequenced using a novel 2-step PCR procedure. Approximately 30% of the mutants were in unknown hypothetical proteins, 30 percent were in phage related genes, 20 percent were in house keeping genes and the remainder was in potential pathogenicity or attachment genes. Those mutants containing Tn5 insertions in anything other than house keeping genes were grown on media and re-inoculated back into grapevines growing in the greenhouse. These plants should be ready to evaluate in March 2005. They also further characterized a number of mutants with a hypervirulent phenotype, i.e. grapevines inoculated with these mutants developed more severe disease sooner and died faster than vines inoculated with the wild type parental strain. Sequence analysis showed these insertions to be in a hemagglutinin (HA) gene, 2 LPS genes, an iron transport gene and several genes of unknown function. A second HA gene homolog was disrupted by site directed mutagenesis and this mutant also showed a decrease in cell/cell attachment as did the HA mutant identified by the random screening process. A manuscript describing these hypervirulent mutants has been submitted for review. Their evaluation of prophylactic applications of plant micronutrients and inducers of systemic acquired resistance (SAR) showed that none of our treatments protected field- or greenhouse-grown vines against Xf infection. In addition, PD-affected vines that we treated in 1999/00 with injected bactericides that had appeared symptomless for the past 3 years have developed symptoms of PD. They now feel that these therapeutic treatments suppressed but did not eradicate Xf populations in the diseased vines. In spring, 2003 they inoculated 10 vines each with 6 bacterial

grapevine endophytes that showed antagonism to Xf in vitro and moved in grapevines. One month after inoculating the vines with endophytes they were exposed to Xf-infectious sharpshooter vectors. In the fall, 2003 these vines were rated for PD symptoms and tested for Xf by PCR. All of the endophyte-inoculated vines tested positive for Xf however the severity of the symptoms in vines inoculated with Bacillus and Cellulomonas was less than the Xf-inoculated controls. In spring, 2004 these vines were taken out of the greenhouse and planted in the field. In fall, 2004 disease symptoms were rated and 9/10 of the control vines were dead from PD. All of the Cellulomonas-inoculated and 8/10 of the Bacillus-inoculated vines appeared healthy without any symptoms of PD. These vines are now being tested for the presence of Xf and the endophyte that was originally used to protect the vine. We plan to expand this study and plant endophyte-protected vines in known PD-hot spot areas in Napa. Additional endophyte strains are also being evaluated for protecting vines against Xf infection.
Impact: We have identified 8 genes that normally function to moderate Xf pathogenicity, thus providing novel insights in Xf pathogenicity mechanisms. We have likely identified several additional Xf genes that are absolutely required for plant pathogenicity. These discoveries offer hope that some of these virulence genes can be suppressed and possibly offer a cure for PD. Our work shows that prophylactic applications of bactericides do not prevent infection by Xylella fastidiosa and therapeutic bactericides can cause a temporary remission of symptoms but they do not eliminate Xf from PD-affected vines.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: Detection of Inoculum Potential, Latent Infection, and Fungicide Resistance of Fungal Pathogens of Fruit, Nut, and Vine Crops in California

Description: To develop and implement molecular systems for the detection and quantification of spore inoculum potential and latent infections of Monilinia fructicola and M. laxa, the pathogens causing brown rot in stone fruits and almonds, and Botrytis cinerea, causing Botrytis gray mold of grapes, kiwifruit, apples, and stone fruit in California. To develop and implement molecular systems for the detection and quantification of spore inoculum potential and latent infections of Botryosphaeria dothidea causing panicle and shoot blight of pistachio and band canker in almond and Alternaria species causing late blight of pistachio and leaf spot of almond. To develop molecular systems for the detection of fungicide resistant pathogens of the above mentioned crops in California. Disease levels in orchards depend on spore inocula. UCX researchers have continued using a pair of species-specific primers for Monilinia fructicola and M. laxa to detect the DNA of these pathogens in samples collected from spore traps and in latent infections of plant tissues. They

are still working with M. fructicola/M. laxa, and initiated a collection of isolates of Botrytis cinerea, causing gray mold in grapes, kiwifruit, and stone and pome fruit. The direct agar plating technique (DAPT) and the overnight freezing incubation technique (ONFIT) used to determine latent infections in stone fruit were compared with the molecular PCR technique, and a protocol has now been developed. The molecular technique can provide accurate results within 30 hours, while for the conventional techniques 5 to 7 days are needed to reveal the results. We have established cooperative agreements with several stone fruit (including almonds), grape, and kiwifruit growers who agreed to allow us to collect multiple samples from their fields in various locations. The samples will be separated in 4 sub-samples to be used, 1) for the DAPT, 2) for the ONFIT, 3) for the species-specific PCR technique, and 4) for the RT-PCR technique. In addition, we have collected a large number of M. fructicola and M. laxa isolates that are being used to fulfill objective 3 of this research program. The methods and the rationale for fruit sampling and detection of panicle and shoot blight of pistachio, bark tissues of almond for band canker caused by B. dothidea, and fruit and leaf samples for Alternaria late blight of pistachio and leaf spot of almond will be generally similar to those for the detection of Monilinia fructicola/M. laxa. Protocols for determining latent infections using similar conventional techniques have been developed for these diseases also. Specifically, for pistachio we use BUDMON to detect latent infections of B. dothidea in buds; samples of pistachio fruit, leaves, and buds and almond trunk tissues and leaves are being used for ONFIT, BUDMON, DAPT, and ONFIT, respectively, and for the RT-PCR technique. They are now working towards developing a protocol for the RT-PCR technique, using latent infections on fruit, leaves, buds, and bark. Once the technique has been developed, comparisons of the various methods should be straightforward.
Impact: The improvement of protocols for conventional and the development of molecular techniques to accurately and efficiently detect latent infections and spore inocula of the fruit/nut and vine fungal pathogens expected to provide results quickly that could help fruit/nut and vine growers make timely decisions on managing diseases effectively. Especially, the real time-PCR technique can provide results on levels of fungicide-resistant pathogens of stone fruit, nut crops, and vines in a very short time allowing the grower to make the proper adjustments for implementing fungicide resistance management programs.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: The Epidemiology and Control of Crown Gall on Walnuts, and the Detection and Ecology of its Pathogenic Agents

Description: The U.S. is the largest producer of walnuts (Juglans regia) in the world, and most production is in California. Walnut trees on Juglans hindsii x J. regia Paradox rootstocks are highly susceptible to crown gall, caused by Agrobacterium tumefaciens and A. rhizogenes. UC researchers' results from multiple trials indicate that wounds from either root pruning or grower handling are not an important factor in crown gall in walnut orchards. As a treatment, wounds made with a serrated blade had no effect (P more than 0.05) on galls at the crown. In another field trial, with six treatments in which trees were wounded or not with 100 replicates per treatment, there was no significant effect (P more than 0.05, Cochran-Mantel-Haenszel test) of wounding on the incidence of gall in any of the root regions: crown plus main tap root; lateral roots; or any subterranean location. Subsequent experiments demonstrated that only wounds that penetrate into the cambium or perhaps the phloem induce galls. In addition, the researchers had four trials in which root-pruned transplants from a nursery were planted and dug again after two years. Galls were rarely present at root-pruned locations, even though the biocontrol agent K84 was not used in these trials. In contrast, galls were frequently formed at sites of root emergence and occasionally at sites of sucker emergence, i.e., at sites with natural wounds. Growth cracks, nematodes and insects may also provide wounded sites in which A. tumefaciens can infect. Their results from a field trial also indicate that application of K84 had either minimal or no significant effect on incidence or severity of crown gall. However, their results indicated that exposure of the trees to the pathogenic bacteria in the nursery, or prolonged ambient storage after digging can have a highly significant impact on subsequent incidence of gall in growers orchards. In an observational study, when trees were dug at the nursery, gall incidence was relatively low, from 0.24 percent in site A, which had been in pasture for the past 20 years to 2.4 percent and 1.1 percent in sites B and C, respectively. After digging, trees with visible galls were removed and the remaining trees were placed in temporary ambient storage for varying time periods, primarily due to El Nino rains. Trees from site C were stored for 14 and 11 days longer than those from sites A and B, respectively. Trees were transplanted into the three sites so that for each genotype, nursery-storage was randomized. In all three post-transplantation trials, trees that originated in nursery-storage group C had significantly more gall than trees from the other two nursery-storage groups.

Impact: Currently in California, the only regulations regarding crown gall on fruit and nut trees is that a bare-root tree with a visible gall in a nursery cannot be sold. However, a tree in the nursery that was planted in amongst trees with crown gall can be sold. This work demonstrates that asymptomatic trees that were in physical contact with a symptomatic tree are likely to be contaminated with the bacteria that cause crown gall, and consequently, current regulations are insufficient to assure growers that purchased gall-free trees have clean trees. Current control recommendations grossly exaggerate the role of grower-induced wounds as sites of entry of Agrobacterium; the pathogen generally invades natural wounds, e.g., sites of root emergence. Finally, current recommendations to use the biocontrol agent K84 are not useful in a situation in which the tree is

infested or infected with the bacteria that cause crown gall. Overall, our results suggest that severe crown gall in young walnut orchards is most likely due to planting infested or infected trees, and that, if a grower unwittingly purchases infested or infected, but asymptomatic plants, there is little that they can do to avoid severe economic consequences.

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: Replicated field experiments on alternatives to methyl bromide for strawberry production were continued in 2003-04 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. Chloropicrin at 300 lb/a, InLine (Telone C-35) at 283 and 425 lb/a, and iodomethane (33 percent methyl iodide/ 67 percent chloropicrin) at 300 lb/a were applied to beds under plastic in water emulsions through drip lines and there were nontreated controls. The ranking of the five varieties used for the final incidence of plants with Verticillium wilt (0-25 percent) on nontreated soil was Camino Real, Aromas, Diamante, Camarosa, and Ventana. All of the fumigation treatments controlled Verticillium wilt in Aromas and Camino Real, while only iodomethane and InLine at the high rate gave control equivalent to MBC in Diamante, Camarosa, and Ventana. Most of the chemical fumigation treatments more than doubled total yields and the highest yields in all varieties were obtained with InLine at the high rate. While the effects of the various chemical treatments on the yields of Camino Real, Aromas, and Diamante were generally similar, Camarosa and Ventana yielded significantly less on soil treated with chloropicrin. 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. Among the combinations of four soil treatments (not treated, MBC, chloropicrin, and metam sodium) and five Pseudomonas isolates used in 2003-04, only one isolate applied to Camarosa and one other applied to Aromas on chloropicrin-treated soil gave significant yield increases (17 and 40 percent, respectively). These two isolates are being characterized fhttp://daisy.uvm.edu/cris/formhelp.htm#pubs 43.
Publications:urther. 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 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: Discovery, Characterization and Modification of Genes for Resistance Against Plant Viruses

Description: Crop protection against specific pathogens is accomplished most economically and with the least environmental impact by employing resistance genes. The cowpea (Vigna ungiculata) line Arlington is the source of a robust and extreme resistance against COWPEA MOSAIC VIRUS (CPMV) that is inherited as a simple dominant locus (gene designation Cpa) and results in no development of symptoms or accumulation of virus particles even after inoculation of CPMV at 10,000x a dose that uniformly infects susceptible cowpea lines, e.g., Blackeye 5 (BE5). UC researchers transferred Cpa from Arlington to BE5 in a backcross series, followed by selfing to create homozygous resistant line 9405C. Co-inoculation of 9405C with CPMV and cowpea-infecting viruses results in interference with accumulation of the latter (Bruening et al. 2000 Virology 266:299), suggesting that CPMV activates a strong and general anti-viral response in the resistant cowpea. Progress on 2 of 5 objectives is reported. OBJ 1: map and characterize the CPMV RNA1-encoded elicitor of cowpea anti-virus defense. They have modified plasmid vectors, developed by others and based on TOMATO BUSHY STUNT VIRUS (TBSV), by incorporating an epitope tag to the 5 prime side of the cloning site and a hexahistidine-encoding sequence to the 3 prime side of the cloning site. Fragments of CPMV RNA1 cDNA will be cloned into these modified vectors and inoculated to BE5 and 9405C in a search for specific CPMV sequences that elicit a differential response in the two cowpea genotypes. The introduced epitope tag and hexahistidine sequences are intended to allow us, respectively, to detect the production of CPMV protein fragments under direction of the infecting TBSV vector and to recover, by nickel ion column chromatography, the protein fragments and perhaps host proteins bound to them. OBJ 2: map and isolate the Arlington-derived gene for extreme resistance against CPMV, designated Cpa. Dominant local lesion resistance (gene L49) to CPMV also is available in line UCR430, and L49 has been mapped to linkage group 3 (LG3) using a population of recombinant inbred lines (Ouedraogo et al. 2002 Genome 45:175). Lines homozygous for the recessive allele corresponding to Cpa or L49 become systemically infected after inoculation of CPMV. A UCR430 x 9405C cross was prepared. More than 300 F3 and later progeny have been examined. Extreme resistance was found to be dominant or epistatic to local lesion resistance. If Cpa and L49 are at independent loci, about 1/16 of the F3 progeny lines should have all individuals supporting systemic CPMV infection. In fact, all progeny (more than 6000 individuals) have shown either extreme

resistance or local lesion formation; none were systemically infected. These results suggest that Cpa and L49 are either allelic or linked within a few centi-Morgans. Thus, Cpa has been mapped to LG3. If Cpa and L49 actually are allelic, the nucleotide sequence and mode of action of the two genes will be of interest in our efforts to understand the cascade of events that follows recognition of the invading pathogen in the establishment of extreme resistance or local lesion resistance.
Impact: The robust resistance against CPMV derived from the Arlington cowpea, when activated by CPMV, acts against several other viruses as well. Understanding this resistance gene could form the basis of resistance strategies that might be effective against viruses in addition to CPMV. The system may provide direct comparison of extreme resistance and local lesion resistance encoded at the same locus.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: Exploiting Xylella Fastidiosa (Xf) Proteins for Control of Pierce's Disease and Other Xf Diseases

Description: Pierces disease (PD) has significantly affected grape production in southern California, especially since the establishment of the glassy-winged sharpshooter (GWSS) vector. The causative agent of PD is the Gram-negative, xylem-colonizing bacterium Xylella fastidiosa (Xf). Xf strains also cause other important diseases such as citrus variegated chlorosis (CVC), almond leaf scorch and alfalfa dwarf disease. CVC is not in the US at present but constitutes a serious threat to the citrus industry. Host resistance against Xf probably is the most effective long-term strategy for effective management of Xf diseases, but natural sources of resistance have proved to be elusive. UC researchers discovered that MopB is the major surface protein of Xf. MopB is displayed evenly over most of the cell surface and therefore presents a suitable target for interference with Xf infectivity based on MopB-binding proteins, either alone or as a chimera with a bactericidal peptide or protein. For an orchard or vineyard crop, it may be sufficient to express the MopB-binding protein or protein chimera in xylem-targeted form in the rootstock, expecting xylem flow to transport the protein throughout the otherwise unmodified scion. Progress on the first of four objectives is reported. Objective 1. Discover or develop low-to-medium-molecular- weight proteins with high affinity for portions of the MopB protein that are displayed on the Xf cell exterior. From their analyses of cell DNA and protein content and the proportion of cell protein that is MopB, they estimated that MopB accounts for at least 10% of the Xf cell surface. The E. coli major outer membrane protein OmpA constitutes a smaller fraction of its cell exterior but nevertheless qualifies as the major outer membrane protein of E. coli. OmpA and MopB have sequence similarities in the

carboxyl terminal portion but no similarities in the regions that are exposed on the cell exterior. The T2-like bacteriophage Ox2 is known to bind to E. coli OmpA using its tail fiber tip adhesin gp38. Mutations in gp38 can change the specificity of Ox2 to accept receptors other than OmpA. The gp38-receptor interaction must be of high avidity for successful infection. Therefore, their approach to obtaining a high affinity MopB-binding protein is to substitute the OmpA exterior of E. coli with a MopB exterior and select Ox2 mutants that can infect E coli using the MopB exterior as the receptor. The resulting Ox2 mutant is expected to be the source of mutated gp38 protein with high MopB affinity. A MopB-OmpA chimeric construction was created in a low copy plasmid vector. The plasmid was introduced into E. coli, which subsequently was selected for loss of OmpA and gain of MopB on the exterior using killing by OmpA-specific bacteriophage K3 and binding of survivors to anti-MopB antibody-coated magnetic beads. Resulting E. coli strains have the chromosomal OmpA gene replaced by a MopB-OmpA chimeric gene and display MopB epitopes on the surface such that they are accessible to anti-MopB antibodies. These strains will be used to select bacteriophage Ox2 mutants that have gp38 with high affinity for MopB.
Impact: The goal of this project, in collaboration with others, is to develop a system for interfering with the establishment of Xf infections and the occurrence of Xf-initiated disease that otherwise would follow introduction of Xf by the GWSS insect vector. Most of the economically important hosts of Xf should be amenable to protection by the approach taken here.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: Breeding Pierce's Disease Resistant Table and Raisin Grapes

Description: UC researchers We are breeding grapes with resistance to Pierces disease (PD) by incorporating resistance from southern US grape species and cultivars. The table grape breeding efforts are in collaboration with USDA/ARS-Parlier researchers. Available sources of resistance have very poor fruit quality and must be hybridized with highly susceptible, but high fruit quality Vitis vinifera cultivars. They are now in the third generation of backcrosses and fruit quality of table, raisin and wine grapes has markedly improved. This project has generated and is maintaining mapping populations being used to develop markers for resistance to Xylella fastidiosa, the bacterial causal agent of PD. They have optimized the resistance screen and have classified resistance as suppressed Xylella fastidiosa population development. Artificially inoculated plants with bacterial levels below 100,000 cfu/ml, based on ELISA testing, are highly resistant to the bacteria and disease as demonstrated through greenhouse testing and comparisons to past field testing. Inheritance testing was completed this year and determined that although resistance is controlled by multiple genes in most resistance sources, it

is controlled by a single dominant gene from a Vitis arizonica-Vitis candicans hybrid. This resistance locus, PdR1, has been mapped to chromosome 14 and linked SSR markers are now being used in the breeding program.
Impact: The researchers are producing new Pierce's disease resistant grape varieties. These resistant varieties will permit viticulture where PD is now endemic and counter the possible wide scale incidence of this disease if the introduced glassy winged sharpshooter vector spreads. They are researching the genetics of resistance to optimize breeding and enable effective genetic engineering of grape resistance genes into high quality susceptible varieties.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: ECOLOGICAL RESTORATION OF DISTURBED LANDS IN SOUTHERN CA: IMPACTS OF NITROGEN EUTROPHICATION, INVASIVE PLANT SPECIES, AND MYCORRHIZAL FUNGI

Description: The overall objectives of this project are to study the limitations to restoration of disturbed lands in southern California that are imposed by nitrogen deposition, invasive plants species, and mycorrhizal fungi: 1) Continue to examine the long-term effects of nitrogen fertilization on coastal sage scrub (CSS) vegetation. Between 1994 and 2003 the exotic grasses that were fertilized with N had greater biomass, and in 8 of 10 years the biomass was greater than 0.5 kg/ha of fine grass fuel, while the unfertilized grasses were above this threshold only 2 of 10 years. This is the threshold that is required to carry fire. Thus the major impact of fertilization has been to increase the potential flammability of coastal sage scrub invaded by annual grasses. However, finally in spring 2004, there was also an increase in the cover of exotic grasses relative to native forbs. This was an unexpectedly long delay in the decline of the native vegetation following elevated N. 2) Study the impacts of anthropogenic N deposition on exotic plant invasion and native plant diversity along a N deposition gradient in coastal sage scrub (CSS), desert and forest vegetation. There was a significant positive relationship between soil N concentration and cover of invasive species, and a negative relationship with richness and cover of native forbs. Native forbs declined from 67 to 16 species per 3 ha along the gradient. A survey of forest understory forbs showed no relationship to soil N, but this may be because the forest cover precludes a high density of understory vegetation in some of the sites. The N gradient is confounded by a precipitation gradient, making diversity patterns difficult to detect. 3) Examine different rates of soil N supply in different soil types, and how this may affect exotic plant productivity under different levels of N deposition or fertilization. This study will be initiated in desert soils during the winter of 2005. In situ mineralization will be measured in desert soils with different parent material and different textures. 4) Examine the effects of a

competitive hierarchy of exotic species on native species establishment in CSS. Treatments that control exotic grasses, including grazing, herbicide, and mowing, promote an increase in native forbs as well as exotic forbs. Erodium macrophyllum, a native forb, had better establishment when seeded in a stand of Erodium cicutarium (exotic forb) than in a stand of exotic grasses. Other studies will compare a diversity of native forbs seeded into backgrounds of different exotic species to test the competitive hierarchy. 5) Study the colonization of arbuscular mycorrhizal fungi (AMF) of native and exotic species, as well as colonization of AMF in urban landscapes. A grant proposal has been submitted to fund a study on mycorrhizae of urban landscapes. The UC researchers have completed a second study on commercial AMF of sweet gum, a common landscape tree, and found it to have variable growth response to the fungi. Some sources of commercial inoculum did not produce any colonization, indicating a need for testing prior to large-scale inoculation of some products on the market.
Impact: A major impact of this research has been the finding that elevated soil N causes an increased fine grass fuel load that promotes an increased fire frequency, which should have major implications for policy relating to control of N emissions. However, the long-term results show that even in the absence of fire, the vegetation will become dominated by exotic species. A second major impact is learning that many of the commercial mycorrhizal inocula on the market will not produce colonization under local nursery conditions. This information provides the guideline to private and public users of inoculum to do preliminary tests rather than spend large sums of money on an untested product, as is currently the case. The restoration research will help local restorationists to understand what vegetation management techniques they need to use prior to seeding native species, to promote the greatest establishment of the native species.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: BIOLOGY, BEHAVIOR, AND ECOLOGY OF VECTORS OF PLANT PATHOGENS

Description: The major focus in the UC lab has been the epidemiology of Pierce's disease (PD), a devastating disease of grape caused by an infection of the bacterium, XYLELLA FASTIDIOSA. This bacterium is vectored by a number of sharpshooters, the most significant of which is the glassy-winged sharpshooter (GWSS), HOMALODISCA COAGULATA. The epidemiological studies seek to understand how GWSS, PD, grapes and the environment interact, with the goal of creating sub-optimal conditions within one or more of these components that leads to a reduction in disease spread. Areawide surveys for PD in the Coachella Valley identified 3 additional fields with PD, bringing the total number of infected fields in this area to 7. In these 7 fields, the researchers have positive identification of 97 vines with

PD. GWSS monitoring over the past 4 years showed a dramatic decline between 2002 and 2003 densities, a reflection of wide scale application of pesticides applied to citrus throughout the region. There was generally a poor relationship between infected fields and numbers of GWSS, suggesting that the fields may have been infected with other sharpshooter species, or that the fields were infected prior to our GWSS sampling. They also have completed work on the initial phases of an epidemiological model for predicting PD outbreaks based on densities of GWSS. This model is based on a set of four balanced delay differential equations, two for the GWSS (infected or susceptible) and two equations for grapes (infected or susceptible). Two additional studies have focused on sampling PD within vines and within vineyards. Their vine-sampling research has shown that PD symptom expression on grape leaves is a poor predictor of infection. Within infected canes they have determined that basal leaves are more likely to be positive than distal leaves and combined with our symptom data, they are developing a strategy that will improve their ability to correctly identify infected vines. This work is the first step for developing a field-sampling program. Studies at the field scale indicate that the distribution pattern of PD can be categorized based on overall disease incidence in the field. Vineyards with < 0.1% PD infection showed no detectable spatial structure in PD dispersion. When vineyards had between 0.1% and 1% infection, a random pattern or trend pattern (higher infection toward citrus) existed. When the infection was between 1% and 5%, the spatial pattern of PD was random and when the infection was > 5%, the distribution was clumped. The researchers concluded work on the coconut mite, ACERIA GUERRERONIS, a pest of queen palm seedlings, and we have published the research on the basic biology of this pest. They also have continued their work on the carob moth, ECTOMYELOIS CERATONIAE, a severe pest of dates. They determined that shaking excised dates from the date bunches onto the ground reduces the infestation in date gardens. Mortality in the dropped fruit was attributed to predation by two native ant species, the desert fire ant, SOLENOPSIS AUREA and the California harvester ant, POGONOMYREX CALIFORNICUS, in concert with extreme summer ground temperatures.

Impact: In the Coachella Valley, the researchers found that numbers of GWSS increased from 2001 to 2002. With the documented increase in numbers of fields with PD, these studies suggest that the areawide spray program implemented by local and state government was necessary and effective. Furthermore, monitoring of GWSS and PD should be continued to insure that the epidemic does not progress in this area. Their epidemiological model, while limited by data gaps in their knowledge of GWSS-vectored PD, is useful for evaluating different components of disease spread. With this analytical tool, it will be possible to model various management strategies and determine their impact before investing in costly field implementation trials. The PD vine sampling research provides a clear methodology for choosing leaves for ELISA testing, the first step toward a field sampling program. On a larger scale, ther field sampling work has shown that by knowing the percentage of PD incidence and the location of vineyards relative to citrus, they can predict the distribution pattern of PD in the vineyard. Such

inferences about the spatial characterization of PD distributions in vineyards will be used to develop a spatially-oriented sampling program, effectively reducing cost and increasing efficiency of PD sampling. In our carob moth research, we demonstrated high mortality for moth larvae in dates shaken to the date garden floor. This cultural control is the first step toward developing an environmentally sound management strategy that will reduce grower reliance on the use of insecticidal dusts.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: DEVELOPMENT AND USE OF SEMIOCHEMICALS IN THE MANAGEMENT OF INSECT PESTS

Description: Our moth studies emphasize understanding how insects navigate in wind along an odor plume to locate its origin. Most of this work is carried out in wind tunnels in which we can manipulate the odor, wind, and visual cues that mediate this process. Flight maneuvers are recorded in two (planar) video views and reconstructed in 3-D. Current experiments are emphasizing how visual feedback and the overall shape of the pheromone plume's envelope contribute to the shape of the flight track. Our parallel work with female Culex and Aedes mosquitoes has two aims. First, we are using wind tunnel studies to see how the structure of plumes of carbon dioxide and other host-emitted kairomones influences the flight path of these mosquitoes as they progress upwind. Second, we are documenting the kinds of orientation maneuvers that female Culex mosquitoes use to identify a suitable site for egg deposition. These studies also involve development of new bioassay systems for monitoring behavior and also for evaluating candidate attractants.
Impact: Understanding in moths how the complete mix of pheromone components regulates precise location of the pheromone source may contribute to improving a new type of direct control, the so-called 'attract-and-kill.' method. Formulations relying on this technique lure the male to the precise locus from which the odor is emitted. Therefore, it is crucial to duplicate the female's complete attractive blend and to understand how it mediates mate finding. Our work with mosquitoes has two potential benefits. First, by optimizing the structure of kairomone plumes, we expect to improve the efficacy of sampling traps that are based on carbon dioxide and possibly other host-emitted odors. Similarly, our work with oviposition attractants is directed toward improving the reliability and sensitivity of traps that are baited with such semiochemicals.

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: The effects of ammonium nitrogen enrichment on resources of larval mosquitoes, larval mosquito abundance, adult mosquito production, and the abundance of related wetland organisms were examined in 0.1 ha replicate riverine wetlands. The hypothesis of a bottom-up effect induced by ammonium addition was not supported by bacterial abundance, bacterial cell size, or algal biomass in the water column; however, larval mosquito (CULEX spp.; Diptera: Culicidae) abundance in wetlands enriched at 5.0 milligrams ammonium nitrogen per liter was significantly greater than for control wetlands at ambient nitrogen levels (8.3 mg nitrate nitrogen per liter, less than 0.2 mg ammonium nitrogen per liter) in the Santa Ana River near Norco, California. Adult mosquito production was enhanced by greater than 9-fold by ammonium nitrogen enrichment. Larvae of non-biting midges (Chironomidae) in enriched wetlands were significantly more abundant than in the control wetlands but other related wetland taxa exhibited no significant trends due to enrichment. Mosquitofish (GAMBUSIA AFFINIS) abundance in enriched wetlands was significantly reduced but other potential mosquito predators were not significantly affected by ammonium enrichment. If municipal or agricultural wastewater containing ammonium nitrogen concentrations greater than 5 mg per liter were added to the Prado Wetlands, the production of pestiferous and pathogen-transmitting mosquitoes is likely to increase significantly, especially following wetland management activities. Experiments testing the hypothesis that the cytolytic protein CYT1Aa is the primary factor delaying resistance to the mosquitocide BACILLUS THURINGIENSIS ISRAELENSIS (BTI) were carried out using separate CULEX QUINQUEFASCIATUS populations selected for twenty generations to recombinant strains of BTI that produced either CYT1Aa, CRY11A, or a 1:3 mixture of these component protein toxins. At the end of selection, the resistance ratio was 1,237 in the CRY11A-selected population and 242 in the CYT1Aa-selected population. The resistance ratio, however, was only 8 in the population selected with the 1:3 ratio of CYT1A and CRY11A strains. When the resistant mosquito strain developed by selection to the CYT1A/CRY11A combination was assayed against CRY11A after 48 generations, resistance to this protein was 9.3-fold. This indicates that in the presence of CYT1Aa, CRY11A resistance evolved, but at a much lower rate than when CYT1Aa was absent. These results demonstrate that CYT1A is the principal factor responsible for delaying the evolution and expression of resistance to mosquitocidal CRY proteins.
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: Multistate Research and State
Scope of Impact: AR, CA, FL, IL, LA, TX

Theme: 4.12 Integrated Pest Management
Title: Insect and Manure Management in Poultry Systems: Elements Relative to Food Safety and Nuisance Issues

Description: We are making significant progress toward meeting the listed objectives for understanding the biology, phenology, and control of nuisance flies. In collaboration with UC Cooperative Extension, research funding was secured to evaluate composting of poultry manure as a means of reducing the production of nuisance flies (house fly and little house fly). We found that composting poultry manure (rich in nitrogen) with either municipal green waste or horse bedding material reduced the development of nuisance flies. Properly composted manure had high internal temperature and low external moisture content resulting in the death of young fly larvae before they could complete their development. The results of this work were presented at the National Livestock Insect Workers Conference and a publication is in preparation. Our laboratory has completed a study of fly dispersal from a poultry operation with an attempt to determine a fly nuisance threshold; i.e. a fly abundance value that resulted in substantial nuisance to neighbors of the poultry operation. The dispersal of little house fly (Fannia canicularis) but not house fly (Musca domestica) into neighboring residential areas was clearly demonstrated. However, a nuisance threshold could not be determined due to poor correlation between fly abundance and the nuisance as perceived by residential neighbors. Operators of animal agriculture facilities must be encouraged to develop appropriate nuisance fly monitoring programs that include treatment thresholds in order to protect themselves from city/county/state nuisance laws. A proposal has been submitted for an ANR Core Issues Grant to evaluate several house fly monitoring methods to determine which would be the most efficient and reliable. Following the arrival of West Nile Virus (WNV) into California in 2003, it became clear that poultry operators were concerned about the effects of WNV on their birds. Neighbors were also concerned about increased risk of WNV due to the presence of large numbers of poultry. Presentations and an article in a trade publication were provided to reduce these concerns prior to the start of significant WNV transmission. In contrast to WNV, a virus that did have a significant negative effect on poultry health was also discovered in California during 2003. Exotic Newcastle disease (END) virus was found infecting a number of southern California poultry operations. This virus can cause severe disease to poultry and may result in the

death of even vaccinated birds. A research study was developed by our laboratory to determine the role that insects might play in the maintenance and transmission of this virus in nature. Flies were collected from premises that contained infected poultry in order to test these flies for the presence of END virus, and laboratory studies have been initiated that will look at the ability of flies to carry this virus over a period of days or even weeks. Results should help to determine the need for fly control to be performed at the same time as other END virus eradication measures are initiated at locations with END infected birds.
Impact: The production and dispersal of nuisance flies is one of the most challenging problems for animal agriculture in California. With the changing landscape favoring a reduced separation between residential homes and animal operations, significant conflict between animal operations and neighbors will increase unless appropriate methods of monitoring and controlling nuisance fly populations can be developed. Further, a fly nuisance threshold that can be held as an industry standard must be developed in order to protect animal operations from encroaching urbanization and increases in the perceived nuisance by residential neighbors. Our work has made excellent progress in developing options for the control of nuisance flies and in determining the dispersal ability of little house fly. Coupled with ongoing studies to determine appropriate fly monitoring strategies and nuisance thresholds, we hope to provide the knowledge and tools that animal agriculture in California will need to work with regulatory agencies such as county health departments in order to ensure compliance with nuisance laws. Work on END virus will provide important information about the role that insects might play in the persistence and transmission of this virus between poultry operations. With the cost of eradicating this virus from California (millions of dollars for each eradication effort), failure to understand the role of insects in the maintenance and transmission of this virus could be very costly considering that insects are not controlled as part of the eradication effort.

Funding Source: Multistate Research and State
Scope of Impact: AR, CA, FL, GA, IN, MN, NC, NYC, TN

Theme: 4.12 Integrated Pest Management
Title: CHARACTERIZATION OF AGRICULTURAL NEMATODES FOR IMPROVED SYSTEMATICS AND IDENTIFICATION

Description: Nematodes typically are the most abundant invertebrates in agricultural ecosystems. Diverse plant parasitic taxa, order Tylenchida, cause substantial crop loss through feeding and interactions with additional disease agents. Non-parasitic nematodes, including Cephalobina, are also significant components of agricultural ecosystems, feeding on bacteria, regulating nutrient cycling and thus affecting soil fertility; specific diversity and taxonomic structure of nematode communities may be indicative of environmental changes linked to agricultural practices. Efficient characterization and management of agricultural ecosystems,

and of plant parasitic pest nematodes, is dependent on reliable taxonomy and specifically a classification system that is predictive because it reflects phylogeny. Our goal on this Hatch project has been to advance a new phylogenetic classification of Tylenchida while addressing: 1) the phylogenetic context of Tylenchida (=the origin of plant parasitism) 2) the internal phylogenetic resolution of diverse and often convergent-pathogenesis in Tylenchida. 3) resolution of taxonomic problems of particular plant pests within Tylenchida. These challenges have tackled in collaboration with molecular systematists and through a range of morphological tools (SEM, TEM, confocal, 4D microscopy) directed at unraveling questions of morphological evolution and character homology. The phylogenetic context of Tylenchida (plant parasites) began, in this project, with the premise (after Blaxter et al.) that this order shares a unique common ancestry with Cephalobina (bacterial-feeders). In collaboration with Nadler and De Ley, this relationship has been specifically articulated through a detailed phylogeny based on nearly complete sequences of LSU RNA that provide a new basis for revised classification (Nadler, Baldwin et al., in preparation). The relationship has also been morphologically defined, with new characters for phylogenetic analysis and particularly with respect to feeding structures in both Cephalobina and Tylenchida in Baldwin et al., 2001,2004ab; Dolinski, Baldwin et al. 2001; Dolinski & Baldwin, 2003, Zhang & Baldwin, 2000a, 2000b, 2001. Molecular work on the broader context of Tylenchida is the basis for new questions on the monophyly of Tylenchida and Aphelenchina (classically considered sister taxa), with important implications for classification and the independent evolution of plant parasitism in these two groups (Baldwin et al., 2004). Within the broader phylogenetic context we have continued to address more focused taxonomic questions including the cyst nematodes, Heteroderoidea (Ferris, Baldwin et al. 2004), Pratylenchidae (Souza & Baldwin, 2000), Paratylenchus (Chau, Baldwin et al., 2004) and a molecular phylogeny of Criconematidae (Subbotin, Baldwin et al, submitted), while supporting outreach to the agricultural community (Baldwin, 2003). From these efforts we are now participating as part of a consortium (Baldwin, Nadler, De Ley, Thomas, Fitch; http://nematol.unh.edu/tree/tyl3.php) leading a subgroup with the immediate goal of developing molecular-morphologically based phylogeny within the Tylenchida.
Impact: Improved taxonomy of plant parasitic nematodes, supports applied management including regulation of exotic pests, implementation of crop rotation, and development/use of resistant cultivars; these are dependent on accurate, predictive identification. Molecular sequences, while primarily for phylogenetic classifications, include regions that are diagnostic for efficient species identification. Detailed morphology, developed for phylogenetic classification, clarifies misunderstood or misinterpreted features, thus supporting efficient species identification. Through-focus video vouchers, museum collections and online databases support research, training tools and outreach for agriculture. These investigations support promising novel approaches to management that are dependent on understanding/confounding particular gene pathways of pathogenesis. This work has demonstrated that certain non-parasitic

Cephalobina are a rational focus of comparison to discover genes specific to Tylenchida parasitism. This project points to patterns that provide new rationale to select model systems for the most efficient and predictive approach to genomics related to pathogenesis. Contrary to classical views, pathways understood for Tylenchida are not likely to be applicable to convergent pathogenesis is Aphelenchida, and pathways of pathogenesis in Meloidogyne are not likely conserved with cyst nematodes. Rather the emerging phylogenetic framework directs research to alternative more reliable extrapolations from models designed for novel environmentally sound approaches to pest management.

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: Root-knot nematode (Meloidogyne spp.) interactions with resistance in the host crops cowpea (Vigna unguiculata) and common bean (Phaseolus vulgaris) interactions were used to analyze genetic variability in nematodes for (a)virulence expression and stability. The resistance traits are being bred into advanced breeding lines and new varieties for use as new dry grain crops and also, for cowpea, as cover crops for root-knot nematode management. New resistance sources have been identified in each of these crop species that confer unique specificities that match avirulence genes in the nematode. UC researchers are studying the suite of Rk genes in cowpea that act differntially on populations of M. incognita and M. javanica. We determined from isofemale line studies that virulent field populations of M. incognita were comprised of virulent and avirulent lineages in this parthenogenetic species. The frequency of the virulent lineages matched the overall virulence level of the field population. By exerting selection pressure on these nematode populations by culturing them repeatedly on nematode resistant plants, the level of virulence increased rapidly. Increased virulence was achieved both by lineage selection and also by selection of new lines with virulence from lines initiated from avirulent females. Studies on the relative fitness of virulent and avirulent nematode isofemale lines indicated that nematode reproduction and female fecundity were associated with reduced fitness in some but not all virulent lines. Also, high extinction rates were found in virulent lineages. Comparisons of nematode hatching and root penetration rates were not different between virulent and avirulent lineages. The reduced reproductive fitness and extinction rates accounted for the progressive decrease in virulence to gene Rk during continuous culturing on susceptible host plants. 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). The segregating populations were cultured on susceptible bean plants for additional generations under greenhouse conditions. They will be used to determine the long-term fate of virulence in M. hapla. AFLP analysis revealed high levels of DNA polymorphism between the M. hapla parent isolates. Initially three AFLP polymorphisms were found to be linked to the (a)virulence locus and a search for additional markers is in progress for use in studying the segregation and stability of the virulence trait in the current plus additional populations.
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: Multistate Research and State
Scope of Impact: AR, AZ, CA, HI, MI, NE, NM, OR, WA, WY

Theme: 4.12 Integrated Pest Management
Title: Development of an IPM framework for implementation of methyl bromide alternatives into orchard and vineyard replant settings.

Description: The UC IIPM-based guidelines for replanting perennial crops without methyl bromide (MB) remain on-line and receive updating. Alternatives to MB are somewhat different for each different crop and create greater complexity for management. Sandier soils containing less than 12 moisture can be effectively treated with 1, 3-dichloropropene (1, 3-D). Prior to this work, nursery crops grown on clay loam soil could only be effectively treated with MB. Where soil moistures range between 12-15% one must rip the soil to 1.3m depth and then apply 280kg/ha 1,3-dichloropropene (1,3-D) at 65-75cm depth in addition to 280kg/ha at 45-50cm depth. The field surface must be covered with a plastic tarp or receive 110kg/ha metam sodium (MS) throughout the surface 15 cm. Lesser treatment rates will not guarantee nematode-free plants even for a 14mo nursery crop. The key requirement for treatment of clay loam soils is attachment of 2 delta wings on each shank to scrape soil into the chimney that remains after each shank passes through. The shanks are followed by the usual disc and cultipacker. At higher soil moisture contents, 15-19, the initial soil preparation must reach 1.6m depth and 1,3-D treatment rates increased to 370kg/ha from each of the two chisel ports on each shank. Application rates at the deeper chisel port can be substituted by the same application rate of chloropicrin. In orchard replant settings there is a 95 reduction of Meloidogyne incognita from roots 60 days after the tree trunk

receives a Roundup application. However, root dwelling life stages of Pratylenchus vulnus can be extracted from these roots 2 years later. If no other root-killing soil treatments are combined the value of Roundup is to provide significant relief from the rejection component of the replant problem. When Roundup is combined with soil fumigation the value of the Roundup treatment is hidden. Complete kill of walnut roots with Garlon provides 99 reduction of P. vulnus in old roots collected 9mo later. Five years later the soil dwelling populations of P. vulnus have finally achieved 95% reduction, still too many nematodes to be considered an alternative to MB. This nematode apparently achieves an inactive, non-feeding, cryptobiotic state. With walnuts the only occasion where significant growth improvement was due to Garlon was where the subsequent fumigation reached only 1.3m deep. In the absence of soil pests the plant growth benefits from Garlon plus one year of fallow were typically 85% of that achieved with MB. Against P. vulnus there was little benefit to a rotation crop of sudan grass compared to leaving the ground fallow except that sudan grass serves to dry the soil profile. A drench of sodium azide proved to be effective at 560kg/ha against nematodes as deep as 1.6m. However, this product does not adequately penetrate roots of walnut or grape and 1/3 of treated plants survive. A drench of Propylene oxide did not out perform sodium azide and a greater number of nematodes survived within roots and soil. Switching rootstocks from Nemaguard to Peach almond hybrid can remedy the rejection component.
Impact: There is greater complexity for the manager when soil fumigants cannot be used because all replacement tools are generally less effective. Loss of Methyl Bromide (MB) will shift interest to 1,3-dichloropropene (1,3-D), then to metam sodium (MS), and finally to some of the approaches being tested here. Grower assuredness declines as these transitions are made, largely because MB does a great job on 95% of occasions. To replace methyl bromide the use of 370kg/ha 1,3-dichloropropene will suffice for deeply dried, coarse-textured soils. Tree growth is further improved if 170 kg/ha of chloropicrin is also placed down each planting rows. In finer textured soils at higher moisture contents (12 to 15%) the treatment rates of 1, 3-D must be increased 50% or doubled where soil is 15-19% moisture. Broadcast applications in excess of 370kg/ha 1, 3-D have not been permitted in California since 1990 but we have found that shifting half the active ingredient to chloropicrin and placement at two different depths can perform if soil is properly prepared. Killing of old roots with Roundup or Garlon and waiting one year can remedy the rejection component of the replant problem but not the soil pest component. Any growth benefits using this tactic are less than that achieved from fumigation. MS can be a very useful product if properly applied; a difficult task for tree and vine growers. Additionally, Prunus spp do not grow well after MS unless there is a one-year wait before replanting or a completely different rootstock is chosen.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: Development of sustainable strategies to manage plant-parasitic nematodes

Description: Experiments were continued to evaluate the difference between tomato, melon and broccoli as a biofumigant source with respect to nematode control. Addition of chicken manure was included as a treatment. Results of this second set of experiments were similar to the first set, in that broccoli was more effective than the other two crops, at the intermediate soil temperature of 25C. Differences between crops at 20C or 30C were not significant. Addition of chicken manure enhanced control levels. Experiments in tubes filled with nematode-infested soil and with broccoli added at different vertical levels in the soil column showed that nematode numbers were only suppressed in soil layers where broccoli had been added. This would indicate that the role of volatile gases in the control of nematodes is limited. Experiments on the use of bio-rational in soil and in rockwool were continued. Particularly abamectin reduced nematode infestation in tomato in both substrates, even when used in a very low dosis. Experiments on the possible effects of mycorrhizal products on plant growth, and the resistance or tolerance of plants against nematodes were terminated. In none of the experiments, consistent significant effects of the use of mycorrhizal products were observed.
Impact: The UC research suggests that broccoli is more effective as a soil biofumigant than melon or tomato when used at moderate soil temperatures, and that addition of chicken manure can further enhance the control level. The use of mycorrhizal products to increase plant tolerance or plant resistance against nematodes does not appear warranted. Abamectin has strong nematicidal activity, even at low dosages, and has potential to be used postplant in nematode-infested crops grown in rockwool (no registration for this use, yet).

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: Nematode management in annual crops with emphasis on host plant resistance.

Description: Host plant resistance to root-knot nematodes (MELOIDOGYNE spp.) is being studied as a primary means of nematode management in annual field and vegetable cropping systems. Analyses of resistance genes are being conducted in carrot, cowpea, cotton, and lima bean. The Rk resistance gene in cowpea is a complex locus with multiple specificities to different nematode populations. Infected and non-infected roots of resistant and susceptible plants were harvested and used for preparing cDNA libraries during the period of resistance

expression, as an approach to develop markers for the Rk genomic region. Histological studies of resistant and susceptible infected and non-infected roots were made at several sampling times during the first two weeks after infection. Avirulent juveniles of M. INCOGNITA developed at least partially after root penetration, indicating that the resistance mechanism operates gradually over the two weeks following infection, unlike a classical, rapid hypersensitivity response. A series of near-isogenic lines in a blackeye cowpea background was produced by recurrent backcrossing, for use in comparing the value of each Rk gene form in protecting cowpea from nematode infection in field experiments. Field experiments were conducted comparing the four near-isogenic lines over a series of replicated inoculum densities of three nematode populations (avirulent and virulent M. INCOGNITA, and M. JAVANICA). Results of cowpea growth and nematode multiplication rates provided a relative index of the protective effect of each resistance gene, using regression analyses. Recombinant inbred lines developed from crosses between root-knot susceptible and resistant Lima bean genotypes were screened to determine the relationship of resistance genes effective against nematode reproduction on roots, nematode induced root-galling, or both. One Lima genotype was shown to be a donor of three resistance genes. A second lima genotype was found to possess two resistance genes based on analyses of recombinant inbred lines derived from the resistant x a susceptible genotype cross. These genes were highly effective against M. INCOGNITA and M. JAVANICA in greenhouse pot tests. A set of recombinant inbred lines from a cross of the two resistant genotypes is being developed to study the relationship between the two sets of resistance genes. Nematode infested field nurseries in the San Joaquin Valley of California were used again to advance one hundred and fifty breeding lines of fresh market type carrots with resistance to M. JAVANICA and M. INCOGNITA. Co-dominant flanking molecular markers for the Mj-1 resistance locus were used to screen progenies in a marker-assisted selection approach in carrot breeding. Analysis M. INCOGNITAFusarium wilt resistance in cotton was continued using crosses between resistant and susceptible genotypes of both pima and upland cottons. Both AFLP and microsatellite (SSR) molecular polymorphisms detected between resistant and susceptible genotypes were found to be linked to nematode resistance genes and are being used for mapping resistance genes in the cotton genome.
Impact: The identification and characterization of resistance genes in crop plants will lead to effective and safe approaches to managing root-knot nematodes by developing resistant varieties. The use of the resistance in crop production systems as alternatives to nematicides is aided by understanding the nature and specificity of resistance genes. Characterized resistance with genetic markers can be more easily selected for in breeding programs and deployed in cropping systems.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: PHYTOBACTERIOLOGY AND BACTERIAL DISEASE CONTROL

Description: Copper-resistant strains of Xanthomonas axonopodis pv. vesicatoria were previously shown to carry plasmid-borne copper resistance genes related to the cop and pco operons of Pseudomonas syringae and Escherichia coli, respectively. However, instead of the two-component (copRS and pcoRS) systems determining copper-inducible expression of the operons in P. syringae and E. coli, a novel open reading frame, copL, was found to be required for copper-inducible expression of the downstream multicopper oxidase copA in X. axonopodis. copL encodes a predicted protein product of 122 amino acids that is rich in histidine and cysteine residues, suggesting a possible direct interaction with copper. Deletions or frameshift mutations within copL, as well as an amino acid substitution generated at the putative start codon of copL, caused a loss of copper-inducible transcriptional activation of copA. A nonpolar insertion of a kanamycin resistance gene in copL resulted in copper sensitivity in the wild-type strain. Analysis of the genomic sequence databases shows that there are copL homologs upstream of copAB genes in X. axonopodis pv. citri, X. campestris pv. campestris, and Xylella fastidiosa. The cloned promoter area upstream of copA in X. axonopodis pv. vesicatoria did not function in Pseudomonas syringae or in E. coli, nor did the P. syringae cop promoter function in Xanthomonas. However, a transcriptional fusion of the Xanthomonas cop promoter with the Pseudomonas copABCDRS was able to confer resistance to copper in Xanthomonas, showing divergence in the mechanisms of regulation of the resistance to copper in phytopathogenic bacteria. In work on the soft-rotting bacterium, Erwinia chrysanthemi, a green-fluorescent protein-based in vivo expression technology leaf array was used to identify genes in the bacterium that were specifically upregulated in plants compared with growth in a laboratory culture medium. Of 10,000 cones, 61 were confirmed as plant upregulated. Putative functions were inferred from the nucleotide sequences of these genes when compared to genome databases. Mutations were constructed in five of the plant upregulated genes, and the mutants were tested for virulence. Several of the genes were shown to be important in virulence. In work on Xylella fastidiosa, a variety of plant species found near a severe outbreak of Pierce's disease (PD) of grapevines in the Temecula Valley of California were tested using enzyme-linked immunosorbent assay, culture on media, and polymerase chain reaction to identify potential inoculum sources in the area. Species that consistently tested positive for X. fastidiosa were the known hosts, grape, almond, and oleander, and two new hosts, Spanish broom and wild mustard. Sequence analysis of the 16S-23S rRNA spacer region found that strains isolated from grapevine, Spanish broom, wild mustard, and almond clustered with previously sequenced PD strains. Thus, these species could serve as sources of inoculum for infection of grapevines. Greenhouse transmission studies indicated that the glassy-winged sharpshooter was able to transmit a PD strain of Xylella fastidiosa to Spanish

broom, black mustard, and other hosts.
Impact: The UC work on copper resistance gene regulation helps us to understand the diversity of copper resistance systems in plant pathogens and the threat of this resistance to the continued success of copper bactericides for control of bacterial diseases on a variety of crops. The identification of virulence genes in Erwinia chrysanthemi is expected to provide new targets for strategies to intervene in the infection process for this and related plant pathogens. The identification of inoculum sources for Xylella fastidiosa has already led to changes in weed management practices in Temecula vineyards, to reduce the spread of the pathogen from weeds to grapevines by the glassy-winged sharpshooter.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: ETIOLOGY, BIOLOGY, EPIDEMIOLOGY, AND MANAGEMENT OF PRE- AND POSTHARVEST DISEASES OF FRUIT AND NUT CROPS IN CALIFORNIA

Description: In 2004 UC researchers continued our research on the biology, epidemiology, and management of pre- and postharvest diseases of fruit and nut crops in California. In our epidemiological studies they developed mathematical models that describe the development of almond anthracnose caused by Colletotrichum acutatum under specified environmental conditions. They also established disease progress curves for Alternaria leaf spot in several locations and over several years. These studies will help to improve the disease severity value (DSV) model currently being evaluated for this disease. Both anthracnose and DSV models will be used for disease forecasting for improved fungicide timing and disease control of almond. As a component of integrated disease management they evaluated the efficacy of new `reduced risk' fungicides and provided data that supported registration and use patterns of these materials on tree crops for management of foliar diseases with emphasis on brown rot. In simulated rain studies they identified materials that are also very effective under highly conducive disease conditions. Evaluation of pre-and post-infection activity of the new fungicides led us to design a delayed bloom spray program consisting of a single application when disease conditions are less conducive, whereas for more conducive conditions a second application is still recommended. For preharvest disease control, they also evaluated fungicide mixtures and rotations to prevent the development of resistant pathogen populations against single-site mode of action materials. For postharvest management of fruit decays they continued to identify new outbreaks of diseases such as sour rot of stone fruit caused by Geotrichum candidum. Currently they are studying the epidemiology of this disease and ways to manage it through pre- and postharvest sanitation and fungicide programs. They also continued to develop `reduced risk' fungicides for different decays of stone

and pome fruits, citrus, kiwifruit, and pomegranates. This involved determining the spectrum of activity and evaluating compatibilities with sanitizers and fruit coatings. Application methods were optimized to improve fungicide coverage, levels of residues, and to make applications cost-effective. A major outcome of this work was the registration of fludioxonil and pyrimethanil on citrus and pome fruits and fenhexamid on kiwifruit in 2004. Additional materials that we identified will be registered in the near future. Baseline sensitivities for selected pathogens to new fungicides were established and will provide an important comparative measure in future monitoring programs for resistance. The spiral gradient dilution method that we previously developed to rapidly and accurately determine 50% inhibitory concentrations for mycelial growth or spore germination has been advanced into an air-sampling procedure. This now allows them to evaluate representative sub-samples of populations of fungal pathogens with abundant spore production (e.g., Penicillium species) for their fungicide sensitivity on a single agar plate. As another improvement of this method, they designed a semi-selective agar medium for Penicillium species on citrus.
Impact: This project is continuing to serve the fruit industries of California and the United States by studying the etiology of fruit decays and the biology of postharvest pathogens, as well as by providing new postharvest treatments to reduce crop losses. A major focus of the research has been on the simultaneous development and introduction of new fungicides that belong to different classes with different modes of action. Aspects of fungicide resistance management have been integrated early on in the research. Thus, mixing and rotation practices between the different classes are being developed. In addition, they are providing critical information on baseline fungicide sensitivities in fungal pathogen populations that was obtained using a new method that was developed in their laboratory. In the preharvest disease research they are identifying the most effective chemicals. Highly efficacious and cost-effective management programs are being developed based on mathematical models derived from biological and epidemiological aspects of the diseases.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: ECOLOGY, EPIDEMIOLOGY, AND CONTROL OF ROOT-INFECTING FUNGI ON CROPS IN IRRIGATED DESERT AGRICULTURE

Description: Over the past 6 years, we have identified Macrophomina phaseolina as one of the causes of vine decline of melons in the San Joaquin, Coachella, Imperial and Palo Verde Valleys. Although the disease does not occur every year in every field, it can be very destructive when it does occur. Our objectives were to determine the onset, location and progression of plant infection by Macrophomina phaseolina over the spring growing season, to evaluate the

efficacy of fludioxonil and thiophanate-methyl applied immediately after seeding for the control of charcoal rot of melons caused by Macrophomina phaseolina and to assess the occurrence and rapidity of pathogen reproduction in roots and stems of melons at the end of the growing season. Results: Macrophomina phaseolina was first isolated from roots from 4% of plants sampled 14 days after planting. By 21 and 28 days after planting, roots from 86 and 100% of the plants sampled, respectively, were infected. The fungus was also isolated from 48, 53 and 81% of the crowns of plants sampled 21, 28 and 77 days after planting, respectively. Microsclerotia were first observed on roots of plants (2.6%) sampled 91 days after planting and increased to 93.1% on roots of plants sampled at crop termination (i.e., 105 days after planting: June 30, 2004). Stem symptoms (lesions and/or microsclerotia) were first observed on 6.7% of the plants sampled 91 days after planting and increased to 87.5% of the plants sampled at crop termination. Canopy collapse occurred 98 day after planting. Infection of stems by Macrophomina phaseolina originated both from root infections as well as direct infection of stems from inoculum at or near the soil line. Percentage of crowns infected by Macrophomina phaseolina approximately 30 days after planting were lower in plots treated with either Topsin M or Scholar than crowns from nontreated plots but the differences were not statistically significant. At crop termination, no significant differences were recorded in the percentage of crowns colonized by M. phaseolina between any of the treatments. Within one week after the foliar application of either Roundup or Ginstar, the percentage of stems with microsclerotia of M. phaseolina were significantly higher in chemically-treated (86.7%) compared to nontreated (6.7%) plants.
Impact: Data indicates that management strategies for the control of charcoal rot of melons needs to be implemented as soon as possible after planting. Data also shows that the pathogen reproduces in infected plant tissue occurs primarily at the end of the growing season. Thus,destruction of crop residue as soon as possible after harvest is recommended in order to inhibit pathogen reproduction. The use of herbicides to accomplish that objective is, however, not recommended because they actually stimulate pathogen reproduction.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: Signaling Pathways that Control Virulence in Fungal Plant Pathogens

Description: Previous work from our laboratory and others has implicated heterotrimeric G protein signaling pathways in fungal development and virulence. Our project is focused on the identification and characterization of cell surface G protein coupled receptors (GPCRs) in the filamentous fungus Neurospora crassa. Our progress during the past year for each objective is detailed below. Objective 1: We have now created gene replacement mutations in six GPCR genes--two

pheromone receptors (pre-1 and pre-2), one putative glucose sensor (gpr-4) and three GPCRs (gpr-1, gpr-2 and gpr-3) with similarity to cAMP receptors from the protist slime mold Dictyostelium discoideum. Objective 2: We have performed phenotypic analysis on all six GPCR mutants. The two pheromone receptor mutants exhibit mating-type specific female sterility. The sterility stems from defective chemotropism of female mating-specific hyphae (trichogynes) towards male cells (conidia) of opposite mating type, a function required for fertilization. The gpr-4 mutants have significantly less mass than wild type when cultured on poor carbon sources. It was previously determined that gpr-1 mutants have defects in perithecial (fruiting body) formation that follows fertilization and meiosis. Phenotypic analysis of gpr-2 and gpr-3 mutants is ongoing. We are in the process of measuring levels of G protein subunits in all GPCR mutants. Objective 3: Mutants lacking both pheromone receptors have been constructed. pre-1 pre-2 mutants are male fertile, but female-sterile in both mating types. We have created mutants lacking the gpr-2 and gpr-3 genes and are characterizing these strains for phenotypes. A gpr-1 gpr-2 gpr-3 triple mutant is being constructed. Objective 4: We are in the process of constructing strains containing all combinations of both a GPCR and Galpha gene mutation. We are making the appropriate vectors to determine whether GPR-4 and one of the Galpha proteins interact in the yeast two-hybrid assay.
Impact: Fungi are important pathogens of plants, and it is of fundamental importance to understand how pathogenic fungi recognize and then damage plant tissues. We are characterizing cell surface proteins in fungi that are important for fungal development and that have also been implicated in mediating early responses of fungi to plants. Once the proteins and the molecules that bind to them are identified, it should be possible to develop novel inhibitors that would block the ability of the fungus to detect and/or invade plant tissue, thus combating disease and increasing crop yield.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: Integrated Management of Diseases in Floriculture and Nursery Crops

Description: Powdery mildew caused by fungi in the genera Erysiphe, Golovinomyces, and Podosphaera is a major yield-robbing disease on delphinium, a popularly grown cut flower. In 2004, we determined in field experiments that powdery mildew severity was lower in double (8 plants per square meter) than in single (4 plants per square meter) rows because leaf wetness duration was greater in the higher plant density. Another popularly grown cut flower is lisianthus. Gray mold caused by Botrytis cinerea causes considerable yield losses in lisianthus production. We demonstrated efficacy of various fungicides in controlling gray mold on lisianthus in a commercial greenhouse. We evaluated several techniques for detecting

resistance to B. cinerea in lisianthus cultivars and identified susceptible and moderately resistant cultivars. We have combined an airflow system we developed in 2003 with plastic mulch to control gray mold on lisianthus in a commercial greenhouse. This modified system is much more effective in controlling gray mold on lisianthus than the airflow system alone. In four fungicide trials we carried out in partnership with growers, we identified fungicides and fungicide rotation schemes that are effective in controlling powdery mildew on roses, downy mildew on limonium, and Alternaria leaf spot on alstroemeria. We also demonstrated efficacy of various adjuvants in enhancing performance of fungicides used to control downy mildew on limonium. In work initiated in late 2003 on mitigation of plant pathogens in recycled water in nurseries, we started by testing container media at the point of reuse of recycled water. We have demonstrated that coir (coconut mesocarp pith) used as a container medium has anti-pathogen properties. Coir extracts inhibited growth of Phytophthora capsici and B. cinerea in vitro. We demonstrated that microorganisms associated with coir have a strong inhibitory effect on P. capsici in vitro. In the greenhouse, potting medium amended with coir reduced populations of Fusarium which causes crown and root rot on gerbera. We are growing gerberas in the coir-amended media to determine if coir can reduce crown and root rot. Occurrence of new diseases on floriculture and nursery crops is of major concern to growers. We observed for the first time occurrence of downy mildew caused by Peronospora obducens on impatiens in California. We also observed for the first time an association between field-grown delphinium and an ascomycetous fungus.
Impact: Identification of fungicides and adjuvants that are effective in controlling diseases of floriculture and nursery crops will enable growers to more effectively control these diseases. Adoption by growers of disease management strategies such as resistant cultivars, row culture, and an airflow/plastic mulch system that do not involve input of pesticides into the environment will result in environmental and human health benefits. Use of effective fungicide rotation schemes will prevent or slow down fungicide resistance buildup among pathogen populations. Cultivars identified to have disease resistance can be used as germ plasm in resistance breeding programs. Information on new diseases will stimulate research on development of effective management strategies.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: Management of Arthropod Pests Impacting Perennial Fruit and Nut Crops in California's Central Valley

Description: 1) Adult olive fly (OLF)(Bactrocera oleae) densities in San Joaquin Valley olive groves dramatically decline in summer when temperatures exceed 35 C.

Laboratory studies showed that at 37.8 and 40.6 C, survival of adult female flies declined to 0% after 24 hours if no water or honey-water (50%) are available. Access to both water and honey-water greatly improves survival (>75%) over 5 days. Access to olive fruit does not aid survival. Access to water alone resulted in > 75% mortality at temperatures > 35 F after 3 days exposure. Caged-field tests in Sept 2004 showed that OLF survival was similar to that in the laboratory with greater than 80% mortality in OLF adults after 4 days when only water was available or no access to water and honey-water was permitted. Preliminary analysis of summer temperature data from the San Joaquin and Sacramento Valleys suggests that lower frequencies of 3- and 5-day sequences of high temperatures (i.e., > 37 C) in the latter verses the former valley may result in greater survival of OLF adults. 2) Field longevity of the fruit fly pesticide bait GF-120 (with Spinosad) was evaluated for OLF suppression under varying climatic conditions. Results suggest that GF-120 residues may remain toxic (>75% mortality) to adult females as long as 21 days post-treatment under high summer temperatures. A solution of 4 parts water to 1 part GF-120 decreased in toxicity much faster than a solution of 1.5 parts water to 1 part GF-120 when residues were tested after 21 days field exposure. 3) Eight parasitoid species were imported and held in quarantine as part of a classical biological control program for OLF. These were evaluated for host specificity range. Besides OLF, parasitoids were offered black cherry fly (Rhagoletis fausta), apple maggot (Rhagoletis pomonella), Cape Ivy fly (Parafreutreta regalis), and yellow star thistle fly (Chaetorellia succinea). Only one natural enemy, Psyttalia lounsburyi (Hymenoptera: Braconidae), confined its attacks and reproduction to OLF. 4) Techniques were refined for monitoring active immatures and adult tenlined June beetle (Polyphylla decimlineata). Light trap counts suggested that adult beetles found in almond orchards decreased dramatically in 2004 compared to 2003. Adult females were less frequently captured in light traps than adult males with ratios of beetles (males: females) captured ranging from 6:1 and 96:1. Sampling of beetle grubs in the soil revealed that grubs were mainly found adjacent to almond roots in orchards with bare floors. Mechanical sifting of excavated soil dramatically improved discovery of grubs within the soil. Additionally, soil sifting revealed the presence of cocoons and adults of the scoliid parasitoid Campsomeris pilipes from 15 to 46 cm below the soil surface. 5) The feeding of glassy-winged sharpshooter (GWSS)(Homalodisca coagulata) adults is dramatically impacted by temperature. Preliminary results indicate that feeding is severely reduced when temperatures are at 10 C. Given this and the low temperatures commonly occurring in the San Joaquin Valley, overwintering survival of GWSS could be signficantly impacted through much of the valley.
Impact: 1) Olive fly (OLF) poses a great economic challenge to table olive growers in California's Central Valley because it requires weekly applications of bait insecticide from June to September. Refinement of control methods and adoption of alternative controls could bring significant economic benefits to growers via reduced management inputs. If the impacts of high summer temperatures on adult OLF populations can be accurately predicted in areas where high maximum

temperatures (>37 C) frequently persist for several consecutive days, growers may be able to halt insecticide applications for 1 to 4 weeks or more until temperatures decrease in early Fall. 2) Findings on the efficacy of aged GF-120 residues may allow growers to reduce the numbers of treatments applied during the season, thereby cutting management costs. 3) The establishment of an effective parasitoid of the OLF would lead to reduced pesticide costs in some areas and the reduction in OLF populations in untreated urban and roadside ornamental olive trees. 4) Effective and simple monitoring of tenlined June beetle (TLJB) will enable growers of almonds and other susceptable crops (cherry, walnut, etc.) to detect early infestations of TLJB before crop productivity is economically impacted. 5) Understanding the impact of winter climate on glassy-winged sharpshooter (GWSS) populations in the Central Valley will allow management efforts to be focused on problem areas where GWSS survival will be highest in the springtime. This will reduce the need to chemically treat areas where overwintering GWSS mortality is heavy.

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: Research was conducted in 2004 on various aspects of rice water weevil (RWW) and armyworm biology and control. Studies were continued in ring plots to evaluate experimental materials versus registered standards for RWW control and to modify the use patterns of the existing product to facilitate management. Three experimental insecticide active ingredients, etofenprox, dinotefuron, and indoxacarb, were tested for the first time against RWW in California in 2004. Etofenprox and indoxacarb, both applied at the 3-leaf stage, were very effective for RWW control; dinotefuron was not effective on RWW. Research continued on thiamethoxam, gamma-cyhalothrin, and F0570 as soil-applied, post-flood and post-flood treatments, respectively. All three of these products provided very good RWW control. Warrior applied as a soil treatment, was effective with applications made at 10, 6, 3, and 0 days before flooding. Gamma-cyhalothrin and F0570 applied preflood at 1 day before flooding also provided excellent RWW control. A study was continued to evaluate the effects of registered (Warrior, Dimilin, and Mustang) and experimental insecticides (etofenprox, dinotefuron, thiamethoxam, and Warrior pre-flood) on non-target invertebrates in rice fields. These organisms could play an important role in mosquito management; this area has taken on added importance with the emphasis on West Nile Virus in California. Preliminary data from 2004 showed that the preflood insecticide treatments appeared to have had minimal effects on the total number of invertebrates. Post-flood applications were more detrimental to

numbers of invertebrates with all five treatments reducing numbers for the first 2 weeks after application. In 2003, populations of total invertebrates were suppressed by the preflood treatments until early July (about 6 weeks) and by the post-flood treatments until mid-August (Dimilin had less effects than the other treatments). The Warrior application made in July (armyworm timing) was particularly harmful to invertebrate populations. The effects of the insecticides on beetles were significant; however, on segmented worms, none of the treatments had any consistent detrimental effect on populations. RWW flight in 2004 was very low and the flight occurred very early and was completed by 3 May. Armyworms have developed into significant pests of rice during the last ~5 years and in some areas a mid-season insecticide treatment for this pest is common. Rice is an extremely important agricultural commodity in several northern California counties. The aquatic nature of the rice agroecosystem, and its proximity to the Sacramento River drainage system and San Francisco Bay, dictates that pest management practices be designed with extreme caution. Several insect pests can cause substantial damage and yield loss in rice. This research resulted in control measures utilizing cultural and chemical measures that minimize damage from insect pests while protecting environmental quality.
Impact: The relationship between weed populations and armyworm levels was studied; results showed a trend for fewer armyworms in plots with weeds controlled vs. plots with high levels of weeds. Pheromone traps were used to gain insights on the timing of armyworm moth flights in correspondence with larval populations. Armyworm moth captures peaked in early-mid Aug. and peak larval populations occurred on 24 Aug. In summary, it does appear that the use of pheromone traps could provide a forewarning of the time sampling needs to be intensified for armyworms in rice fields.

Funding Source: 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: Material on three initiatives was published this year. The first concerns arbovirus surveillance and the role of mosquitoes in the transmission of West Nile (WN) virus. As part of the California surveillance program, UC researchers tested specimens from humans, equines, mosquitoes, sentinel chickens and dead birds for evidence of mosquito-borne encephalitis virus activity. Results were reported by the California Department of Health Services to mosquito and vector control districts and were used to make decisions about application of mosquito control programs. They were also was part of a team that determined by assaying horse sera that horses in California were commonly infected with arboviruses (i.e., Bunyaviruses) prior to 1998, but there was no evidence of equine St. Louis virus infections. From this they predicted that WN virus will have a wide distribution when it is fully

established in California. Concerning mosquito research, our results on vertical transmission of WN virus indicates that mosquitoes infected vertically (from mother to her progeny) in the fall could serve as a mechanism for WN virus to survive in the winter when mosquitoes are inactive and then rapidly initiate virus transmission the following spring when mosquitoes become active and start biting again. The second initiative concerns the use of genetically modified mosquitoes to interfere with or prevent transmission of pathogens. In a series of computer simulation studies they concluded that understanding ecological factors is critical for designing transgenic vector-borne disease control strategies. Specifically, we determined that release of genetically modified mosquitoes into natural populations with age-structure will be difficult and depending on the circumstances may not be economically or logistically feasible. The third initiative concerns new ways of estimating the chronological age of mosquitoes. In a series of field studies we developed and validated new models for estimating a mosquitos age that will be useful for epidemiological studies and for assessing the impact of mosquito control interventions on disease prevention.
Impact: Results from their studies on vertical transmission of WN virus and arbovirus surveillance in California are directly relevant to improved arbovirus surveillance and mosquito control for prevention of arbovirus transmission. Their studies on genetically modified mosquitoes provide a theoretical and empirical basis for the development of novel mosquito control and disease prevention programs. Their application of age-grading methods to wild mosquitoes allows one, for the first time, to determine the age distribution of natural mosquito populations, which will be a powerful new tool for assessing the effectiveness of mosquito control programs.

Funding Source: Animal Health and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: CONTROL OF CULEX DISEASE VECTORS OF CALIFORNIA

Description: This past year progress on pyrethroid resistance surveillance and identification of resistance mechanisms in the major West Nile virus vector was made. Populations of C. pipiens s.l. with low frequency of individuals resistant to permethrin were found in several locations throughout California. Of more concern, two populations, in the vicinity of Fresno and Yubba City were more resistant, where 20% or more of the mosquitoes survived 3 hours of continual exposure to permethrin. In most instances resistance was due to presence of the sodium channel gene allele that lowers sensitivity to pyrethroids. A few mosquitoes also survived pyrethroid exposure by recovering after being knocked down suggesting presence of enzyme mediated resistance. Both these populations were found in areas close to high agricultural use of permethrin and low use of permethrin by mosquito abatement district. <p> The presence of

Glutathione, S-Transferase mediated resistance specifically targeting lambda cyhalothrin was found in a colony of Cx. pipiens pipiens mosquitoes originally established from individuals collected in Marin County. An assay for detection for the presence of this GST mediated resistance is currently being developed. This will enable us to monitor for the presence of this mechanism of resistance in areas of high lambda cyhalothrin use in California. Coloremetric and fluorescent tagged substrates for detection of mixed function oxidase and esterase mediated detoxification of pyrethroids were developed. Work has now begun using these substrates to molecularly and biochemically target isolation and characterization of the appropriate detoxifying enzymes from the complex of these multiple functioning enzymes in mosquitoes. <p> Photomaps of salivary gland polytene chromosomes were made from two populations of Cx. pipiens quinquefasciatus. An in situ hybridization technique for physically mapping locations of DNA clones was developed. This work will allow us to now effectively lobby for funds to continue into phase II of the Culex pipiens quinquefasciatus entire genome sequence initiative that will require physically mapping sequenced tagged DNA clones to annotate the genome library. This past year an array of 10 polymorphic microsatellites were isolated and then selected that will be used in a detailed population genetic study to examine the population structure of members of the Culex pipiens complex to more clearly define the members of this complex that are vectors of West Nile virus. <p> Gravid traps loaded with infusions of Bermuda grass and Rabbit chow were found to be more efficient than traditionally used carbon dioxide baited traps in collection of members of the Culex pipiens complex in urban and rural environments. However, the gravid traps were significantly less efficient than CO2 traps in collection of Culex tarsalis which is another major vector of WN virus in California.
Impact: Resistance to pyrethroids in a major West Nile virus vector, Cx. pipiens s.l. in California was found widespread in California. In the interest of maintaining an effective mosquito adulticide program everyone needs to be ever vigilant about monitoring the spread of resistance so that resistance management strategies can be applied before high level resistance arises. Tools such as polytene chromosome analysis and microsatellite markers now open many opportunities for conducting detailed studies to examine the systematics and population structure of the Cx. pipiens complex mosquitoes which are major vectors of WN virus in the USA. The UC studies on gravid traps will result in significantly more mosquito abatement districts incorporating use of gravid traps in their arbovirus surveillance efforts. Gravid traps will be more efficient than currently used CO2 baited traps for detection of WN virus in Cx. pipiens mosquitoes in California.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: INTEGRATED PEST MANAGEMENT OF INSECTS IN AND AROUND

STRUCTURES

Description: Liquid baits were tested for delayed toxicity against Argentine ants, Linepithema humile. Baits that provided 50% kill of workers between days 1 and 4 were considered to have delayed toxicity. Baits containing 1% boric acid, 5 x 10-4 to 5 x 10-3% imidacloprid, and 1 x 10-5 to 1 x 10-3% thiamethoxam had delayed toxicity. Two different liquid bait delivery systems were tested with 1 x 10-4% thiamethoxam + 25% sucrose bait in citrus groves. Water evaporation from bait stations was determined for each device and represents a major problem for some baits. Stations with large capacities (1000 ml) reduced the amount of maintenance and labor required to service them. Both bait stations provided good control of ants over 3 months. The potential effectiveness of insecticide barriers applied as perimeter against Argentine ants was evaluated. The horizontal transfer of bifenthrin, B-cyfluthrin, and fipronil from Argentine ants exposed to treated surfaces to non-exposed nest mates was determined. Fipronil was readily transferred from one ant to another. Brief exposures to bifenthrin and B-cyfluthrin provided rapid knockdown and kill to donor ants and less was transferred to nest mates. Thus, there was little horizontal transfer. Three formulations of granular fipronil and a bait treatment of pyriproxfen followed by hydramethylnon baits were compared against red imported fire ant, Solenopsis invicta. In areas with heavy irrigation of golf course, the fipronil granules provided significantly better control than did the pyriproxyfen bait. A world-wide monitoring of cat flea populations, Ctenocephalides felis, for physiological resistance to imidacloprid (Advantage) is ongoing. Last year, about 125 field-collected isolates were tested. All of the strains tested were susceptible.
Impact: Argentine ants are a major pest species in agricultural, urban and natural environments in California. In the past, the primary control recommendation has been the broadcast application of insecticides. However, data supports the limited applications of fipronil sprays to trails and nesting sites because the transfer of fipronil from treated surfaces to ants and the subsequent horizontal transfer to unexposed nest mates resulted in significant kill of worker ants. Limited treatments reduces the amount of insecticide applied around structures. In addition to killing workers, ant baits target the immature and reproductives in the colonies. Low concentrations of thiamethoxam and imidacloprid provided delayed toxicity and kill of Argentine ants. Field studies confirmed that 1 x 10-4% thiamethoxam + 25% sucrose water provided excellent control of Argentine ants. Fipronil granules applied to lawns and grass fairways on golf courses to control red imported fire ants provided outstanding control. This is especially important because these landscapes are typically watered several times a day in the summer reducing the effectiveness of most treatments.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: BIOLOGY AND CONTROL OF STRUCTURAL INSECT PESTS

Description: The effects of hexaflumuron consumption on the mortality of western subterranean termites, Reticulitermes hesperus, were determined using substrates treated with14-C-labeled hexaflumuron. Uptake was rapid and peaked at about 280 ng per termite 12 days after exposure. Termites began dying at day 8 and 96% were killed by day 45. Excretion of hexaflumuron was rapid, half-lives ranging from 2.1 to 4.7 days. Trophallaxis was efficient between workers and colony members. Alternate food sources inhibit the movement of hexaflumuron. Movement of hexaflumuron by cannibalism and coprophagy were only significant when termites were starved. In addition to killing workers, hexaflumuron affected egg development. Western subterranean termites prefer papers treated with various mono-, di-, and trisacchrides. Papers treated with 5% ribose, 3% xylose, 2% maltose, 2% fructose, 2% arabinose, and 2% ribose were preferred. In choice tests, the termites were unable to differentiate between the sugars. In a feeding study with 14-C labeled sucrose, most of the sucrose consumed was used as an energy source (89.2%). About 9.2% remained in the termite tissues and only 1.5% was excreted. The sugars act as a phagostimulant, but are in much higher concentrations encountered by termites in natural conditions. Their use in baits may increase consumption and retention at bait matrices. Urbanization patterns in the southwest have dramatically expanded the range and prevalence of the western drywood termite, Incisitermes minor. Changes in building practices, building materials, and commerce have contributed to the spread of drywood termites. This increasing problem has already changed the control practices and pest control industry in the southwest.
Impact: The radio-labeled feeding studies with hexaflumuron help explain the variable efficacy of hexaflumuron baits in the western United States. The difficulties in bait presentation (low foraging activity, poor bait station foraging fidelity) inherent in the western subterranean termite are compounded by the rapid excretion of hexaflumuron. Clearly better bait matrices and feeding stimulants to retain termites at bait stations and increase their feeding are needed. Several carbohydrates act as feeding stimulants could be incorporated in to baits to increase consumption.

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: 1. UC researchers have shown that transposable elements placed into the mosquito Aedes aegypti through the process of genetic transformation become relatively immobile. This is consistent with the post-integration behavior of the mariner

transposable element in transgenic Drosophila. The mechanism by which this inactivation occurs is unknown. It is not thought to be due to integration into heterochromatin since several of the transposable elements have clearly integrated into euchromatic DNA. While inactivation of movement is ideal for the construction of stable genetic strains, subsequent movement of these elements is required for several genetic control strategies envisaged for mosquitoes that are based on population replacement. The basis of this inactivation remains to be investigated. One possibility is localized silencing of the incumbent transposase either through methylation or through an RNA-mediated silencing pathway. 2. They have shown that transgenesis of mosquitoes can come with a cost of genetic fitness. This is of concern for all insect genetic control programs since insect genotypes generated for the purpose of genetic control need to efficiently compete with field insects in order to pass their genes into subsequent generations. This is critical for population replacement strategies and even for sterile insect technique strategies in which the released insects must be competitive upon release. Their studies used established parameters for measuring fitness and applied them to several transgenic lines of mosquitoes. The decrease in fitness observed in all of them indicates that, at least in these lines, there is a fitness cost to transgenesis. The magnitude of this cost needs to be overcome in order for insect genetic control strategies using transposable elements to be effective. 3. They identified, isolated and characterized a new transposable element, Herves, from the malaria mosquito, Anopheles gambiae. Herves is functional, as shown by the ability to use this as a gene vector in Drosophila, and is the first functional class II transposable element isolated from this important mosquito vector of malaria. Herves may well prove to be useful in efforts to develop gene vectors in Anopheline vectors. Preliminary studies show that Herves is present in field populations of Anopheles in Africa and is in disequilibrium in them, suggesting it is currently active. 4. We participated in the determining that the Hermes transposable element excises and transposases via a mechanism that is very similar to that used by the human Rag recombinases in the generation of immunoglobulin genes and T cell receptor genes in developing B and T lymphocytes. This links extant transposable elements with this process of V(D)J recombination and so opens up the possibility of using these insect transposable elements to study aspects of this vertebrate recombination pathway required for the development of the acquired immune system. Interestingly there is evidence that aberrations in V(D)J recombination can lead to the development of some blood cancers.

Impact: THeir work on insect transposable elements used for the transformation of economically and medically important insects provides a sound basis for the future application of genetics to contemporary problems in agriculture and medicine. These will not rely on the use of chemical or viral insecticides and will be specific to the target species. The researchers' goal is to develop these transposable elements as gene vectors by understanding how they function both in the insect and in vitro. Their studies in 2004 have increased the understanding of these elements through linking them with the important process of vertebrate V(D)J

recombination. This has enabled them to extrapolate between these this recombination process and transposition and, in doing so, we have gained insights into the function of Hermes in insects. In addition their bioinformatics studies have enabled them to isolate the first functional transposable element from a mosquito species. This transposable element may well form the basis of future genetic control strategies in mosquitoes.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.12 Integrated Pest Management
Title: MOLECULAR BASIS OF EGG DEVELOPMENT IN MOSQUITOES

Description: Mosquitoes generate an enormous burden on human health worldwide. Disease-transmitting species utilize a reproductive strategy termed anautogeny that requires a blood meal to initiate egg maturation. The molecular mechanisms underlying this phenomenon are poorly understood. A central event in egg maturation is vitellogenesis, the production of yolk protein precursors. These proteins are synthesized in the fat body, the insect analogue of the vertebrate liver. Mosquito vitellogenesis is regulated by the steroid hormone ecdysone. However, ecdysone alone is not capable of activating vitellogenesis. The most significant finding of the reported grant period is the discovery that amino acids signaling through the nutrient-sensitive pathway is essential for the activation of yolk protein precursor genes. The amino acid extracellular level, similar to the increase observed after a blood meal, is critical for ecdysone stimulation of yolk protein precursor genes. UC researchers used an approach, called RNA interference, to selectively inactivate two key participants of the nutrient-sensitive pathway, TOR and TSC2. Knockdown of TOR inhibited amino acid stimulation while knockdown of TSC2, a negative regulator of TOR signaling, resulted in enhanced yolk protein gene expression. Thus, amino acid-based nutrient-sensitive signaling regulates the activation of egg development after a blood meal, an adaptation to the unique life-style of mosquitoes. Future plans are to carry out research as outlined in the last competitive proposal. In particular, the intracellular signaling pathway connecting amino acids and yolk protein gene activation will be investigated. Their preliminary data have implicated insulin pathway in vitellogenic events and this pathway will be investigated.
Impact: The mosquito reproductive cycle is a fine tuned system permitting mosquitoes to thrive in a variety of strenuous environmental conditions. In mosquitoes that serve as vectors of diseases of humans and domestic animals, the female reproductive system becomes active only after a blood meal. Anautogenous mosquitoes are efficient disease vectors because they require frequent host contacts for blood feeding. It is therefore of importance to gain an understanding of the molecular mechanism underlying the phenomenon of blood feeding as required for reproduction and integrate this knowledge in the development of

future vector- and vector-borne disease control strategies. UC researchers made a breakthrough observation that amino acids are a principal signal initiating vitellogenesis and egg maturation in blood-feeding mosquitoes. This signal is transduced by the nutrient-sensitive pathway. Evidence suggests that in response of amino acids originated from the blood this pathway causes the mosquito female fat body to shift from the pre-blood feeding state of arrest to post-blood feeding activation of yolk protein genes. In turn, this mechanism permits the ecdysone to up-regulate Vg gene expression to the extremely high levels required for successful development of eggs. Thus, their work has uncovered a mechanism underlying the arrest and blood meal-activation of vitellogenesis, a key event in reproduction in disease harboring mosquitoes. This discovery is expected to have a significant impact on the future development of novel anti-mosquito control strategies.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.13 Land Use
Title: CENTRAL VALLEY FARMLAND TRUST

Description: Prime farmland is disappearing at an alarming rate all across the nation and the problem is especially acute in the San Joaquin Valley. Both farmers and local governments need more effective tools for preserving prime farmland. There is considerable interest among farmers in starting farmland trusts, but the technical obstacles are numerous. Working with a group of interested farmers, Merced County CE gave technical assistance in organizing a farmland trust for the county, and later for the north San Joaquin Valley - providing a significant amount of personal and institutional expertise to the founding and development of the Merced County Farmland and Open Space Trust and later the Central Valley Farmland Trust. A CE Farm Advisor developed the criteria and chaired the technical committee that developed priorities for areas that needed protection. He developed the procedures by which applications from farmers wishing to protect farms are evaluated, and wrote the first fund-raising letter to solicit funds for operations. A UC Cooperative Extension public policy specialist, and experts from the American Farmland Trust, consulted with the local team which developed the Merced trust's organizational structure and operational procedures. The Merced group later collaborated with groups from Stanislaus, San Joaquin and Sacramento counties and, with assistance from the Great Valley Center, established the Central Valley Farmland Trust.
Impact: The Central Valley Farmland Trust is fully operational and working to expand its capacity to serve area farms. As of September 2005, 142 acres of orchard land, 630 acres of field crop land and 7,389 acres of range land have been protected in Merced County and projects are pending in the other counties. The number of applications by growers who would like to place their farms into the trust has increased. Town hall meetings have been held in local communities around the Valley to brief farmers about the program. Memberships in the Trust also have

increased, indicating better awareness and support in the community. All of the farms that have entered the program are still in production agriculture today.

Funding Source: Smith-Lever 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.
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 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: When flowers were removed from buckwheat or Alyssum plants associated with broccoli in intercropping designs, densities of immature aphids increased dramatically in relation to densities on broccoli intercropped with intact flowering plants. Aphid populations also increased when randomly selected broccoli plants (20 plants in plot containing 400 plants) growing in an organically managed field, where fertilized with a chemical N fertilizer. In such plants immature aphid densities grew rapidly compared to densities in neighboring organic plants in the same field. In plots where broccoli plants were mulched with barley straw, a practice that conserves soil moisture, the crops grew larger, yielded more and

experienced less aphid infestation levels than plants growing in plots with bare ground (no mulch). Such trends were even more marked in mulched plots where broccoli was intercropped with favabeans or mustard.

Impact: Lowering aphid populations in broccoli plants through intercropping with flowers and/or applications of mulch seems a viable approach to 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: Integrated use of prescribed burning and clopyralid for yellow starthistle control and optimum rangeland health

Description: 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). 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 (percent 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 percent. In Yuba County, this treatment increased medusahead (Taeniatherum caput-medusae) cover from 12 to 19 percent. 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. The 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 percent cover in both sites. This combination also reduced ripgut brome and medusahead cover in Yuba County. Prescribed burning stimulates yellow starthistle germination the following winter, thus rapidly reducing the starthistle seedbank and increasing the efficacy of a subsequent clopyralid treatment. In 2001-2002 we 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 percent compared to the adjacent untreated plots. 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, we demonstrated that clopyralid toxicity in Fowlers toad was low. A wide safety margin was shown when used under field conditions. Monitoring of clopyralid drift following aerial application demonstrated that 30m buffers between treatment areas and water sources provided adequate drift protection for both an adjacent stream and vernal pools.
Impact: Our 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. Finally, we showed that when the herbicide clopyralid is used properly, toad toxicity and drift potential for clopyralid are minimal.

Funding Source: 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: Dodder is a stem parasite which attacks a wide range of crop plants, including tomatoes, alfalfa, asparagus and melons. Once attachment occurs, it is very difficult to control without killing the host plant. In 2004, greenhouse studies were conducted to evaluate 22 processing tomato varieties for tolerance to field dodder (Cuscuta pentagona). An additional 11 varieties are currently being evaluated. Tomatoes have been direct seeded and once emergence begins, scarified dodder seed is introduced. Additionally, an herbicide, sulfosulfuron, was also examined for selective control of dodder in these same processing tomato varieties. Safety of sulfosulfuron appeared good to tomatoes in field studies, but varied considerably in greenhouse studies among varieties. Tomato growth was suppressed by up to 30 percent for the first few weeks after treatment, but declined to near zero by 4 weeks after treatment. The decline in growth associated with treatment would not be a problem if the alternative was to do nothing for dodder control, which would result in nearly 75 percent yield loss. Dodder resistant tomato varieties included CDX 233, H1100, H9888, H9997, SVR 024 2 0664, SVR 024 2 0662, SVR 024 2 0312 and SVR 024 2 0665. Generally, dodder attached to these varieties, but quickly died, indicating a lack of good attachments to the xylem and phloem. In 2004, we completed studies on

pre-irrigation followed by weed removal to deplete the weed seed bank prior to crop planting.

Impact: Sulfosulfuron has shown potential to provide selective post-attachment control in both field and greenhouse studies. Dodder resistant tomato varieties are the best choice for managing this weed at this time. They are commercially available and the only thing needed to implement this program is to make growers aware of which varieties to use.

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 objective for UC researchers is to develop improved weed management options for vegetables. The project is focused on two principal areas: (1) development of season-specific weed management programs for vegetables, and (2) evaluation of methods to improve weed control in lettuce with herbicides and soil fumigants. Season-specific weed management. The project goal is development of season-specific vegetable weed management programs. Seasonal patterns of burning nettle (Urtica urens) development were monitored for three years. A 5.1 deg. C growing degree day (GDD) model was developed to quantify the time from watering to emergence, flowering and first seed set. Seasonal mean time from watering to emergence, flowering and first seed set was 99.5, 342.5 and 429.0 GDD (5.1 deg. C). These data will be used to develop weed management recommendations for organic and conventional vegetable producers. Irrigation strategies for pronamide activation. Heavy irrigation can push pronamide below the weed germination zone in soils important for lettuce production in Yuma, AZ, such as the Indio silty clay loam soils. The result of this is poor weed control in lettuce. Some suggest that pronamide activation by intermittent initial irrigation improves weed control compared to continuous irrigation. However, to the best of our knowledge no one has verified that intermittent irrigation reduces pronamide soil mobility. We conducted a series of soil column leaching studies, to compare effects of intermittent and continuous irrigation on pronamide mobility in soil.
Soils used in the studies were Chualar sandy loam soils from Salinas, CA and Indio silty clay loam from Yuma, AZ. Soil columns were packed with 10-inches of untreated soil, and pronamide treated soil was added to the top of the soil column. The continuous irrigation treatment was 12 acre inches of water applied continuously over 24 hours. The intermittent treatment received 1-inch of water in 2 hours, followed by a 12 hour dry period, followed by 12-inches of water in 24 hours. Results indicated that the continuous and intermittent irrigation both readily move pronamide through the Indio silty clay loam, but the Chualar series soils impeded pronamide movement. Our results indicate that intermittent irrigation does not improve pronamide retention in the upper soil layers any better than continuous irrigation on Indio silty clay loams from Yuma. The data also

indicated that the pronamide did not move readily in Chualar soils. Nutsedge management. In 2003 we found that applications of 1,3-dichloropropene plus chloropicrin (1,3-D/Pic) at 28 gallons/A (GPA) followed by EPTC at 7 pts. /A to fallow ground in the Coachella Valley, resulted in good nutsedge control in the following lettuce crop. In 2004 we evaluated 20.5 and 26 GPA of 1,3-D/Pic applied by shank injection. Following fumigant applications, 7 pts./A EPTC was applied. Again in 2004 nutsedge control was excellent with 1,3-D/Pic followed by EPTC treatment.
Impact: 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: Chemical and Cultural Practices as Alternatives to Methyl Bromide Fumigation For Vegetable Crop Production

Description: The soil fumigant methyl bromide (MeBr) is applied extensively to suppress soil-borne fungal pathogens and weeds in many crops. Methyl bromide is a potential ozone depleting substance and is scheduled for phase-out by 2005. 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. Three field research experiments and Four demonstration projects were initiated to test and optimize chemical alternatives to MeBr for strawberry and cut flowers production in California. Research Experiments: The objective of this study was to compare the efficacy of several alternative fumigants applied through drip irrigation systems for strawberry production in CA. Four research plots were initiated in Watsonville, Salinas, and Solidad. The alternative chemicals tested were chloropicrin (200 lbs/ac), Inline (300 lbs/ac), Midas (200 lbs/ac), and KPam (30 gal/ac). This research found that crop quality and yield under the alternative fumigants to be equivalent to those grown under MeBr/chloropicrin fumigated soils. Growers Demonstration Project: Four demonstration plots (each approx. 1 acre) were established on growers' fields in Watsonville, Santa Maria, Oxnard, and Carlsbad between July and November, 2004. Chloropicrin, Inline, and Midas were applied at 200 lbs/ac under standard mulch and Vertually Impermeable film (VIF). Metam sodium was applied at 45 gal/ac to one-half of the treatments. The purpose of this project is to demonstrate drip fumigation to strawberry and cut flower growers and to evaluate reduced rates of fumigants under VIF for different soil types. Results suggest that reduced rates (less than 200 lbs/ac) are sufficient to control pathogens if applied in combination with metam sodium.
Impact: The UC research effort resulted in the development of techniques to apply alternative fumigants through drip irrigation systems for crop production (strawberry, cut flowers, and vegetable crops). 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 35% of the strawberry land was fumigated with the alternative
fumigants in 2004.

Funding Source: Hatch and State
Scope of Impact: State Specific

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 was 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 UC IPM 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: 4.13 Land Use
Title: Longitudinal Study of the Relationships among In-migration, Changes in Land Ownership and Land Use Patterns and Vegetation Change

Description: Parcelization has occurred throughout the county but the full extent of the transition to an increasingly fragmented landscape is not easily visible. Nothing in the landscape reveals the precarious financial position of most remaining large-scale farms and ranches. Forty percent of private rural parcels in the county can be developed according to existing zoning designations. More than 3.5 times as much private rural land remains available for future development as all the private rural land already developed in the county. Both absentee and resident owners of undeveloped parcels almost universally indicate that they intend to develop these properties for retirement or plan to sell to others for development. The build-out population that can be reached under current zoning rules is 2.5 times the current population. Parcels of 1 acre or less account for 31 % of all private rural parcels, they represent only 1.5 % of the total private rural acreage (0.9 % of the total area). The highly visible effects of suburban-style developments have relatively little impact on the landscape overall. More of the rural landscape is dominated by low-density rural-residential development on parcels typically ranging from 5 to 40 acres. A UC analysis suggests the overall impact of the residential transition is mixed and should not be considered inevitably ecologically harmful. The most notable vegetation transition is increased canopy closure across all forest types. The greatest transition observed 1957-late 1990s was from small woody growth to dense hardwood forest. The second greatest transition was from sparse conifer forest with shrub-statured vegetation to mixed hardwood-conifer forest, also reflecting the change from small to mature hardwoods. With the expansion of conifer and hardwood forests, there is a decreasing diversity of other vegetation types as forest

encroaches or replaces annual grassland and short-statured woody vegetation. The UC researchers observed the expansion of improved road networks that fragment the landscape ecologically and a simultaneous disappearance of older networks of logging and ranching roads. The types of land use associated with residential homes today is very different from the types of land use associated with the agricultural structures and farm houses that dominated in the 1950s. Thus, the appearance of new houses on large rural residential parcels may be less significant than the fact that these houses signal new land uses. There are many relatively large residential parcels whose owners practice active management of forests and vegetation to reduce fire hazards. Particularly on such larger parcels, the ecological impacts of residential use in comparison to other types of use (ranching, logging) appear less clear than the literature portraying residential development as ecologically harmful suggests. Their study suggests that many rural residential owners allow riparian vegetation to regrow, resulting in significantly improved conditions compared to ranching and agricultural use, in which stream conditions are often harmed by cattle and erosion and pesticide and fertilizer runoff.
Impact: Build-out figures and other information from this study are helping Nevada County planners address the contentious environmental planning arena with hard data. It should motivate planners in other areas to address the question of the consequences of the potential development status of undeveloped land.

Funding Source: McIntire-Stennis and State
Scope of Impact: State Specific

Theme: 4.13 Land Use
Title: LAND USE AND TRANSPORTATION PLANNING METHODS FOR EVALUATING AIR QUALITY AND LAND CONSUMPTION

Description: We recently completed a USEPA demonstration project developing a simple urban model for the Merced Co. Assoc. of Governments. They successfully applied it in an evaluation of county transportation plans. Caltrans has funded the second stage, which is to apply the model to the other counties in the San Joaquin Valley. This model will help the 12 counties reduce sprawl due to new roads and road widenings, and so reduce the consequent loss of ag lands and valuable habitats, such as vernal pools. We rewrote the model, UPlan, to work in the new geographic information system software now in common use. We also added new capabilities, such as redevelopment and multi-county modeling. We also completed running a complex economic urban model in the Sacramento region to evaluate compact growth scenarios, with citizens groups.
Impact: The Sacramento region transportation planning agency has adopted the urban model the researchers first applied to this region. As a result of that work, Caltrans has funded them to present a set of workshops on urban modeling to the major regional transportation agencies in California and to recommend model types for them to

use. Merced Co. successfully applied their simple urban model. As a result of that project, Caltrans has funded the application of this model to the rest of the San Joaquin Valley counties. This model will help the 12 counties reduce sprawl due to new roads and road widenings, and so reduce the consequent loss of ag lands and valuable habitats, such as vernal pools.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.14 Natural Resources Management
Title: Spring-ecosystem structure and function on California's oak woodlands

Description: This research has produced the longest continuous data-set on spring-fed wetland species composition and cover responses to controlled grazing. Two experiments on grazing intensity effects on spring-fed wetlands are ongoing. Response variables include plant species composition and cover. Water quality sampling was initiated again to compare to previous (1992-1997) red from a water quality point of view) and decreased methane flux (good from a greenhouse gas point of view). Plant cover and plant diversity decreases under moderate grazing treatments, while light grazing and removal of grazing results in higher plant cover. Plant biodiversity is maximized under light grazing treatments.

Funding Source: McIntire-Stennis and State
Scope of Impact: State Specific

Theme: 4.14 Natural Resources Management
Title: Rural Communities and Public Lands in the West: Impacts and Alternatives

Description: The analysis of the economic model of dynamic games between public lands ranchers and the government has been completed. Low grazing fees provide incentives for ranchers to internalize the nongrazing public benefits of good stewardship. The second best optimal contract and monitoring and enforcement strategy randomizes monitoring over space and time. Stationary Poisson processes for intertemporal monitoring on each grazing allotment presents ranchers with time autonomous decision problems. The rancher's compliance decision at any time in the planning horizon then is a subgame perfect Nash equilibrium. When the marginal social cost is zero to evict non-compliant ranchers and replace them at random from the population of potential public lands ranchers, optimal penalties extract the full expected discounted present value of a non-compliant strategy for the worst rancher type. Analysis of spatial and intertemporal stochastic relationships with active Bayesian learning has been

undertaken and completed.
Impact: These results are helping policy makers, public lands ranchers, and environmental groups better understand economic issues and trade-offs involved with contract design and administration for public management problems involving agriculture and the extensive margin.

Funding Source: Multistate Research and State
Scope of Impact: AK, CA, CO, ID, NM, NV, OR, UT, WY

Theme: 4.14 Natural Resources Management
Title: Benefits and Costs of Natural Resources Policies Affecting Public and Private Lands

Description: A major focus of the project this year continued to be developing theoretically-consistent models of environmental valuation that include data on how people spend their other scarce resources besides money on the environment. One model developed (the 'wtp time-wtp money-value of time model' in Larson-Shaikh-Layton) shows how to combine information on peoples' willingness to spend their time to achieve environmental improvements with information on their willingness to pay money, which produces estimates of the individual's marginal value of time. This is important because information on the economic value of time is a critical piece of information for recreation valuation and there are relatively few rigorous ways of obtaining it for empirical work. A second model (the 'labor supply-recreation demand' model) shows how to correctly specify and estimate the marginal value of time as part of peoples' economic choices; this model combines information on the person's labor supply choices with their recreation demand choices. A major contribution is showing that it is theoretically consistent to estimate the value of time as part of the 'full' price of recreation and 'full' budget constraint the consumer faces. A third activity for the project this year was showing how 'nonuse' value estimates from recreation demand and wtp for environmental quality improvement is very similar to the 'calibration factors' sometimes invoked in the literature when comparing stated preference and revealed preference approaches. Another paper (Larson-Pienaar) showed how the fundamental concept of weak complementarity is a fundamental part of valuation models that use information on how people spend their time related to the environment as well as their money related to the environment. A final activity was analyzing the demand for organic produce from shoppers' actual purchase decisions This research identified the price premia shoppers pay for organic as opposed to conventional produce items, which is market evidence of willingness to pay for environmentally friendly production practices.
Impact: Results from this research are being adopted and implemented by other researchers and government agencies. The City of Seattle has adopted the time valuation approach in their evaluation of recycling programs. The National Marine Fisheries Service is using the 'labor supply-recreation demand' time valuation

approach in their upcoming analysis of sportfishing for Pacific halibut.

Funding Source: Multistate Research and State
Scope of Impact: AL, AZ, CA, CO, CTS, GA, IA, KY, LA, MA, MD, ME, Mi, ND, NH, NYC, OH, OR, PA, TX, UT, WA, WVA, WY

Theme: 4.14 Natural Resources Management
Title: Invasions and Diversity in California Grasslands: Studies at the Landscape Scale

Description: In the past year, new activities under this project include the following. (1) A graduate student is using the study sites to examine the relationships between local extinction, local colonizations, and the regulation of grassland diversity. (2) Another graduate student is using the study sites to test for the biotic and abiotic factors limiting the distribution of annual lupines, postdoctoral scholar is using the study sites to examine the relationships between native diversity, exotic diversity, disturbance, and invasibility. (4) a UC researcher has applied to NSF for funding to turn the study sites into a long-term study system (under the Long-Term Research in Environmental Biology program), with the aim of examining how temporal environmental variability contributes to grassland biodiversity. All of these new projects are in a stage where they have not produced major results or publications yet.
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 have implications 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: This project is long-term study (22 years) on demography of two species of perennial desert shrubs, the rabbitbrush CHRYSOTHAMNUS NAUSEOSUS and

greasewood, SARCOBATUS VERMICULATUS. In 2004, UC researchers studied the mechanisms of seedling establishment, including germination of seeds, seedling growth and survival, and they tested for competition, through the collaborative research of a graduate student. Their research investigated how environmental heterogeneity, intraspecific competition, and variation among individuals all interact to influence the initial spatial distribution and establishmentof seedlings. Using field observations and experiments, the graduate student showed that: 1) environmental heterogeneity causes seeds to be unevenly distributed in the landscape; Unexpectedly, seeds did not accumulate in depressions or on saltgrass mats but rather under living shrubs even though the seeds are wind dispersed; 2) microsites promoting seed retention are not those that promote seedling survival; Seeds initially do better under shrubs but then lose that advantage as they get older, compared to seeds in other microsites 3). intraspecfic variation among seedling size and/or time of emergence interact with density to influence a seedling's survival within aggregations, but we are as yet unable to detect any effect of competition among seedlings; 4). variation in seedling emergence time and initial seedling size interact with environmental heterogeneity to influence seedling establishment. Analysis of these preliminary results will continue in 2005.
Impact: 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. By learning the demographic patterns of key shrub species, the researchers can develop cost-effective restoration strategies in areas 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: Covariance Between Environment and Competition: Its role in the Maintenance of Biological Diversity

Description: Studies were continued on the theory of competition between plant species, with a particular view to developments in practical terms methods needed to test theory. The focus is on detecting the operation of mechanisms that promote coexistence of plant species. These issues have practical applications in several different areas. If we are to successfully manage natural environments and halt the decline of biological diversity, we need a better understanding of how diversity is maintained in nature. Biodiversity has also been linked to the healthy functioning of both natural and agricultural ecosystems. Finally, the study of plant competition has important application to the study of invasions, which cause serious economic and environmental problems. In this area, we ask, What are the conditions that allow natural communities to prevent invaders from establishing or growing to large densities? The theory goes under the heading of

the storage effect. It focuses on how differences in the environment in space and time allow species to coexist. Storage effect theory leads to a quantitative measure of the coexistence promoting effect of the ways in which different species are in tune with varying characteristics of their physical environment. The primary developments of this theory have come from this and related projects. Over the past year, new mathematical models exploring this theory were developed. These lead to more robust understanding of the application of the theory. Second, new statistical methods were developed to test the theory in nature. These methods are applied to several different kinds of experiments in nature. In the first kind, fluctuations in plant growth over time are studied with some species reduced in abundance, and others not deliberately manipulated. The methods compare fluctuations in growth between these different conditions, and use the comparison to assess the operation of coexistence mechanisms. The second kind of experiment assesses also variation in space or time in the physical conditions that allow plant growth. Instead of basing the statistical methods on variance, these tests are based on covariance with physical conditions. The theory predicts how coexistence mechanisms can be detected and measured by changes in covariances as the abundances of the organisms are altered experimentally. Statistical methods for carrying out these tests were developed, and promise a new era in the testing of diversity maintenance mechanisms in ecology. Much greater scientific rigor can be brought to this subject than has been possible previously. As a consequence, understanding of the maintenance of biodiversity will be greatly facilitated, including understanding of how biodiversity can be lost through climate and landuse change, and through the invasion of alien organisms.
Impact: This study develops methods for testing hypotheses about interactions between plant species. It provides the means to gain a better understanding of the maintenance of biological diversity, and a better understanding of the ability of invading species to have large environmental impacts. It is facilitating management of natural and agricultural systems.

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: Digital remote sensing methods that measure reflected solar energy provide spatially explicit information about the properties and condition of plants and soils over large regions. These data can provide a cost-effective methodology for improving agriculture and natural resource management while providing a permanent record of spatially explicit site conditions at specific times that can be used as an objective basis to evaluate the efficacy of management, restoration,

and mitigation activities. Nonetheless, numerous technical impediments to adoption have limited the operational use of these data for environmental management and monitoring. A UC researcher has continued to extend his long-term research activity on developing image analysis methods to quantify canopy and site conditions using various remote sensing devices and mapping the spatial distribution of environmental factors that affect agriculture and ecosystem processes. Building on previous work, the researchers demonstrated that canopy moisture can be detected from field-based and airborne hyperspectral sensors and that this measure can be related to water stress and irrigation management in cotton crops and related to wildfire risk in forest ecosystems. They have tested retrieval of various spectral index methods for estimating biochemical composition, including relating chlorophyll content to yield prediction in cotton, presence of soil contaminants in wetlands, and for mapping invasive weed species against a vegetated background. These physiological index methods have the advantage that they are easy to apply and interpret for more widespread applications by non-specialists. This year they also extended their method for estimating soil moisture using a Gaussian fitting model to allow for the first time, quantification of carbonate and clay contents in surface soils under variable soil moisture contents. This is a significant improvement in the accuracy of soil biochemical estimates, which opens the potential for improved mapping of additional soil quality parameters that can lead to methods for quantifying soil carbon, among other possibilities. At the ecosystem scale, they have examined detection and quantification of coral reef ecosystem properties and coral reef health using hyperspectral imagery combined with field spectra from several sites in Hawaii and developed similar applications for conifer forest properties in the Pacific Northwest. They have made a major effort in developing and testing methods for mapping invasive weeds in a wide range of ecosystems, from fresh and brackish aquatic systems, semiarid warm and cold deserts, and temperate deciduous forests. They demonstrated a method for detecting vegetation decline in hyyperspectral imagery following a crude petroleum spill in the Jornada desert ecosystem. Wildfires remain a significant environmental and health risk in many ecosystems. They developed several review papers on remote sensing methodologies this year.
Impact: Digital remote sensing imagery 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 cost-effective permanent record of site conditions at specific times and 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: Role of Common Mycorrhizal Networks in Carbon-Nutrient Transfers

among Plant Roots, Fungi, Soils in Calif. Oak Woodlands and Pygmy Forests

Description: California's long-lived oaks compete with annuals for nutrients. Do belowground fungi affect nutrient transfers? In the field, UC researchers added 15-N to vegetative, flowering, and senescent grasses. Grasses acquired more N from flowering donors; oaks acquired more from senescent donors. They also added to 15-N to pine leaves; it moved rapidly to receivers. Grass removal decreased N transfer, as grasses are strong N sinks. Nutrient transfers were rapid, microbes were short-term winners, long-lived oak species were winners in the long-term.
Impact: California oak woodlands are threatened by urbanization, agriculture, and vineyards. Retention of existing oak woodlands is critical since oaks grow slowly and reproduce poorly. The UC research determines how to enhance oak growth and nutrition, particularly how mycorrhizal fungi enhance nutrient uptake and transfer between oaks. Long-term survival of oak woodlands may depend on mycorrhizas.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.15 Nutrient Management
Title: REDUCE POLLUTION WITH PROPER FERTILIZER TIMING

Description: Applying nitrogen and phosphorous with irrigation water is a common practice in the Imperial Valley. If the fertilizers are applied incorrectly, the nutrients end up in the drains rather than in the crop. Nitrogen and phosphorous are the two main nutrients that cause eutrophic conditions (high algal biomass and low dissolved oxygen concentrations that cause massive fish kills) in the Salton Sea. Current and proposed federal water quality standards for California require growers to improve the quality of drainage waters. To achieve both federal and state water quality objectives, growers will have to reduce the amount of phosphorous that rearches the drains and the Salton Sea. UCCE Imperial County advisors evaluated various lettuce irrigation and fertilizer application practices on (1) basin irrigation systems (0% slope and 0% runoff) and (2) free-draining graded furrows (1.5% slope and normal runoff). We compared various water flow rates and the timing of fertilizer applications. They developed a relationship between water application rates and the amount and rate of fertilizer applications. They then developed recommendations on the amount and duration of fertilizer applications during irrigation events for each irrigation method.
Impact: The UCCE advisors' recommendations (Best Management Techniques or BMTs) are being adopted by growers. This is improving fertilizer use efficiency and reducing the nonpoint point source pollution in the Salton Sea watershed. Our educational materials also are used to implement plans to meet the TMDL (Total Maximum Daily Load) regulations. Their BMTs were included in the Regional Water Quality Control Board (Region 7) silt/sediment TMDL standards. For additional information, please visit our water quality website http://tmdl.ucdavis.edu.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 4.15 Nutrient Management
Title: ASSESSING NITROGEN MINERALIZATION AND OTHER DIAGNOSTIC CRITERIA TO REFINE NITROGEN RATES FOR CROPS AND MINIMIZE LOSSES

Description: 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. Due to the highly dynamic properties of the nitrogen cycle in soils, it is very difficult to make fertilizer recommendations that ensure a high yield and at the same time minimize the risk of nitrate leaching to groundwater. Accurate and reliable tests for quantifying the rate at which soils will mineralize nitrogen during the cropping season are highly desirable. Such a test would permit more efficient use of nitrogen fertilizer, thereby allowing maximum net returns to farmers and reduced environmental pollution. To overcome the limitations UC 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. Researchers in Illinois recently modified older methods for measuring the amino sugar fraction of soil nitrogen. They have shown that the amino sugar content in soils is well correlated with the response of corn to nitrogen fertilizer application. The sufficiently different climate and soils of California require that N mineralization assays be modified in order to be applicable to warm irrigated conditions and to be adopted by commercial soil test laboratories. The objective of this project is to develop and test in California a simple soil test that will aid in making appropriate nitrogen fertilization recommendations that ensure a high yield and minimize nitrate leaching to groundwater. The approach is to investigate the relationship between the amino sugar content in the soil and nitrogen mineralization during the cropping season and compare the amino sugar method with other methods used to make N fertilization recommendations. Preliminary results from an incubation study showed that the amino sugar content is well related to the nitrogen mineralization during aerobic incubation. Our goal for the next season is to find more field sites in order to add more data to this comparison and to compare the amino sugar content in the soil with the response of corn to nitrogen fertilization. Furthermore, an incubation experiment will reveal how fast the amino sugar concentration changes after the application of animal manure and cover crop and how these changes are related to other indicators of microbial activity such as microbial biomass, carbon dioxide evolution or nitrogen mineralization.

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: Multistate Research and State
Scope of Impact: AK, CA, FL, IL, IN, IA, KS, MN, MO, NE, NYG, OH, SD, WI

Theme: 4.15 Nutrient Management
Title: MANAGEMENT OF NITROGEN FERTILIZATION IN CALIFORNIA COTTON PRODUCTION SYSTEMS

Description: This project evaluated present nitrogen application rates in San Joaquin Valley cotton production systems. The impact of seasonal climatic variation, crop rotation, soil residual nitrogen, cotton biomass turnover, and other management practices on nitrogen availability and use were assessed. The results clearly show that nitrogen fertilizer applications in cotton often exceed crop needs. Three scientific papers were published in 2004, and one paper is in press. A Cooperative Extension bulletin on nitrogen management guidelines for San Joaquin Valley cotton production is in preparation.
Impact: This research clearly demonstrates that excessive nitrogen applications are commonplace in San Joaquin Valley cotton production systems. The newly developed nitrogen management guidelines are leading to reduced nitrogen use and lessening the negative impact of agricultural nitrogen on the environment.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.17 Pesticide Application
Title: UC FINDS SOLUTION TO SERIOUS PEST OF ARTICHOKES

Description: Meadow voles, small rodents that live throughout California, are in most situations a natural and harmless part of the environment, but in artichoke fields and some other agricultural crops they feed on and damage the crops. In perennial artichoke fields, primarily in the Monterey area, voles are the most serious pest and controlling them is essential for production. Recently, the only method available to reduce this damage, a rodenticide, was cancelled by the manufacturer. With a potential crisis looming, the artichoke growers turned to UC for help. In consultation with with the California Artichoke Advisory Board, Monterey County agricultural commissioner, California Department of Food and Agriculture and the rodenticide manufacturer, UCCE specialists set to work. After extensive review of the current

pest management practices, they began intensive laboratory tests to evaluate alternative materials and procedures. After just a few months, the UC researchers began field trials to test a newly developed rodenticide. Their laboratory findings were borne out in the field where good control of the vole pest population was achieved. The UC data were submitted to pesticide regulators as part of the proposed change in the rodent bait registration.
Impact: Word has just been received that UC's data have been accepted by the pesticide regulators and the changes have been approved. Thus, artichoke growers, who were facing a potential disaster, can begin using the new material in time to smoothly transition from the remaining stocks of the old rodenticide.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 4.17 Pesticide Application
Title: SEEDLING ALFALFA WEED CONTROL

Description: Throughout the irrigated west, a number of weed species, including perennial and poisonous weeds, can infest alfalfa hay. The types of infestations in any given area are usually associated with planting time, previous cropping history and environmental factors. Any of these weeds left uncontrolled can seriously reduce yield or cause a complete loss of stand in the establishment year. Even if the stand is not lost, infestations can weaken young alfalfa seedlings, retard growth and delay the first cutting. Weeds also reduce the quality and value of alfalfa hay because many are less palatable and less nutritious than alfalfa. Poisonous weeds make hay unfit for livestock and some, such as sandbur and foxtail, although not poisonous are mechanically harmful. The UCCE Alfalfa Workgroup conducted trials with grower cooperators throughout California's alfalfa production areas to evaluate weed control efficacy of both registered and promising new herbicides in seedling alfalfa. Both annual and perennial weeds were evaluated. UC efficacy data were then submitted as part of the registration packet to the California Department of Pesticide Registration, resulting in the registration of two herbicides, Pursuit and Raptor. Previously available herbicides did not provide adequate control, resulting in poor hay quality and reduced stand life.
Impact: Growers have been provided with viable control options for postemergence control of broadleaf weeds and grasses in new alfalfa stands. More importantly, applications of Raptor for resistant weeds are allowed between cuttings, a control strategy not previously available. Raptor is considered by EPA to be a reduced-risk pesticide. It provides growers an environmentally friendly option because it is applied in ounces/acre as opposed to pounds/acre of currently registered herbicides. Also, it has little to no potential for movement with surface water or into ground water.

Growers receive as much as $30 more per ton for USDA premium weed-free hay than for USDA good to fair quality weedy hay. With production of 10 tons per

acre, this increases returns by $300 per acre. In addition, the stand life of weed-free hay can be one to two years longer. When establishment costs of $800 per acre are amortized over four years rather than three, the result is a $66 per acre savings.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 4.17 Pesticide Application
Title: Mechanisms and mitigation of agrochemical impacts on human and environmental health.

Description: 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: Multistate Research and State
Scope of Impact: CA, FL, HI, IN, KS, NM, NV, NYC, OR, UT, WA

Theme: 4.17 Pesticide Application
Title: Animal, Cell, Enzyme Models for the Detection of Exposure to Pesticides and Other Toxicities

Description: Using the ultra-sensitive atomic mass spectrometer at Lawrence Livermore and Japanese quail, UC researchers have been standardizing the assay for a fecal testosterone biomarker to monitor reproductive state of birds. Round robin blood cholinesterase testing with clinical laboratories has led the state of California to remove permission from 11 of 20 clinical laboratories to participate in mandated monitoring until their results are consistent with ours. We continue to analyze the data from thousands of cholinesterase assays conducted by the Department of Defense to establish a normal range of blood cholinesterase values and are proceeding to compare their pH based assays with our colorimetric one. Brain and muscle cholinesterase studies of fish and amphibia from rivers and estuaries of California are revealing differences in enzyme levels that may relate to temperature and stage of embryonic development.
Impact: The success of the clinical cholinesterase assays are helping to make pesticide

use more safe and to prepare responses to possible terrorist episodes. Their studies of fish and amphibia cholinesterases are providing baseline data to assess exposure of these animals to pesticides and to evaluate the health of freshwater and brackish water ecosystems.

Funding Source: Animal Health and State
Scope of Impact: State Specific

Theme: 4.17 Pesticide Application
Title: Biorational methods for insect pest management (IPM): Bioorganic and molecular approaches

Description: UC researchers have found that scorpions use potassium ion as a prevenom and have isolated several novel toxins from scorpion venom. This information helps select insect specific toxins for use in the recombinant baculoviruses. They demonstrated that combinations of toxins can be used synergistically in baculoviruses for insect control. They looked at recombination frequencies as a possible environmental risk factor related to the release of the recombinant viruses. They 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. We are investigating the molecular mechanism by which insect viruses gain control of the behaviour of their hosts. They have helped several countries develop recombinant baculovirus technology both for protein expression and for the development of green pesticides.

Impact: Recombinant baculoviruses work as fast as classical pesticides, preserve yield while not disrupting natural enemies and thus are very effective insect control agents on major insect pests. No evidence of potential harm to humans or to the environment has been found. They are a cost effective way to move away from dangerous pesticides in many third world areas.

Funding Source: Multistate Research and State
Scope of Impact: AZ, CA, CO, FL, NV, PA, TX

Theme: 4.19 Riparian Management
Title: Hydrogeomorphic Restoration of Riparian Agricultural Land

Description: Millions of dollars have been spent on land acquisition and planning for Sacramento-San Joaquin Delta restoration. UC researchers used paleo reconstruction of 12 cores to interpert the environmental history of the McCormack-Williamson Tract (MWT) and the Delta Meadows (DM) tidal wetland. MWT was a non-tidal floodplain in the late-Holocene, with a mosaic of other habitats including dry

uplands, riparian forests, and freshwater wetlands nearby. The upper delta gradually came under tidal influence 3,000-800 years before present (cal BP). Floodplains prevailed at DM from 3,650-330 cal BP after which wetlands expanded. A flood disturbance regime has controlled the upper delta for the last 3000 years. Recent agriculture has caused nearly complete habitat loss. A flood-based disturbance regime will recur at MWT if levees are removed, culminating in a melange of unstable habitats. Concentrations of Hg, Pb, As, and P pollutants are elevated several-fold in surficial sediments, which may be problem after restoration. A palynological approach was used to estimate sediment deposition rates on a North Coast floodplain affected by logging. The approach used downcore variations in fossil pollen concentration to calculate rates of deposition. We determined that deposition rates increased over 400% within years of logging events and that the increased rates persisted for less than 4 years. After logging-induced deposition peaked, deposition decreased over 60% relative to the pre-logging background values. The decreased deposition rates persisted for over 40 years. The immediate effect of logging in this watershed was to induce mass wasting events in hollows that produced rapidly traveling sediment pulses. In the subsequent recovery period, reduced sediment loading occurred as a result of a reduction in the volume of sediment available for transport. The reduction in sediment load led to a reduction in deposition rates until subsequent logging disturbances destabilized and emptied other hollows. A study using optimization theory was published in which they considered placement of beacons and loggers in the Cosumnes River Preserve where agricultural lands are being restored to natural floodplain habitat. Currently, there are many sensors deployed. Their goal was to determine the min number and location of beacons and loggers for maximal wireless sensors deployed in the preserve. They solved an optimization problem with an Integer Linear Program. A 1-yr study was done in the Salton Sea basin to assess the problem of excessive suspended sediment. Two field-scale drain channels were monitored to quantify 5-minute and daily variations of sediment load (Qs) and discharge (Q) due to the variations of land use, irrigation methods, land cover, and soil texture. Daily Qs and Q showed that early-stage soil erosion was more intensive than that in the late stage. Hourly data revealed that surface irrigation produced higher Qs than sprinkler irrigation. Daily Qs and Q combined with particle size analysis of soils in 6 fields connected to 1 drain channel indicated that pasture crops produced less Qs than sugar beets and that sandy soil produced much higher Qs than clay soils.

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. Data generated is being used for improved water resource planning and sustainable land-use that both restore nature and protect land from flood damages.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.19 Riparian Management
Title: Rehabilitating Instream Habitat in California

Description: The work involves studying river processes and implementing river rehab experiments to improve the efficiency and benefits of rehab projects on regulated rivers. Rehab experiments are implemented using the Spawning Habitat Integrated Rehabilitation Approach (SHIRA). Funding is provided by CALFED, NSF Hydrology, NSF NCED, USFWS, and USBR. The rivers that have been studied include Mokelumne, Trinity, American, and Yuba Rivers (CA) as well as Santiam River (OR) and Teanaway River (WA). A website explaining SHIRA was developed and is at http://shira.lawr.ucdavis.edu On Mokelumne River, the fourth of 5 river rehabilitation projects was designed, implemented, and monitored in 2004. Also, a study was performed on the importance of habitat heterogeneity. In that study we found that proximity of physical habitat to structural cover (pools, large woody debris, boulder clusters and overhanging vegetation) and hydrodynamic shear zones provide equally important refuge from predation and resting zones for energy conservation. The increased heterogeneity appeared highly effective in terms of redd utilization, with 70 redds located in close proximity to 93% of the available structural cover, and 42 redds located in close proximity to 90% of the available shear zone refugia. On Trinity River, design development and final design selection phases of SHIRA were done. 6 alternative channel configurations were developed, analyzed and 2D-modelled at a spawning Q and a flood Q. A presentation at the Weaverville library shared the results with the public and aided in final design selection to account for interests of fishermen. Trinity River provides an interesting contrast to Mokelumne River because it is more mountainous and thus requires consideration of unique processes that are poorly understood. Construction is anticipated for summer 2005. On Yuba River, a large and highly detailed topographic surveying effort has been completed, including locating individual salmon redds in relation to topographic features. About 30,000 painted tracer stones were placed in the river to track sediment transport and a stage recorder was installed to monitor flood hydrographs. The Yuba provides an interesting contrast to the Mokelumne and Trinity because it has a more natural flow regime due to the lack of dams on the south and middle forks and the limited regulation at Englebright dam. Its floodplain is much wider than for the other rivers under study and its gravel is moved more frequently. Research into mountain river geomorphology important for management hydropower projects significant advanced this year. During winter a waterfall was located in central Oregon on the Santiam River that was ideal for applying the patent-pending Robitic River Truss. During March several weeks were spent there make the first-ever measurements of hydraulic in an unwadable, deadly natural waterfall. In April and May 3 smaller, wadable horseshoe waterfalls located in Washington State were studied for topography, drag forces (with a newly developed sensor), velocities, and sediment transport.

Scouting of suitable locations for making measurements in the northern Sierras is now underway.

Impact: Efforts are underway to rehabilitate fisheries at risk from dams, diversions, and mining. If these efforts fail, then federal law could restrict use of rivers causing serious economic damage. To avoid this calamity and to promote ecosystem health, this project is testing a new approach to rehabilitating rivers. Because it combines science and experience from many disciplines it is much less likely than standard approaches to result in serious unanticipated problems.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.21 Soil Quality
Title: THE BIOGEOCHEMISTRY OF FLUCTUATING OXYGEN ENVIRONMENTS IN HUMID ECOSYSTEMS

Description: The production of carbon dioxide (CO2), nitrous oxide (N2O), and methane (CH4), all important greenhouse gases, is sensitive to soil redox potential. Under well aerated conditions aerobic respiration leads to the production of CO2; as soil oxygen (O2) availability declines N2O production increases and under strongly anaerobic conditions typical of some wetland soils, CH4 production occurs. Low or fluctuating redox conditions also affects the storage of carbon, and cycling of nitrogen and phosphorus, all of which impact plant growth and ecosystem health. UC research has focused on the effects of fluctuating O2 concentrations (i.e., redox dynamics) on the production of greenhouse gases and carbon and nutrient cycling. Results indicate that disturbance resulting in root mortality increases the magnitude of all three greenhouse gas emissions, due primarily to the increase in carbon inputs from dead and decaying roots and the decrease in plant competition to nutrients. Root mortality also increased soil moisture and likely led to more frequent and greater magnitude fluctuations in soil redox potential. In undisturbed soils, researchers found that fluctuating redox conditions in humid soils led to higher rates of nitrification during aerobic periods and nitrate reduction during periods of low redox. Nitrate was reduced to N2O, dinitrogen gas, and to ammonium via dissimilatory nitrate reduction to ammonium (DNRA). DNRA is a conservative pathway and contributed to nitrogen retention by decreasing nitrogen losses to ground water and the atmosphere. Denitrification is a terminal loss pathway, decreasing nitrogen availability for plant growth. In our experiment, denitrification to N2O was greatest at high levels of nitrate and carbon availability. Denitrification to dinitrogen is often difficult to measure due to the predominance of dinitrogen in our atmosphere (the air we breathe is 78 % dinitrogen). In this experiment, flux rates were very high, and indicated that soils release a significant amount of their labile nitrogen to the atmosphere under

humid conditions. The release of dinitrogen was not sensitive to carbon or nitrate availability, but increased significantly under anaerobic conditions. Their results indicate that DNRA has the potential to conserve nitrogen in ecosystems, and may contribute to decreased N2O fluxes from humid soils, particularly at low levels of nitrate availability. Low and fluctuating redox potential can also lead to rapid oxidation and reduction of iron. In highly weathered soils, oxidized iron is a strong sink for phosphorus, decreasing its availability to plant roots. They found that low and fluctuating redox conditions led to increased phosphorus availability, enhanced by the addition of labile carbon.
Impact: This UC research examines patterns in and controls over oxidation-reduction (redox) potential in soils and the impact of redox dynamics on trace gas production, carbon sequestration and loss, and ecosystem nutrient cycling. Their results demonstrate that humid soils experience fluctuating redox potential and that this can lead to increased carbon storage, increase nitrogen losses, and greater soil phosphorus availability. Their results are informing land managers and policy makers of key processes that affect ecosystem performance and sensitivity to changing environmental conditions, improving ecosystem management approaches.

Funding Source: McIntire-Stennis
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: OBJ. 3 and 4: The state of California's recent financial crisis eliminated most state programs that promoted and helped support ecological research on the Sacramento River, an alluvial river that is one of the main focuses of this Experiment Station project. Only one state program remains and is administered by the California Bay-Delta Authority to implement the CALFED program. These funds are limited and highly competitive. Despite these problems I collaborated with a team of private and university scientists to submit a proposal to the CALFED Ecosystem Restoration Program (ERP) which is still pending. A UC researcher collaborated with his colleagues and received modest funding to complete some vegetation data analysis and construct predictive models. They also collaborated and submitted a paper for publication that quantifies the relationship between stream power and floodplain erosion patterns. The findings from this research will help river planners, managers and scientists better manage the riparian and aquatic ecosystems on the Sacramento River by being able to forecast bank erosion patterns through monitoring flow (cumulative discharge) parameters. Another publication in review is a book chapter that he co-authored with a colleague that describes the riparian ecology of the Great Valley (i.e. Central Valley). They expect this book to be widely accessible to scientists and to the general public thereby providing a resource about the riparian ecosystems of the Central Valley.

OBJ. 6: The UC Davis Arboretum is both and an ex-situ plant conservation program and in-situ native plant collection on an alluvial river waterway.He collaborated with a colleague and funding was procured for a 2-year project from the Institute of Museum and Library Services (IMLS), Museums for America Program to map the plant resources in a computer geographic information system (GIS) and improve the database capabilities. The project aims to allow faculty, students, staff and the general public greater access to the arboretum's plant collection through the electronic maps. In another collaboration between he received funding from CALFED for a 5-year study to evaluate the effectiveness of best management practices (BMPs) on reducing excessive volumes of water runoff and improving water quality from urban runoff into alluvial rivers.
Impact: The project assists public and private agency land managers devise plans to conserve, manage and restore alluvial rivers 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 alluvial rivers.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.22 Sustainable Agriculture
Title: Engineering for Pest Control in Reduced Chemical and Organic Crops

Description: Work is continuing on detection and precision treatment of weeds within seedlines of high value, specialty crops, especially in organic production. Machine vision techniques using image processing for shape analysis and spectral inspection techniques have been implemented in field situations to discriminate young weeds from crop plants. Hyperspectral analysis, using 16-bit resolution, appears very promising with success rates over 95% under laboratory conditions. Field data have been collected on a number of crops and analysis is continuing. Once weeds and crops have been distinguished, the challenge is to selectively treat the weeds while leaving the crop plants undamaged. Improved precision dosing systems have been designed and tested. These systems allow micro-dosing of herbicide materials to deliver volumetric doses in the range of 40 microliters during a 10 millisecond event. Additionally, these systems are being adapted for use in precision thermal treatment systems to eliminate the need for any active chemical treatment. 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. Experimental work has investigated the use of spatially-selective thermal treatment using heated liquids. Engineering design of the precision dosing systems and the bioassays of weed and crop response to heated oils are underway. Typical weeds in Californias Sacramento Valley have been controlled by selective application of heated oils. Additional work will investigate the use of organically approved herbicides and spray adjuvants. Acetic acid was evaluated as a bio-derived herbicide; however, at concentrations that would quality as organically derived materials, the acetic acid was not reliably effective. Increasing concentration to the ca. 25% range significantly improved efficacy.
Impact: This project is developing weed detection methods based on machine vision and spectral techniques. Once weeds are identified and located, organic and reduced-risk chemicals may be used to control the weeds. Alternatively, precision thermal or mechanical control methods can be used. These methods will reduce growers dependence on conventional herbicides.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.22 Sustainable Agriculture
Title: Disease Management in Ornamental Crops

Description: Over the past year, UC researchers have continued work on alternatives to methyl bromide for field-grown ornamental crops in coastal production areas. Research comparing butyl-, benzyl-, ethyl-, and phenylethyl-Isothiocyanate (ITC) showed that LD50 (to Fusarium oxysporum) differed by soil type. Ethyl-ITC was consistently the most efficacious in all soil types. Benzyl-ITC was generally the least efficacious, and butyl- and phenylethyl-ITCs were variable, appearing relatively efficacious in some soils, and relatively non-efficacious in others. ITC persistence in the different soils also varied, and both persistence and LD50 were influenced by soil pH. Differences in ITC species produced and differences in soil properties degrade the reliability and reproducibility of biofumigation using Brassica species. Their research on water treatments to eliminate fungal pathogens from recycled irrigation water has emphasized ozone treatments over the past year. They have initiated a large-scale field trial at a commercial nursery comparing the root health and survival of container-grown plants irrigated with fresh water, recycled water, and ozone-treated recycled water. A split-plot design includes fungicide treatments on either a scheduled basis, or on an as-needed basis. The purpose of this trial is to test the long-term efficacy of ozone, and to compare plant quality

and production costs under different scenarios. Finally, they have begun research 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. One of their study sites has been Monrovia Nursery in southern California, where a serious disease outbreak occurred in the spring of 2004. They have conducted soil-baiting trials to determine survival of propagules, and have been baiting out of the San Gabriel River to check possible avenues of entry into the nursery. This work is ongoing.

Impact: Flower growers in coastal regions of California urgently need alternatives to methyl bromide and there has been great interest in biofumigation as an environmentally friendly approach. These experiments have shown that biofumigation with Brassica species is not reliable and that growers should explore other means of soil treatment.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.22 Sustainable Agriculture
Title: ESTABLISHMENT OF IRRIGATION STRATEGIES TO MAXIMIZE YIELDS AND FRUIT QUALITY OF GRAPEVINES

Description: The goals of this UC laboratory are to establish reliable crop coefficients for grapevines grown in California and then use those to schedule irrigations. Research concluded this past growing season included the continued study investigating the interactions of canopy management (leaf removal in the fruiting zone) and irrigation amounts in a Merlot vineyard in the San Joaquin Valley and to determine the effects of different irrigation management practices on vine productivity and wine quality in a Cabernet Sauvignon vineyard near Paso Robles. Irrigation amounts at both locations included various fractions of estimated vineyard evapotranspiration (ETc). The results indicated that leaf removal in the fruiting had a greater effect on wine composition than irrigation amount, similar to that found the previous season. The irrigation management strategies study did not include the partial rootzone drying (PRD) treatments for the 2004 growing season. Wines were made from the nine remaining treatments, however, as of this date they have not been bottled and/or analyzed. Another study was initiated to determine the effects of a potassium (K) or nitrogen (N) fertilizer, applied either at berry set or veraison in a Merlot vineyard, on the K or N contents in the wine. Wines will be analyzed sometime this winter.
Impact: The competition in California between urban and agricultural interests for limited water supplies requires that growers have objective numbers on the amount of water their specific crop requires to maximize yields of high quality. Irrigation work the researcher has conducted at the Kearney Ag Center and at other locations around the state has provided grape growers with such information. Studies he is conducting presently will demonstrate which irrigation management technique will work the best. In

addition, the application of nitrogen fertilizers in California vineyards needs to be reanalyzed in order to maximize fertilizer use efficiency while minimizing potential pollution of the state groundwater resources. The studies he initiated last summer in the San Joaquin Valley should assist grape growers in determining the best management practice for the application of both N and K fertilizers.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.22 Sustainable Agriculture
Title: AGRONOMIC PRACTICES AFFECTING YIELD, FORAGE QUALITY, AND SUSTAINABILITY OF IRRIGATED ALFALFA

Description: This project integrates both research and extension activities pertaining to alfalfa and forage crops. The scope is broad, with projects pertaining to water-use efficiency, irrigation management, variety adaptation, forage quality, and the introduction of biotech traits in alfalfa. Alfalfa is grown on about 1 million acres of irrigated land, the largest acreage crop in CA. Alfalfa consumes about 19.5 percent of the state's agricultural water, and a major focus of this program is on the water quantity and water quality challenges of the single-largest water user in the state. Research on deficit irrigation of alfalfa was conducted in 2003-2004 at Tulelake and Davis, with the aim to increase the flexibility of alfalfa water use transferred in times of drought. Substantial quantities of water can be saved (1-2 acre-feet per year) from alfalfa deficit programs in July-August, but with substantial yield losses in some environments, but not others. High water tables enable continued alfalfa production with little yield loss under deficit conditions. Questions about the calculation of water available for transfer are complicated by high water tables which enable ET even under low water application situations. Deficit irrigation strategies appear to hold some promise for late-season water transfers under drought conditions, freeing up hundreds of thousands of acre feet if voluntary methods of exchange are developed. There is a need for better understanding of the yield losses associated with deficit irrigation, methods for approaching deficit irrigation, and the economics of water use efficiency. Mitigation measures for preventing off-site movement of pesticides used in alfalfa were reported, which is focused on chlorpyrifos off-site movement. Off site movement can occur via either surface runoff directly. Additionally, surface waters which collect in holding ponds that may affect groundwater. The third and final year of a cutting schedule-variety trial at UC Davis (2001-2005) was completed, with one additional cutting for data collection to be taken in 2005 on all plots. Economic analysis of the yield-quality tradeoff in alfalfa showed quantitative differences between varieties in yield and quality due to differences in Fall Dormancy (FD) Ratings. Guidelines for estimating the yield-quantity tradeoff in alfalfa were provided. Yield losses of 0.3 to 0.6 t per acre per unit of FD were observed in this collection of 18 varieties. Quality changes of

approximately 2 points change in either ADF, NDF or CP per unit of FD, although there are some varieties which are exceptions. The relationship between FD and quality was stronger than the relationship between FD and yield. Cutting schedule had a more powerful influence on quality and yield than did variety. Studies were conducted on alternative forages in 2004 on sudangrass and BMR sorghum crosses. Yield studies on new varieties of alfalfa with glyphosate-resistant gene were initiated, and continued during 2004, showing yield potential of glyphosate-resistant plants to be essentially equivalent to varieties of the same dormancy level that did not contain the glyphosate-resistant gene.
Impact: Information on the yield-quality tradeoff in alfalfa as affected by variety and cutting schedule has resulted in changes in practices in CA. Information technology to choose a superior-yielding variety from our trials can be worth 50-400 million dollars per year to CA growers. Proposed mitigation techniques for preventing pollution have been adapted by some growers, and will help to improve the quality of surface waters in California.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.22 Sustainable Agriculture
Title: Improvement of Fruit Size and Yield of Mandarins in California and Genetic Analyses of Date Palms and Ornamental Foliage Plants

Description: . In order to solve the problems of mandarin production in California, a UC researcher developed a very extensive program to enhance fruit set, yield and fruit size of mandarins and mandarin hybrids using plant growth regulators (PGRs) and fertilizers. By identifying the best application timing and concentration of 2,4 dichlorophenoxyacetic acid (2,4-D) in the past three years, he was able to increase the fruit size and yield of mandarins significantly. California citrus growers will benefit directly from this research starting either 2004 or 2005. An extra 17 to 37 million dollars return could be generated annually based on this research. He also investigate the issues of compatibility among mandarins and the necessary isolation distance for prevention of cross-pollination. The information is very useful for citrus growers when they establish new orchards. He also established long- term production trials of new mandarins, mandarin hybrids, and sweet oranges throughout California. These new cultivar production trials will ensure the long-term competitiveness and sustainability of the citrus industry in California. The amplified fragment length polymorphism (AFLP) molecular marker is highly polymorphic and repeatable. Using the AFLP markers, He studied the germplasm accessions of date palm (Phoenix dactylifera L.) from California, Egypt, Morocco and Oman. His goal is to clarify the genetic relationship of date palm accessions from around the world and eventually determine the origin of date palm. He also used AFLP markers to study accessions of ornamental foliage plants from many genera and establish the genetic relationship within the genera. The studies of date palms and ornamental foliage plants will offer a tool to identify individual accession, establish the genetic

relationship among the accessions, and facilitate future germplasm collection, maintenance, and conservation.
Impact: A 24C registration of the use of 2,4 dichlorophenoxyacetic acid (2,4-D) (CitrusFixTM) for fruit size increase of mandarins and mandarin hybrids in California was granted by the Department of Pesticide Regulation, California Environment Protection Agency in January 2005 based on results from this project. Growers in California could begin using this application for 2005 season. 2005 season is expected to be an OFF year. The real benefit of this application may come in the 2006 season, an anticipated ON year. This application should increase the return for growers in an ON year by significantly increase the fruit size of mandarins and mandarin hybrids. From one of the new mandarin trias, the researchers identified four early season Satsuma mandarins (easy peeling, completely seedless and great taste), two of them, Miyagawa and Xie-Shan, are super early season Satsuma. Preliminary data suggests that these two cultivars could potentially be harvested in San Joaquin Valley of California in early September, may be as early as late August. This early marketing window is at least one month earlier than any seedless mandarin currently available in California and USA. Growers in California are eagerly waiting for the release of these two new cultivars. Large planting of these two super early season Satsuma mandarins may occur in the next 3-4 years. They will continue to evaluate these new cultivars on different rootstock combinations at more locations through out California.

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: Research has continued on evaluating N-use efficiency in cotton cropping systems. The investigation focused on the availability of residual fertilizer-N and cotton residue-N to subsequent crops. This study determined the recovery of residual 15N fertilizer in cotton plants and in soil for the second and third crop after fertilizer application and the recovery of N from cotton residue in the soil and for subsequent cotton crops. Total 15N-fertilzer recovery in the second year after application averaged 5.8% for Acala cotton and 2.9% for Pima cotton. In the third year after application, total 15N-fertilizer recovered by Acala cotton from the soil fraction averaged overall 2.7%. Most of this 15N-fertilzer recovered in the second and third year was cycled through soil pools and roots with only small amounts recovered from 15N cycled through aboveground residue. Virtually all the 15N applied in the form of labeled aboveground residue and recovered in the soil, was found in the top 0.3-m of the soil. The 15N-fertilizer cycled through the belowground pools (soil and roots) and recovered in the soil, was found in the top 0.6-m but some was located below 0.9-m depth. Recovery of residual 15N-

fertilizer appears to contribute little to total N uptake in the second and third crop after application.
Impact: Research on the distribution and availability of nitrogen applied as fertilizer is important for making decision on the efficient use of this fertilizer. . The research reported provides information for the development of new guidelines for N fertilizer application in cotton cropping systems. A bulletin providing these guidelines will be published for use of cotton growers in the San Joaquin Valley.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.23 Water Quality
Title: DEVELOPMENT AND APPLICATION OF CROP MODELS FOR CUT-FLOWER ROSES

Description: Greenhouse speciality crop production is under significant pressure to improve production efficiency and to reduce pollution due to run-off. Growers are facing significant challenges that threaten to drive them out of business. The UC researchers' objective is to develop, test, and implement tools and production methods to help growers manage the greenhouse environment more efficiently, while optimizing irrigation and fertilization to maximize crop productivity. Towards this purpose they have been developing computer simulation models and using these as basis for software tools that growers can use in production management. The model system in this case is cut flower rose production and the core model for this is a mathematical model of rose stem growth and development. During the period under review we investigated the water use and photosynthesis rate of rose tissue that is bent as part of a production method called "bending". Currently their research focuses on including the effect of root-zone moisture, nutrient concentration and oxygen concentration. Our model for simulating nitrogen and potassium uptake is being tested and expanded and in collaboration with scientists from Korea they are also considering secondary nutrients. They are also continuing their work on quantifying the effect of dissolved oxygen and nutrient availability on rose plant and shoot growth. We also developed a final version of a rose crop scheduling tool that growers can use for managing the greenhouse environment of rose crops. The scientific basis for this software is the rose shoot model. We are also currently validating this tool.
Impact: Growers of greenhouse and nursery crops are always seeking ways to be more productive and efficient. 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. The information being developed in this project will be particularly useful in allowing growers to reduce fertilizer waste while minimizing pollution from run-off. As many states have implemented restrictions on run-off from greenhouses and nurseries, such information will allow these commercial operations to stay in

business. One portion of this project has yielded a software tool that growers can use to help them make decisions for timing rose crops for holiday markets.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.23 Water Quality
Title: RANCHERS USE NEW METHOD TO IMPROVE WATER QUALITY FOR SALMON

Description: To reduce impacts on salmon habitat, water-quality regulations concerning sediment are being established for Northern California watersheds. These regulations require agricultural landowners to inventory, monitor and control sediment delivery to salmon-bearing streams, with the overall goal of reducing the impacts of fine sediment on salmon habitat. Exactly how to conduct such surveys across millions of acres of private and publicly managed rangeland was not entirely clear. Effectively identifying sites of water quality impact in an efficient manner is the critical first step for reducing the impacts. This is particularly true for rangeland managers, regularly facing overburdened schedules and limited budgets. UCCE advisors and specialists developed an improved method to inventory and monitor sites of sediment delivery, in collaboration with the Natural Resource Conservation Service, Regional Water Quality Control Board, California Farm Bureau Federation and private landowners. The new method has helped landowners and rangeland managers to reduce sediment delivery to streams and improve water quality. The monitoring method is available to the public online at:

http://anrcatalog.ucdavis.edu/InOrder/Shop/ItemDetails.asp?ItemNo=8014.

UCCE has trained more than 500 private and public rangeland managers in the new water-quality method through the Rangeland Watershed Program. These trained managers typically manage from 1,200 to 2,500 acres of rangeland within salmon-bearing watersheds. During the training, participants learn how to use a two-page worksheet and simple field evaluation methods to determine the quantity of potential sediment that will be delivered from a site. The rangeland manager then evaluates multiple sites to compare and prioritize the order and approach for controlling the sediment delivery at each site. In addition to training, UCCE surveyed sediment-delivery sites using the new method and site definition, as specified by the Total Maximum Daily Load process. As a result, 117 sediment delivery sites were characterized on 10 North Coast ranches. These results have been used widely: in presentations and conferences on water quality — such as the Ranch Water Quality Planning Program — and in ANR's California Agriculture magazine. These visible data highlight priorities for the control of sediment delivery sites that managers and regulators can both use in their decision making.
Impact: The UC sediment-delivery monitoring method complies with regulatory requirements -- including the federal Clean Water Act, state Porter-Cologne Act

and sediment total maximum daily loads -- as a tool for identifying and prioritizing sites that impact water quality. This gives rangeland managers a cost-effective method to comply with these regulations and more importantly identify and prioritize the control of sediment delivery sites. The estimated cost to inventory sites for sedimentation with the new method is $5 per acre compared to $50 per acre using other common methods.

Thus far, New Mexico State University Cooperative Extension and the Resource Conservation Districts of Yolo and Shasta Counties have adopted the new UC method, improving water quality at a lower cost.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 4.23 Water Quality
Title: Factors Controlling the Distribution of Trace Elements in the Solid-Phase of Terrestrial Ecosystems

Description: Retention of selenium in bays and estuaries sediments is an important component of its biogeochemical cycle. The greatest activity for retention and release of selenium is at the water-sediment interface. In our microcosms we examined the amount of selenite and selenate selenium transported into the sediment through diffusion and mass flow during a typical tidal period using 25 parts per billion selenium on a mass bases(an environmentally relevant concentration). Greater than 80 percent of the selenite was removed from the aqueous phase within 24 hours. Greater than 60 percent of the selenate was removed from the aqueous phase within the same time period, which was similar to the theoretical amount removed by diffusion only. Additional experiments were conducted allowing water to evaporate from the saturated soil before application of a selenium-spiked aqueous phase to examine potential influences from mass flow on the transport of selenium to the sediment in a 24 hour time scale. Selenite transport was strongly influenced by factors other than diffusion and mass flow (such as adsorption). Diffusion and mass flow may be more important factors in the transport of selenate at environmentally relevant concentrations a short time scale.
Impact: The California Water Resources Board and San Francisco Bay area water quality monitoring organizations are utilizing these results to improve water quality monitoring programs.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.23 Water Quality

Title: Using Genetic Engineering to Enhance Phytoremediation of Toxic Trace Elements

Description: A UC lab 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. The narrative below highlights our most significant achievements. Phytoremediation Field Trial of Genetically Engineered Plants: In 2003, in collaboration with a researcher from USDA-ARS, Parlier, CA, they conducted the first-ever field study to evaluate the applicability of genetically engineered plants for phytoremediation. This successful field trial was followed by two field trials conducted in 2004 in the same sediment with high concentrations of salts, Se, sulfur, and other trace elements, with the following plant lines: wild type (WT) and transgenic Indian mustard (Brassica juncea) overexpressing the enzymes selenocysteine methyltransferase (SMT), cystathionine gamma-synthase (CGS), or both ATP sulfurylase and SMT (APSxSMT). The results of these studies in terms of relative tolerance, Se accumulation, and Se volatilization are currently being analyzed. Elucidating and genetically manipulating plants for trace element phytoremediation: 1) APSxSMT Indian mustard: The researchers previously developed double homozygous plants overexpressing both APS, from Arabidopsis thaliana, and selenocysteine methyltransferase (SMT), from the Se-hyperaccumulator, Astragalus bisulcatus. APSxSMT plants have increased accumulation of Se and S when grown in the presence of selenate. They have since shown, in laboratory studies, that APSxSMT seedlings can accumulate up to 9 times higher concentrations than WT when grown on selenate, the largest increase that we have observed yet. The seedlings also had increased tolerance to both selenate and selenite, as well as increased accumulation on selenite. As was previously observed with the SMT plants, this increased Se tolerance and accumulation corresponded with an increase (3 to 4.5 times higher) in the production of methylselenocysteine, the enzymatic product of SMT. 2) Other hyperaccumulator genes from A. bisulcatus: They have initiated a project designed to detect and characterize other important genes in the A. bisulcatus Se hyperaccumulation mechanism. Their approach is to compare the transcriptomes of A. bisulcatus and its non-accumulator relative, Astragalus cicer. We are currently propagating plants. 3) Heavy metal tolerance and GRP3. They previously identified the At-GRP3 protein as being involved in heavy metal resistance and oxidative stress defense. We have overexpressed At-GRP3 in A. thaliana and B. juncea. The transgenic plants had increased tolerance to a wide variety of oxidative stresses. They have determined that At-GRP3 is part of a signal transduction pathway that turns on a number of genes involved in plant stress defense. They are currently attempting to localize At-GRP3 within plant cells. Finally, they are optimizing methods to produce At-GRP3 protein to determine if direct spraying on plants can be used to induce a protective stress response, like that seen in the transgenics, in wild type plants.

Impact: The multi-disciplinary research has allowed us to develop innovative means of optimizing phytoremediation from the bench to the field. This bioremediation research will be used to efficiently and economically clean up trace element-contaminated environments.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.23 Water Quality
Title: Wetland macrophytes and microphytes: their role in ecosystem nutrient cycling with applications for wetland restoration and bioremediation

Description: During this research period UC researchers continued in our ongoing field and mesocosm experiments concentrated on the nutrient, specifically nitrogen (N) and phosphorus (P), uptake and resorption by emergent macrophytes. They are finding significant differences in nutrient uptake and resporptin by two functional groups of macrophytes, the rushes (Eleocharis spp.) and cattails (Typha spp.). Different levels of N and P resorption are determined by the respective nutrient availability but also by the functional group. The nutrient economy of these two functional groups has a strong impact on decomposition of litter and also on microbial processes in the rhizosphere. They have started some preliminary research that would document changes in rhizosphere microbial activities by analyzing the total phospholipids fatty acid contents (PLFA) and the activities of extracellular enzymes in the sediment dominated by the two types of macrophytes. We also conducted a series of measurements to document changes in nutrient and Eschericia coli levels in runoff water from irrigated pastures passing through cattail-dominated wetlands. The results are very promising and this specific research component will continue throughout the 2005 growing season. In terms of microphyte, specifically cyanobacterial mats communities; they have demonstrated a significant species diversity decrease following nutrient addition and a switch from cyanobacteria-dominated communities to assemblages dominated by filamentous green algae.
Impact: The use of macrophytes and microphytes in waste water treatment systems requires a thorough understanding of nutrient uptake and resorption characteristics of individual species. In terms of macrophytes, this project demonstrated that cattails (Typha spp.) improve water quality, specifically the nitrate and Eschericia coli levels, in the runoff from irrigated pastures. We also confirmed that cattails abundance increases in natural wetlands that receive nutrient enriched water input. In regard to microphytes, the researchers elucidated the response of cyanopbacterial community to different nutrient additions and salinity. This is guiding the management plans for use of wetlands for wastewater treatment.

Funding Source: Hatch and State

Scope of Impact: State Specific

Theme: 4.23 Water Quality
Title: OAK MANAGEMENT IMPACTS ON WATER YIELD AND NUTRIENT CYCLING IN ANNUAL RANGELAND

Description: Annual rangelands occupy three million hectares in California, and represent the landscape where California's urban-wildland-agricultural interface is most pronounced. Grazing and prescribed fire are critical vegetation management tools allowing managers to maintain economically feasible agricultural enterprises, maintain open space, reduce fuel loads, improve habitat for certain wildlife species, and manage weed infestations. Grazing and prescribed fire are the most cost effective vegetation management tools available to most rangeland managers. However, the watershed-scale impacts of grazing and prescribed fire on water quality, hydrology, nutrient cycling and plant community dynamics have become the subject of intense debate on these rangelands. Public concern is fueled by recent events such as the listing of various aquatic dependent species on the Federal Endangered Species List, development and enforcement of numeric water quality standards (Total Maximum Daily Loads-TMDLs), litigation concerning grazing impacts on municipal drinking water quality, and costly wildfires due in part to unmanaged fuel loading. A large number of stakeholders have an interest in the resolution of this debate including ranchers, watershed groups, regulatory agencies, land management agencies, municipal drinking water districts, consultants, and environmental groups. UC researchers continue to monitor the flux of nutrients into and out of the 103 hectare Schubert watershed at the Sierra Range Research and Extension Center. They have completed 25 years of continuous monitoring and have a database against which more short-term monitoring projects can be based. Long-term water quality records that can be used to assess natural variability in water quality constituents, assess the impact of management practices on water quality, and guide regulatory processes to safe-guard water resources are particularly rare. For the first twenty years of the project, mean annual precipitation was 734 mm (range 366 - 1205 mm per year) and mean annual stream flow was 353 mm (range 87 - 848 mm per year). Average annual stream flow was 48.1 percent of precipitation. Mean annual nitrate-N export from the watershed was 1.59 kg per hectare per year (range 0.18 - 3.6 kg per hectare per year). Annual nitrate-N fluxes generally increased with increasing annual stream flow (correlation coefficient was 0.32; P was 0.01). Mean daily nitrate-N export was 0.004 kg per hectare per year (range 0.001 to 0.55 kg per hectare per year). Mean annual suspended sediment export from the watershed was 198 kg per hectare per year (range 23 - 479 kg per hectare per year).
Impact: There is paucity of information concerning the influence of rangeland management practices on water quality in California oak woodlands. Long-term water quality records that can be used to assess natural variability in water

quality constituents, assess the impact of management practices on water quality, and guide regulatory processes to safe-guard water resources are particularly rare. This project helps to fill this void, leading to improved water quality in California oak woodland systems.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.23 Water Quality
Title: INFILTRATION MANAGEMENT IN CLAY SOILS: EFFECTS OF WATER TABLE DEPTH AND BIOSOLIDS APPLICATION

Description: Infiltration and water table management is not only a major challenge for growers irrigating crops in arid and semi-arid areas, but also an erosion hazard related problem in hillslope orchards, vineyards or other disturbed soils. Managing salinity involves application of sufficient water for crop production (including cover crops for erosion control) combined with additional water or use of rainfall to leach the soil profile. In addition, delivery canal/irrigation seepage must be limited so as to control waterlogging of lands. The main source of salt is the applied irrigation water although in places with high water tables, salts may be brought into the rootzone by capillary rise of shallow groundwater. The leachate or deep percolation carries salts into the regional groundwater, or artificial drainage system for disposal elsewhere. In some areas, river stage sets the waterlogging levels through control of adjacent water table elevations, an issue exacerbated by heavy clay soils with very small soil permeability. UC researchers continue investigating the combined effects of early season waterlogging and later water shortages on crop yields. Lack of early season growth, reduces evapotranspirative demand, stunts growth and of forage/hay crops, reduces yields; these effects appear to be additive. Though seemingly incongruous, both problems manifest themselves similarly in terms of decreased plant respiration rates and production. Following several publications about cut-off irrigation of sudangrass and alfalfa hay and its potential water savings and effects on soil salinity and infiltration rates, we have completed three summer seasons of measurements of infiltration rates in disturbed soils under different surface treatment conditions (i.e. mulches and native vegetative cover) using a portable rainfall simulator. Generally, mulches improve infiltration rates, slightly reduce runoff rates and erosion rates (gm/mm of runoff), while vegetation cover reduces erosion rates with mixed effects on infiltration and runoff rates. Clearly, multiple years of trials will be needed as native vegetation is established. The model they developed of pesticide runoff process for use in developing BMPs for infiltration management techniques as a practice towards reduction of pesticide concentrations in runoff has been adopted in the Sacramento River basin EPA modeling efforts.
Impact: Results from this project are directing effect assessment of the amount and value of agricultural water available for market transfer, better describe irrigation-

drainage processes and their effects while developing improved infiltration management schemes to reduce erosion and pollutant transport to surface waters.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.23 Water Quality
Title: Reducing Barriers to Adoption of Microirrigation

Description: The quality of soils, ground and surface waters is specifically vulnerable in climatic regions where agricultural production is possible only by irrigation such as in California (USA) and in many other (semi-) arid regions of the world. The regular excessive application of nitrogen fertilizers with irrigation water is likely responsible for the increase in nitrate concentrations of groundwater resources in these areas. As a result, nitrate concentrations in groundwater exceeds the drinking water standard in these areas. Therefore, alternative irrigation water and soil management practices are needed that tactically allocate water and fertilizers to maximize their application efficiency, by minimizing fertilizer losses through leaching towards the groundwater. Micro-irrigation systems can be designed and operated so that water and solute 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. Yet, at present, there are few soil and crop specific guidelines for designing and managing irrigation/fertigation systems that minimize nitrate transport, considering typical nonuniform distributions of soil solution nitrate and crop uptake. This study will assist operators of micro-irrigation systems to better manage fertigation, as well as their design, especially, to minimize nitrate leaching. The specific objective of this study was to evaluate the controls of fertigation strategy and soil type on nitrate leaching potential for four different micro-irrigation systems, each associated with a typical crop. The selected combinations of micro-irrigation system and crop are representative for California conditions. These strategies included different injection durations, different injection times relative to the irrigation set time, and different concentrations. Model simulations will be presented for 4 different pressurized irrigation systems; each associated with a typical crop. These are surface drip tape (SURTAPE; strawberry), subsurface drip tape (SUBTAPE; processing tomatoes), surface drip emitter (DRIP; grape), and microsprinkler (SPR; citrus). The modeling of water flow and fertigation scenarios was conducted using an adapted version of the computer simulation model, Hydrus-2D. This software package can simulate the transient two-dimensional or axi-symmetrical three dimensional movement of water and nutrients in soils. In the applications the UC researchers solely considered nitrate as applied by the micro-irrigation systems through fertigation. In addition, the model allowed for specification of root water and nitrate uptake, affecting the spatial distribution of water and nitrate availability between irrigation cycles. For each soil type and

emitter type, the spatial patterns of water content and nitrate concentration were determined for various fertigation strategies.
Impact: A modeling study on various micro-irrigation systems concluded that nitrate leaching is reduced in coarse-textured soils if fertigation is conducted early on during the irrigation. Total seasonal leaching was the lowest for subsurface drip tape, for which water and fertilizers are effectively supplied to the rooting system. Total seasonal leaching was the highest for the surface tape system, mostly because of the relatively shallow root depth of strawberries.

Funding Source: Multistate Research and State
Scope of Impact: AZ, CA, CO, FL, IA, ID, KS, LA, NM, NYG, OH, OR, PR, TX, UT, VI

Theme: 4.23 Water Quality
Title: REDUCING THE POTENTIAL FOR ENVIRONMENTAL CONTAMINATION BY PESTICIDES AND OTHER ORGANIC CHEMICALS

Description: Perchlorate, a pollutant resulting from rocket fuel, highway flares, and fireworks manufacturing, and some fertilizer use, has been detected in soils, surface and ground water, and vegetables. UC researchers investigated the microbiology of perchlorate reduction in soils and contaminated vadose zone samples and investigated technologies for perchlorate remediation. Using a DNA fingerprinting method to characterize the microbial community associated with perchlorate reduction, we detected DNA sequences of four bacteria strains unique to soil incubated with perchlorate. Sequencing indicated the bacteria were members of bacterial phylogenetic groups reported to reduce perchlorate in other soils and bioreactors. Perchlorate-reducing organisms were present in both uncontaminated and contaminated soils suggesting that the ability to reduce perchlorate may not require previous exposure to the contaminant. We tested the ability of zero-valent iron (ZVI) to enhance perchlorate biodegradation by native soil microbial communities in saturated microcosms under anoxic conditions. The mechanism involved is hydrogen gas, and possibly divalent iron, generated from ZVI provides an electron donor for microorganisms that reduce perchlorate. Perchlorate removal was faster in the presence than absence of ZVI, suggesting the potential for use of ZVI for treatment of perchlorate-contaminated groundwater. They investigated the phylogeny and phenotypic traits of a methyl tertiary butyl ether (MTBE)-degrading bacterial strain isolated by their lab from a compost-filled biofilter and that occurs naturally at many locations in the environment. The strain represents a new genus, based on its phenotypic distinctions from the 16SrRNA sequences of its closest neighbors and its scientific name is Methylibium petroleiphilum Strain PM1. The organism is a methylotroph but does not appear to use methane for growth. The bacterium also uses a wide variety of aromatic pollutants (toluene, benzene, xylenes). PM1 growth but not MTBE biodegradation was enhanced by presence of cobalt. MTBE biodegradation, however, required the presence of iron. They also

investigated the metabolic pathway and enzymes involved in MTBE biodegradation by PM1. Inhibitor studies indicated that addition of allyl thiourea, formaldehyde, or butadiene monoepoxide inhibited MTBE biodegradation, whereas 1-amino benzotriazole and carbon monoxides, both inhibitors of P-450 activity, had no impact on degradation. Ethanol is rapidly replacing MTBE as a fuel oxygenate in many US states. Few studies have evaluated how accidental releases of ethanol into groundwater will impact the biodegradation of other petroleum compounds and residual MTBE. They are conducting a field study at Vandenberg Air Force Base comparing the fate of benzene, toluene and xylene, either in the presence or absence of ethanol, in groundwater. The ethanol release repressed the biodegradation of benzene and enhanced conversion of MTBE to an intermediate compound, tertiary butyl ether. Ethanol release stimulated bacterial growth and shifted the microbial community to a great proportion of Archaea.
Impact: Perchlorate and MTBE are both widespread contaminants throughout the United States. Both compounds have contaminated drinking water supplies and perchlorate has also been detected in milk and vegetables. Results of our studies on perchlorate are useful in developing in situ remediation schemes for contaminated groundwater, agricultural soils contaminated by perchlorate-tainted irrigation water (e.g. the Colorado River) or hazardous waste sites.

Funding Source: Multistate Research and State
Scope of Impact: AL, AR, AZ, CA, CT, DE, FL, GA, HI, IA, ID, IL, IN, KS, MI, MN, MT, SD, TN, TX

Theme: 4.23 Water Quality
Title: Long-Term Sustainability of Groundwater Quality in California Agricultural Basins

Description: 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 2003-04 we conducted such a field test by pumping and intensively sampling a well constantly for 50 days. The wells were sampled for several environmental tracers typically used to estimate mean groundwater age (CFCs, SF-6, 14C, 3H-He). Results show generally systematic, measurable shifts in apparent CRC and SF6

ages, confirming the original hypothesis that each sample consists of a broad range of ages. Noisy, elevated CFC concentrations from the shallow interval indicate local contamination (non-atmospheric input), confounding interpretation of ages from this interval. The chromatograms also indicate presence of other VOCs that interfere with the analytical determination of CFC-113. These VOCs appear to be breaking through to the well in an episodic fashion, which is also consistent with our numerical model simulations and should provide additional insights into groundwater age and contaminant transport phenomena. Detailed analysis of these data and model refinement are ongoing. Work continues on their random walk computer code (RWHET) for accurately modeling transport of non-point source and point source pollution. They are adapting the code for inclusion into the family of groundwater flow and transport codes used by the US Geological Survey.
Impact: This work is providing more efficient, scientifically-based means of characterizing and modeling contaminant problems in groundwater, especially for nonpoint sources. The results are leading to more effective, cost-effective protection and cleanup of groundwater resources as well as reduction in the probability of human exposure to harmful substances.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.23 Water Quality
Title: INFLUENCE OF PREFERENTIAL FLOW ON WATER AND CHEMICAL TRANSPORT IN SOIL

Description: The Newport Bay/San Diego Creek Watershed has had a total maximum daily load (TMDL) established for the allowable loading of nitrogen into the bay. Although agriculture is identified in the TMDL as a major contributor of nitrogen in the watershed, observations from a monitoring study and estimates from a conceptual model show that agriculture is contributing far less than assumed. As a result, limitations on loading from agricultural sources to be obtained by 2007 have already been met. Agricultural land use in the region has been greatly reduced, from approximately 20% of the watershed area in the 1980s to a current 2% of land area. UC researchers developed a simple nitrogen transport model that superimposes contributions made by all of the sources contributing to the flow of the surface water. The model assesses the travel times from the sources and their mass estimates. It predicts that agriculture now contributes only 2% of N loading directly to surface waters. An additional 6% from agriculture is contributed if estimates of leaching to shallow groundwater and subsequent mixing with surface water are also considered. The time lag involved in groundwater mixing suggests that even if all remaining agricultural production in the watershed were ceased today, the effects of nitrate loading from fertilization would continue to be seen for another 10 to 30 years. The greatest input to

current surface water conditions is not agriculture, but increasing urban development. Nurseries also contribute a significant portion of nitrate, and have the highest contribution per unit area of any N source.
Impact: This study clearly demonstrates the influence of travel time on surface water quality and the need to include time estimates in TMDL assessments. The UC research shows that agriculture is not a significant contributor to nitrogen levels in the watershed, and that changes in surface management by agriculture will have no discernable effect on water qualify in the region.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.23 Water Quality
Title: CHARACTERIZATION OF FLOW AND TRANSPORT PROCESSES IN SOILS AT DIFFERENT SCALES

Description: This project is being conducted on a plot located at the University of California-Riverside Turfgrass Research Facility. The experimental design is a random complete block (RCB) design with N treatments arranged in a 2x3 factorial. Slow-release N and water soluble, fast-release N were applied at the same three rates 8, 6, 4 lb/1000 ft2). The plot is irrigated at 100% ETO minus the amount of rainfall. The actual amount of irrigation is determined each week based on the previous 7d accumulative ETO and rainfall, obtained from an on-site California Irrigation Management Information System (CIMIS) station, and is applied in two irrigation events per week. The data concerning nitrate leaching, from a well-established tall fescue, will help support BMPs for fertilizing tall fescue lawns to optimize plant performance and nitrogen uptake while reducing the potential for nitrate leaching. Several preliminary observations follow. 1. Minimalist irrigation reduces the potential for nitrate leaching. However, sufficient irrigation is needed to promote healthy turfgrass. 2. An annual N rate of 4 to 6 lb/1000 ft2 produces an acceptable to good quality tall fescue lawn. Higher rates are not necessary and increase the risk of nitrate leaching. 3. Slow-release N sources (Nutralene, Milorganite, and Polyon) cause less nitrate leaching than a fast-release N source (ammonium nitrate). 4. The amount of nitrate leaching from a fast-release N source can be drastically reduced if N rates of individual applications do not exceed 1.0 to 1.5 lb/1000 ft2.
Impact: The test turfgrass (Tall fescue) is the most popular species used in California lawns. Identified best management practices (BMPs) for fertilizing lawns can significantly improve the N use efficiency and reduce the adverse impact on water quality.

Funding Source: Multistate Research and State
Scope of Impact: AZ, CA, CO, CTS, DE, IA, ID, IL, MN, MT, ND, PA, TN, TX, UT, WA, WY

Theme: 4.23 Water Quality
Title: Water Quality in Southern California Surface Water

Description: Research on water quality in southern California lakes has continued. The effects of recycled water inputs on water quality in Lake Elsinore formed the basis for the M.S. thesis of Rebecca Veiga Nascimento. Recycled water was added as a pilot project for 2 years to help offset evaporative losses during the drought that has persisted in Southern California through the fall of 2004. Although nutrient inputs from the recycled water were substantial, internal recycling of nutrients due to mineralization of organic sediments and wind-driven sediment resuspension remained the dominant sources of nutrients to the water column. A change in algal ecology was also observed, with the buoyant blue-green alga Oscillatoria dominating the algal ecology beginning in the summer of 2002, just prior to recycled water inputs. The limited freshwater inflows over the past several years, combined with strong evaporative demand in the region, has led to salinization of the lake. The high salinity of the lake was implicated in changes in the zooplankton ecology of Lake Elsinore as well. The zooplankton community was largely comprised of copepods and rotifers, with very few Cladocerans present. This contrasted zooplankton measurements made in 2001, when Daphnia, Ceriodaphnia, and other Cladocerans were comparatively abundant in the lake. The influence of salinity as a stressor to Cladoceran reproduction and survivorship was evaluated in laboratory toxicity tests. These tests confirmed that the salinity levels in Lake Elsinore were sufficiently high in 2003 and 2004 to result in acute toxicity to Daphnia pulex and chronic reproductive impairments to Ceriodaphnia dubia. Because Lake Elsinore is often phosphorus-limited, strategies to control phosphorus release from the sediments were also evaluated in laboratory studies. Alum has been added to eutrophic lakes for several decades to form a reactive barrier that prevents phosphorus flux from the sediments, although such applications have generally been made in lakes with circumneutral pH and modest alkalinities. As a result, a series of laboratory tests were conducted to evaluate the efficacy of alum treatment for the high pH and alkalinity water in Lake Elsinore. Alum treatment resulted in only modest reductions in pH that were reversed over time due to slow outgassing of carbon dioxide formed from reaction of acidity generated from aluminum hydrolysis with lake alkalinity. The high pH maintained relatively high dissolved Al concentrations, although dissolved levels declined over time due to solid phase transformations to lower solubility crystalline solid phases. The influence of calcium salt additions on water quality was also evaluated. The high pH and alkalinity of Lake Elsinore water was quite favorable for precipitation of calcium carbonate, although calcium carbonate was shown to be much less effective at binding phosphorus than the aluminum hydroxide formed from alum. Current research includes laboratory and field studies of alum treatment in Big Bear Lake.
Impact: These studies improve our understanding of surface water quality in Southern

California, and have been used to identify appropriate management strategies for these 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: 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, we 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. The UC research has increased the understanding of the processes that affect short-term climate variability. Such understanding is 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: 4.25 Wetlands Restoration and Protection
Title: Biodiversity Studies of Spiders

Description: A UC researcher is studying spiders from a diversity of habitats both in California and the Pacific, to understand patterns of biodiversity and identify sites of rarity and conservation concern. This year he has focused on: 1. Patterns of spider diversity across the Pacific. He has undertaken field trips to various islands in the Pacific, including the Hawaiian and Society islands. He has collected different groups of spiders in an effort to understand diversity patterns: Where are the sites of high

biodiversity, and what are the impacts? He has collected many undescribed species (presumably endemic), and many presumed introduced species and have been generating molecular characters for these taxa to show how they are related, and/or to determine whether they are recent introductions. In this way we will be able to assess biodiversity hotspots and impacts of non-native species. 2. Species community formation. Representatives of one group of spiders in Hawaii in the long-jawed orb-weaving genus Tetragnatha (Tetragnathidae) can be classified into four distinct ecological types, or ecomorphs. He has shown that spider species can evolve and differentiate from a single species on the same island so species of one ecomorph on an island are often more closely related to a species of a different ecomorph on the same island. Moreover, the highest diversity of species is on the second oldest island, being reduced to a single representative of each ecomorph on older islands. This research has important implications, showing that there are common processes underlying community formation, whether species arise through colonization or evolution. Another study on Hawaiian Tetragnatha has shown how the web architecture varies between species. Within any one island no two species build the same sort of web, but certain basic web architectures occur in different species on different islands. Molecular genetic analysis reveals that species spinning similar web types are only distantly related, but have hit on the same web architecture independently. Further work is now required to establish how web architecture affects prey capture success in different habitats. 3. 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 we 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, we can also determine associations with agricultural and urban areas.
Impact: Among arthropod predators occurring in wetlands, both fragile riparian and island systems, and agroecosystems, spiders (in particular long-jawed spiders, genus Tetragnatha) are often the most important insect predators. Understanding patterns of endemism of spiders in such areas, and identifying hotspots of biodiversity, is key to conservation efforts. Moreover, elucidating historical changes in biodiversity allows us to predict future trajectories in the face of human-mediated habitat modification.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.27 Wildlife Management
Title: GLOBAL WARMING AND SURVIVAL OF DESERT BIGHORN SHEEP

Description: Bighorn sheep inhabit 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. Research was conducted to characterize and model the current status and predict the future prospects for survival of desert bighorn sheep in southeastern California. Droppings of bighorn sheep were collected and analyzed. Mitochondrial DNA was extracted to infer population structuring. Fecal nitrogen was analyzed to determine diet. Measurement of fecal nitrogen content-which varies with growth and moisture content of forage plants-from the same droppings will indicate seasonal precipitation patterns. Areas with winter precipitation are expected to show winter and spring peaks in fecal nitrogen, whereas summer precipitation is expected to show summer peaks with greater variation in amount and timing. Summer thunderstorms typically result in greater precipitation where they occur, but are much more variable in time and space. DNA information indicates that these populations showed a surprising degree of genetic differentiation and a large degree of spatial structuring of bighorn populations. Analyses of fecal nitrogen levels, an index of diet quality, showed that spring diet quality was significantly lower in low-elevation mountain ranges, as predicted by the climate-extinction model, and was positively correlated with lamb recruitment (and thus population growth) across ranges. Using a GIS model that includes the most important environmental variables, and data from 27 previous extinctions, we modeled the vulnerability of bighorn sheep to climate changes projected by global climate models. Lower elevation, drier, and more isolated ranges are most vulnerable. We 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 affects the viability of the metapopulation cluster by loss of sources of dispersal necessary for recolonize following extinction.
Impact: For the first time, predictions from a survival model for desert bighorn sheep allows one to anticipate, and possibly mitigate, the impact of global climate warming. Data collected have established a baseline condition against which the consequences of actual future climate changes can be compared.

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 characteristics of vegetation in the urban/wildland interface have changed over time in the San Francisco bay Area due to plant succession and the ageing of trees in forest plantations. An increase in fire hazard, as measured by fire-line

intensity and average flame length, has occurred as a result succession of grassland to brush dominated plant communities. Older forest plantations in the urban-wildland fringe exhibit an increasing frequency of wind throw. Landscape level patterns of wind throw were correlated in this project with tree species, age of plantation, topographic position, and soil shear strength. The feasibility of mapping areas of high windthrow potential based on these factors was demonstrated. The results of this research indicate fire hazard can be reduced by a proactive management of grassland succession to brushlands and a conversion of brushlands back to grasslands. Shorter rotation ages, avoidance of planting of Monterey pine on exposed ridges with soils of low shear strength, and minimizing the size of forest openings can be used to avoid future problems of wind throw associated currently with older stands in the urban/wildland interface.
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 in Mount Tamalpais State Park as a result of this research. Wind throw hazard maps, based on this research, are being used at the Golden Gate National Recreation Area and at The Sea Ranch in Sonoma County, to plan the long-term management of older forest plantation and natural forest stands in the urban-wildland interface.

Funding Source: McIntire-Stennis and State
Scope of Impact: State Specific

Theme: 4.27 Wildlife Management
Title: Demography of Threatened and Exploited Birds

Description: Field work ended on studies of the demography and population trends of Marbled Murrelets (Brachyramphus marmoratus) in central California that UC researchers had conducted since 1995. Two papers were published. One developed approaches and tested hypotheses for the mechanisms responsible for low levels of reproduction in this population. A second paper examined the inland flight behavior of telemetered murrelets in relation to measures of population size produced by radar for monitoring. Manuscripts recently completed from mark-recapture data estimated adult survival and population size. Analyses have been used to evaluate if the central California population may be sustained by immigration from populations further north and may be a demographic sink. We completed the 17th year of continuous studies of the demography and behavior of Green-rumped Parrotlets (Forpus passerinus) in Venezuela, conducting field work from June through December. Long-term analyses of sex ratio variation were published and a second paper on egg size variation was completed. Analyses concentrate on evaluating behavioral, spatial and temporal factors driving rates population change. We conducted the third year of studies of metapopulation dynamics of Black Rails (Laterallus jamaicensis) in the foothills of

the Sierra Nevada Mountains in Yuba and Nevada Counties. These secretive birds occur in small, isolated wetlands mostly smaller than1 ha and typically on private lands. We conducted systematic surveys (broadcasting rail calls) to determine the presence or absence of rails from 130wetland patches in relation to patch size, isolation, grazing, and water management. 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 nesting in Spartina had reduced nesting success due to flooding and predation from Marsh Wrens, which appeared to exclude sparrows from their territories and punctures sparrow eggs.
Impact: Results from their murrelet studies are yielding important information about factors causing declines in this species and guiding the application of forest restoration management strategies in old growth forests in California. Sparrow and rail studies have yielded important information for improving wetland management.

Funding Source: McIntire-Stennis and State
Scope of Impact: State Specific

Theme: 4.27 Wildlife Management
Title: Biotic and Abiotic Factors Affecting the Biodiversity of Temporary Waters in California

Description: This year UC researchers completed some of our work on biotic and abiotic factors affecting species of concern in temporary waters. They submitted a paper to Ecological Applications reporting several years of work on how mosquitofish affect the threatened California Tiger Salamander (CTS), in both temporary and permanent pond situations (Leyse et al., submitted). Mosquitofish are frequently used to control mosquito larvae in California. The manuscript presents two replicated, controlled field experiments in constructed ponds. Mosquitofish had little effect on salamander larvae when fish were introduced in low numbers to simulated temporary pools. However when we simulated fish population sizes expected in permanent ponds, salamander size and survival both decreased by biologically significant amounts. Side experiments showed that the mechanisms underlying this result were likely to be competition for invertebrate prey, and behavioral avoidance of fish. This shows that mosquitofish should not be used to control mosquitoes in semi-permanent or permanent sites where CTS breeds. One researcher also continued to write up her study of the decline of long-toed salamanders in the Sierra Nevada. This adds to our body of work on how mosquito control techniques affect temporary pond fauna including tadpole shrimp, fairy shrimp, frogs, and salamanders. They completed the first field season of their study on how intensified use of ultra-low volume pesticide fogs for mosquito control affect the invertebrates of seasonal wetlands. The Colusa Mosquito Abatement District applied a pyrethrin insecticide over wetlands on Colusa Wildlife Refuge twice per week in September and October of 2004, and

left Delevan Wildlife Refuge untreated. They established four study areas on each refuge, encompassing at least three large wetland basins. They completed two series of light-trapping samples on nights before, during, and after a spray to estimate mortality of flying insects. They collected zooplankton samples and sweep-net samples of aquatic insects at least once per week from all sites. We are currently enumerating and identifying invertebrates in the laboratory. A parallel study by another researcher is assessing whether the pesticides tated into the wetlands.

Impact: Results presented in Leyse et al. (submitted) informed Mosquito and Vector Control Districts (MVCDs) that mosquitofish are incompatible with preservation of California Tiger Salamander populations in permanent waters and semi-permanent waters. This information helps MVCDs and wildlife managers protect a declining and endemic amphibian, thus helping to preserve California's biodiversity. The researchers are evaluating whether adulticides used in mosquito control are compatible with sustaining production of invertebrates in seasonal wetlands. This information will be useful to wildlife managers and mosquito abatement districts as they negotiate their Pesticide Use Permits for refuges. Aquatic invertebrates are important resources that support resident and migratory waterfowl. Because adulticiding is a widespread practice, this work has relevance

elsewhere in California, the USA and internationally.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.27 Wildlife Management
Title: Habitat fragmentation and biodiversity of aquatic habitats in California

Description: The project evaluated the population status and recovery potential of the federally threatened Valley Elderberry Longhorn Beetle (VELB) (Desmocerus californicus dimorphus). The species is endemic to California's Central Valley and is vulnerable to extinction because it feeds only on patchily-distributed elderberry in riparian habitats. It inflicts a significant annual cost on public agencies through mitigation in response to incidental take of the species. In 2004 aims were: (1) improve our understanding of the factors controlling the distribution, abundance and extent of VELB populations within the American River Parkway (ARP); and (2) to study the success of habitat mitigation efforts that aim to ameliorate for habitat loss. 1) Assessment of factors promoting VELB occupancy and abundance expanded mapping to cover a total of 13 of the 23 miles of the ARP. Beetle occupancy and abundance increased with: proximity to the river and presence of adjacent elderberry; intermediate levels of canopy and shrub cover; and in larger elderberry clumps with more elderberry stems. Identifying these factors helps us to improve the design of mitigation sites and to evaluate the value of different habitat areas. These data will also be used for constructing a mathematical model predicting (meta) population viability in 2005. An additional activity was to use a natural experiment to assess the effects of dust from dirt roads on both the host plant and the VELB. A comparison of dirt and surfaced (control) roads showed that there were no significant impacts of dust on elderberry density, plant stress or VELB abundance. Mitigation for dust impacts is a significant source of cost to agencies. A manuscript reporting the dust results was submitted to Environmental Management. 2) Habitat mitigation success was assessed using all mitigation reports in the Sacramento USFWS office (89 reports from 45 sites). On average 64% of plantings were replantings that replaced dead plants, representing substantial additional cost. Overall 2,379 elderberry seedlings were planted and 351 elderberry were transplanted annually. Based on expectations from reporting guidelines only 20-60% of the expected reports were filed, indicating a substantial information loss. Initial survival of planted seedlings was greater than that for transplanted elderberries. However per bush seedling and transplant survival were equivalent by year 7, and this was the soonest that colonization of seedlings by VELB occurred. 48% of sites were colonized by VELB, but almost all of these sites received transplants containing VELB and natural colonization of seedlings was rarely reported.
Impact: Factors identified to be positively associated with high Valley Elderberry Longhorn Beetle presence and abundance are being incorporated in recommendations to US Fish and Wildlife Service (USFWS) about how to

improve habitat mitigation practices for the species. The evaluation of mitigation reports shows that mitigation efforts are extensive, that transplanted shrubs are more valuable than seedlings, that mitigation reporting is inadequately monitored by USFWS, and that longer term monitoring for more than the current 10-15 years is needed to see whether the species utilizes planted seedlings. These activities will reduce public cost of habitat mitigation and result in improved recovery potential for this threatened species.

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: UC researchers' 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 two projects on the landscape genetics of an endangered salamander (the California tiger salamander, CTS) and an endangered frog (the California red-legged frog), both of which demonstrate that existing conservation protection needs to be reconsidered. They also completed a project documenting that the hybridization dynamics of a non-native and native species of salamanders are extensive and ubiquitous, calling into question how to manage the federally endangered CTS. Finally, they have completed and published a spatial ecology project on upland habitat use in the endangered California tiger salamander. They have continued to collect material for genetic analyses of additional 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: Their work on population genetics continues to define Distinct Population Segments (DPS) and species boundaries of several sensitive species of amphibians and reptiles in California. Because they work in agricultural landscapes, helping to define the biological units of protection, be they species or DPSs, is essential for the effective management of both agriculture and sensitive species on the same landscapes. They provided the US Fish and Wildlife Service with critical data on DPS of the endangered CTS to help guide management; this work led to the listing of the CTS under the US Endangered Species Act during this review period. Their spatial ecology work has provided critical data on management and regulation of CTS, and their work on hybrids provides important information on threats. Given the sometimes conflicting goals of agriculture, development and species protection, their work helps to identify the critical areas where species must be protected, while still keeping the maximal options for alternative land uses open across a species' range.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.27 Wildlife Management
Title: ECOLOGY AND CONSERVATION OF INLAND FISHES OF CALIFORNIA

Description: (1) A extensive review of the biology of splittail was published and the species was taken off the federal endangered species list as a consequence. (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) Year 25 of monthly fish sampling in Suisun Marsh was completed, showing a leveling of abundance of the fishes. We are continuing to document the impacts of a new invasive shrimp and problems in water quality caused by duck club management. (4) A study of the benthic and planktonic invertebrates of Suisun Marsh has revealed that the system is dominated by non-native species with strong seasonal and distributional variability. (5) Funding was obtained for the experimental introduction of Lahontan cutthroat trout into Sagehen Creek. (6) Three papers analyzing patterns of fish invasions in California were published. (7) A study on the population dynamics of longfin smelt in the San Francisco Estuary has been completed. (8) A draft of a review paper on the history and ecological importance of floodplains in the Central Valley was completed. (9) The first phase of a major study of the biology of Sacramento perch was completed and the information is being used to plan re-introductions at 10 sites in the Central Valley. 10. A literature study evaluating the efficacy of fish screens in protecting fish populations was submitted for publication.

Impact: The information obtained from the Suisun Marsh and Cosumnes River studies are helping CALFED set priorities for research and restoration activities. 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.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.27 Wildlife Management
Title: TEMPORAL AND SPATIAL DYNAMICS OF SQUIRREL POPULATIONS

Description: During 2004, 123 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. For the second year in a row, densities increased dramatically; in fact, both density and reproduction this year were the highest ever recorded in this population of squirrels. The causes are unclear at this point. For example, early snow melt can enhance reproduction, but snow melt was not especially early this year. At

present, these extraordinarily high numbers seem likely to be the result of multiple factors acting in concert, and that lag effects from factors in previous years come into play.
Impact: Results on temporal and spatial dynamics of ground squirrels enhance our knowledge of how pest species respond to environmental factors, allowing managers to design control programs that are more effective at reducing damage by squirrels.

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: 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, a UC 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 require baiting strategies that reduce the frequency of bait applications, reducing the potential for environmental contamination.

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: (1) UC researchers are completing a collaborative project with Central Valley Habitat Joint Venture (CVHJV) partners to quantify winter habitat needs for waterfowl; specifically, to determine: (a) the amount of food available in moist-soil habitats and agricultural fields when waterfowl arrive in fall, (b) the rate at which this food is depleted throughout the winter, (c) the minimum food-density threshold below which waterfowl will abandon or avoid agricultural fields and moist-soil habitats and (d) the rate at which moist-soil seeds decompose and thus lose their energetic value for waterfowl. They have measured moist-soil and rice seed

abundance over a range of habitat types and management regimes. Analyses of these data have been completed and results are being prepared for publication. These data are currently being used in the recent planning update used to establish habitat goals for the Central Valley. Their results indicate that many wetland restoration projects are not providing high quality foraging habitat and we have identified a number of management techniques that could improve seed production. (2) They are continuing research on the effect of land use and agricultural practices on the population dynamics of wood ducks to determine habitat management needs and to assess the impact of agriculture on riparian habitats. They are studying several populations of wood ducks to document inter-annual changes in key demographic variables. Wood ducks represent an excellent indicator species of the health of riparian ecosystems in California given their dependency on riparian habitats. Their studies provide a long-term monitoring assay of this key natural resource. (3) They are continuing their studies using molecular genetic techniques to evaluate the population structure of waterfowl in the Pacific Flyway. These studies are focused on determining the appropriate conservation units for the management of Canada geese, wood ducks, mallards, northern pintails and Stellers eiders. For example, their work suggests that the federally listed population of Stellers eiders in Alaska may not comprise a homogenous genetic population, and may warrant alternative management considerations. (4) They are initiating new research to determine the factors limiting production of mallards in California. Beginning in 2004, they followed 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. For example, their initial results suggest that breeding probability of females is less than 70% (compared to 95-100% in other populations), indicating that early season pair and nesting habitat may be a critical resource need. Their research will help target essential management programs needed to improve breeding conditions for this economically and recreationally important species.
Impact: This project is providing key information to guide waterfowl conservation and wetland restoration efforts while promoting sustainable agriculture in California. The UC researchers'studies on the agronomic benefits of providing habitat for waterfowl in the rice growing region of the Sacramento Valley illustrate the compatibility of agricultural practices and wildlife habitat objectives. Their research has provided the necessary information to establish realistic acreage goals for wetland conservation efforts, including critical winter and breeding habitats. They 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 individuals in mid-life are less likely to use avoidance and negative coping strategies than younger ones; that publication of a newsletter on aging issues provides an avenue for communication both within the university and with external agencies; that daily activities for Alzheimer's disease patients should be set up to depend as much as possible on semantic memory ability, rather than episodic/event memory ability; that providing farm operators with training on how to diversify their businesses resulted in ranchers and farmers in diverse communities taking preliminary steps toward embarking on new tourist ventures; that young children, when encountering a novel problem-solving situation, often retrieve relevant prior experiences such as procedural strategies and attempt to apply familiar approaches to solve novel problems; that teens can handle physical independence before emotional independence; that interviews with young people with diverse gender, ethnic, and sexual identities reveal how they navigate and even shape cultural ambivalences and anxieties through every day processes of appearance style; 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; that data gathered by youth on physical environment can influence decisions made by local youth advisory boards and can have widespread influence on how other communities evaluate the role of physical environment in the lives of youth; that local capacity building projects can provide the means to create networks and an on-going

dialogue with the Latino community and other previously unconnected organizations in the community; that training teachers in experiential learning techniques can result in a change in teaching practices; that participants in a pond mapping experience could have a better understanding of geometry concepts; and that programs that focus on youth victimization may not be effective—programs should focus on increasing all youth's sense of safety because sense of safety decreased both youth perpetrator/bully behaviors and victimization behaviors.

CE advisors delivered 156 local extension programs in this area. In addition, 15 statewide collaborative workgroups and one continuing conference 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 54 peer-reviewed articles and 4 extension publications to address Goal 5 last year.

FY 2004-2005 Allocated Resources

Extension Federal Funds (Smith Lever 3 b&c)	Extension State Match	Research Federal Funds (Hatch)	Research State Match
$962,162	$962,162	$153,335	$153,335

Extension Total FTE	Research Total FTE
32.67	10.90

Theme: 5.01 Aging
Title: DAVIS LONGITUDINAL STUDY

Description: California researchers continued to analyze the data, with the students taking a major role. They found that some times of childhood stress did have an influence on adult physical health. While ordinary life events in childhood did not apparently have an effect, abuse did. Physical abuse was related to poorer physical health, while emotional abuse was related to higher levels of depression. They organized a symposium of students from the lab at American Psychological Association who presented different studies from the Wisdom Project. They analyzed the DLS data to show that religious affiliation per se was not associated with wisdom, but that spirituality was. This is important because wisdom is associated with less perceived stress and better coping strategies. A graduate student will also be doing her dissertation on the DLS, and has passed her orals. Her topic links three different types of adaptational processes, anticipatory coping (thought to avoid or minimize the occurrence of stressful events), stress and coping processes for a major problem, and

stress-related growth. Another student has also been working with this data set, and they presented a poster showing age differences in coping strategies, with individuals in mid-life less likely to use avoidance and negative coping strategies than younger ones. He will be doing his thesis examining longitudinal change in depression from young adulthood to mid-life in the DLS, and plans to take his orals in February.

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 which 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: WORKGROUP ADDRESSES AGING ISSUES

Description: The Cooperative Extension (CE) Workgroup on Aging Californians in Rural and Urban Areas and its advisory group are working to meet the challenge of an increasingly elderly population. The group disseminates information to county advisors and supervisors in order to increase understanding of aging issues (http://groups.ucanr.org/elderly).

In 2001, the workgroup completed a survey of CE advisors and supervisors regarding currently used and needed programs on aging. Although only 45 percent of respondents provided aging programs, 80 percent had a desire to do so. Results indicate that programs on finance, wellness/illness and grand parenting are top priorities. Lack of time, staff and funding are the major barriers to providing programs.

To address these issues, the workgroup is publishing a news bulletin titled "California Aging Issues" (http://groups.ucanr.org/elderly). The group hopes to increase knowledge of aging issues, encourage aging programs and enhance communication of CE personnel working in areas related to aging. Each issue includes a pull-out section, e.g., "How to Talk to Your Doctor," highlights of a senior volunteer, myths about aging, news from the state Legislature, information about coming events and web resources.
Impact: Workgroup meetings and publication of “California Aging Issues” provide an avenue for communication among CE advisors and administrators interested in aging issues, as well as enhanced communication with government institutions and private, not-for-profit groups. Northern and Southern California CE personnel are contributing to the publication, describing their innovative and usable programs on aging. Others are writing articles about their senior volunteers or share information on special interests. The publication is drawing interest from around the nation, with several requests to reproduce specific articles or portions of articles.

Funding Source: Smith Lever and State

Scope of Impact: State

Theme: 5.01 Aging
Title: SEMANTIC MEMORY IN ALZHEIMER'S DISEASE: LIMITS ON LOSS

Description: 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. The 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. California researchers have recently completed the data collection for a comprehensive 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. researchers have data on all 40 combinations of task and domain for 21 AD, 30 elderly control, and 30 young control subjects. Researchers also have partial data on an additional 30 AD subjects. Researchers have just completed and submitted for publication an overview of the findings for the subjects who have participated in all of the experimental conditions. Pathfinder network analyses showed that the AD group showed very similar semantic networks to the elderly control group, who in turn showed very similar semantic networks to the young control group. This indicates that neither AD nor normal aging is associated with impairments in semantic memory organization. Multidimensional scaling analyses, as well as Pathfinder analyses, converged on the conclusion that task and domain effects are much larger than subject group effects, in terms of semantic memory organization.

Impact: These findings of relatively normal semantic networks in AD, across a number of semantic domains and tasks, are highly relevant to the assessment, treatment, and management of AD (which affects approximately 8% of individuals over 65 years of age). For instance, daily activities for AD patients should be set up to depend as much as possible on semantic memory ability, rather than episodic/event memory ability.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 5.02 Agricultural Financial Management
Title: INTERNET AND THE AGRICULTURAL ECONOMY

Description: The proposed survey was completed and the data was analyzed. California researchers are in the process of completing an article for Rural Sociology.
Impact: The study results suggest that exposure to the technology through college, outside employment, friends, and family is ultimately more influential than farmer age and farm size. Notably, about half of those who use the Internet for farm- related business report zero economic benefits from it. Whether a farmer perceives that the Internet generates economic benefits depends primarily on how long the farmer has used the Internet for farm business and for what
purposes.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 5.04 Child Care/Dependent Care
Title: LEARNING AND PROBLEM SOLVING IN YOUNG CHILDREN

Description: Issues related to young children's learning processes are critical aspects in human cognition and intelligence, and examining these issues will help link research on cognitive development during infancy and during later childhood. A great deal of research has examined toddlers' and preschoolers' abilities to understand symbol-referent relations and use the information about the hiding locations of a source space (e.g., a scale model, picture, or map) to guide searches in a target space (e.g., a room). Although young children have demonstrated impressive abilities, relatively little is known about how children come to accomplish such feats. California researchers conducted two studies to examine whether and how young children acquire strategies involved in mapping spatial arrays with experience. With a micro genetic design and multiple analogous tasks, 2.5-to 5-year-old children were tested on their ability to discover new strategies for locating a hidden toy by mapping two spaces when no instruction concerning the relations between the analogous spaces was provided. The basic task of the present research involved the presentation of a pair of spatial arrays (a small model and a large model) that were perceptually similar but different in size and other details. Each model contained three locations where a toy could be hidden. On each trial, children were shown a hiding location in the small model and were asked to search for a target toy in the corresponding location in the larger space. Children were tested with

multiple sets of spatial arrays in multiple trials, and in each trial their performance and strategy use in target search were observed. Thus, children's task was to recognize and abandon their own unproductive strategies and to develop a new way to map the spaces. In one experiment conducted over the past two years, the larger toy was hidden in a location of the larger space perceptually and spatially similar to a corresponding location in the smaller space in each trial. It was evident that with experience, only older children (3.5- to 4-year-olds) discovered the strategy for mapping corresponding locations that shared both perceptual and spatial similarities. Researchers conducted a follow-up experiment where children received feedback concerning the correspondence between the hiding locations between the spaces at the end of each trial.
Impact: Even younger children (2.5- to 3-year-olds) showed the ability to acquire a new strategy, using the hiding information in the source spaces to guide their searches in the target spaces. They also transferred the acquired mapping strategy to solve novel problems involving new special arrays. Researchers have designed further experiments and are currently working on a conceptual model of the processes that underlie young children's acquisition of mapping strategies. Three key components - namely, encoding locations within each space, noticing the general relations between spaces, and detecting precise mapping correspondences - are hypothesized to contribute to children's proficient mapping between spatial arrays. 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: 5.04 Child Care/Dependent Care
Title: SAND TRAY PROJECT

Description: The article "The structure of toy attributes in sand tray play situations: A chain-P factor analysis" is being revised according to the feedback given by reviewers (at Multivariate Clinical Experimental Research). Plans for future....New data is being collected on pre-teen subjects and they will be followed through their teen years. Sand tray samples will be gathered at least twice a month and the resulting single P technique factor analyses will be compared to the existing Chain-P results. The hypothesis is that the structures will be very similar and will go a long way into the establishment of reliability and added validity.
Impact: Data gathered on repeated measures of sand tray play will allow (via factor analysis) a way of making available personality factor scores for individual children. It is planned to link these factor scores to behavioral measures both normal and pathological. The final result will be a non-verbal way of measuring personality in children and the possibility of correlating this with children's'

problems. Many children do no want to talk about their fears and problems but most children don't mind playing in the sand-box. Their creations can thus reveal a lot about their personality and possible pathology.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 5.05 Children, Youth, and Families at Risk
Title: THRIVING IN MID-ADULTHOOD: A PROSPECTIVE LONGITUDINAL STUDY FROM MIDDLE CHILDHOOD TO ADULTHOOD

Description: This Hatch project supplements W-167 Multi-State project. Three manuscripts worked on. First, data suggest that transitions are a time of heightened vulnerability and require special attention. California researcher considered the effects of mothers entering the full-time work status as their children enter adolescence. Based on a sample of 90 14-year-old adolescents, first studied when they were 10, those youth with mothers who entered fulltime employment after their children were age 10, those whose youth who were able to maintain access to emotional availability with their mothers was critical for youth to maintain previous levels of well-being. The physical availability of working mothers was not related to teens well-being. This manuscript is still in preparation. Second, finalized the methods used to track individuals over time for longitudinal research over long periods of time. This manuscript was written and published. Third, consistent with interest in the use of the internet for extension and utilization of research, researcher revised a manuscript pertaining to effective strategies for using electronic discussion sections to enhance intellectual discussions.
Impact: First, the data on maternal transition to working when their children are entering adolescence provides empirical support for the idea that parents need to stay emotionally available despite less physical availability. This counters the popular notion that teens need to gain emotional independence from their parents. Teens can handle physical independence before emotional independence. Second, extension personnel have been provided with a research tool to help them do longitudinal evaluation studies of their programs.

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: There were two crucial objectives for the study during the past year. First, analyses were conducted with the goal of confirming the existence of the intergenerational transmission of competent behaviors from the family of origin to young adults entering into romantic relationships. Second, efforts were made to identify pathways of risk and resilience during the transition to young adulthood. Specifically, California researchers investigated the degree to which early life adversities increased risk for psychiatric disorder during the transition to adulthood as well as social supports that reduced risk to adversity. The findings

were supportive of study hypotheses. With regard to the first goal, one article was accepted for publication which demonstrated the intergenerational transmission of competent adult behaviors. The results suggested that nurturing and involved parenting in the first generation leads to a warm and supportive interaction style in early adult romantic relationships. This interaction style promotes more stable and satisfying romantic unions. The second goal was addressed in a paper. The analyses showed that traumatic life events during the adolescent and early adult years increase risk for psychiatric disorders such as depression. Especially important, support from family and friends increased resilience to disorder even in the face of significant adversity.
Impact: The findings generated from the second year of this project are among the first to demonstrate the major influences of the family of origin on the social 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 negative life events and parenting problems 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: YOUTH STYLE AND IDENTITY DEVELOPMENT: ARTICULATING CULTURAL AMBIVALENCES AND ANXIETIES

Description: This study focuses on appearance style as a vehicle to analyze how youth become the subjects and the objects of cultural ambivalences and anxieties. The research involves multi-method approaches to determine the relations between (a) dominant cultural discourses about youth (e.g., children's apparel advertising, children's apparel industry publications, popular literature characterizing children as growing up too fast) and (b) the negotiation of identities among youth. In this last year, California researcher completed a project with a University of Illinois colleague, in which California researchers analyzed the historical and contemporary constructions of 'tween' apparel consumers. Researchers reveal how the 'tween' was created in the 1990s as an ambiguous, age-delineated marketing and merchandising category. Researchers argue that the 'tween' cannot be understood apart from its articulation with market exigencies of childhood (and, especially, girlhood- .i.e., 'subteens,' 'preteens') as they have emerged since the Second World War.
Impact: In the analysis of cultural discourse, as well as the interviews with ‘tween’ girls, researchers have found that they are both beneficiaries of and are subjected to a ‘trickle down’ fashion process of increasingly sexualized versions of femininity. (Other publications below detail this theory in greater detail.) Further, research with African American youth, also presented in publications below, shows how the intersections between gender and ethnicity further complicate dominant construction of ‘youth style.’ Interviews with young people with diverse gender, ethnic, and sexual identities reveal how they navigate and even shape

cultural ambivalences and anxieties through everyday processes of appearance style. As they do so, they cross boundaries of age, gender, ethnicity, in a complex and nonlinear way---one that is difficult (especially for adults) to put into words. Popular publications ranging from Seventeen to Tiger Beat, Essence, and the Sacramento Bee have interviewed the PI in articles that continue to grapple with issues related to this project: parental anxieties about the sexual maturity of tween girls' clothing styles, the specific challenges that African American girls face in terms of clothing choices, concerns about gang-related (or what is perceived by adults as such) attire, and the influence of celebrity style on youth.

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: 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 suggest 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 the many networks to reach minority families in rural areas.

Funding Source: Multistate Research and State
Scope of Impact: CA, CA-R, IA, IN, KY, LA, MA, MD, MI, MN, NE, NH, NYC, OH, OR, SD

Theme: 5.05 Children, Youth, and Families at Risk
Title: RESILIENCE TO VIOLENCE AMONG AT-RISK YOUTH

Description: Over the course of this project, approximately 1800 youth from 6 states have been surveyed regarding internal and external factors relating to resilience to violence. During 2004, the research team merged the data sets from all research sites including the various age cohorts (6^{th}, 8^{th}, and 10^{th}/11^{th} grades). The team met and reviewed the data, discussed analysis procedures, and developed manuscript topics. During this period, California researcher finalized the summary report of the “Teen Safety Survey” to Hiram Johnson High School and prepared a summary of eight focus groups conducted with 40 students at the school. Even though the project has been terminated, the research team is still examining the data and preparing reports and manuscripts.
Impact: The initial results of the study indicate some significant connections between youth satisfaction or well-being and their physical environments. For example, analysis of the merged data sets indicate that for female youth a lack of participation in their home environment (i.e. making decisions about their room) corresponded with a higher rate of suicide risk. This finding indicates that youth need to be given useful roles at home and alternatively, useful roles should be provided in school and community settings. Analysis of the focus group discussions revealed the importance of group territories at schools. The students repeatedly expressed the importance of both knowing where they can find their friends at school and where to avoid other students. This finding indicates that school design and policies should allow for the clustering of teen groups in common areas to foster a sense of safety among the students. Over the past decade, violence among youth has increasingly been viewed as a major public-health issue. This project addresses violence from an ecological/contextual framework and focuses on the processes by which protective factors help adolescents at high risk for self and peer-related violence compensate for their vulnerability, both as a perpetrator and as a victim of violence.

Funding Source: Multistate Research and State
Scope of Impact: AZ, CA, CO, NV, OR, WY

Theme: 5.05 Children, Youth, and Families at Risk

Title: POSITIVE YOUTH DEVELOPMENT THROUGH PLACE

Description: During 2004, the data gathered in the previous year was coded and analyzed. Data on the physical environment was obtained from youth participants in Sacramento, San Luis Obispo and Santa Clara Counties. Initial efforts to repeat this research were begun in Pasadena. Additional funding of $10,000 to pursue this research has been secured from the Los Angeles 4-H Initiative for Quality After-School Program. Interviews with previous youth leaders were conducted to determine changes to the youth photographic survey instrument for use in the next phase of information gathering. In addition, researcher continued work on a multi-site case study that has additional funding from the British Academy. Other team members include researchers at the University of Edinburgh (Scotland) and Cornell University. The research team met in Davis during 2004 to develop a standard analysis tool and discuss publication topics and venues.
Impact: The survey results continue to influence decisions made by local youth advisory boards. The project has also had a widespread impact by influencing how other communities are evaluating the role of the physical environment in the lives of youth at local, national and international levels. At the national Search Institutes Healthy Communities-Healthy Youth conference, a session on the design and analysis of the photographic survey was well attended and generated numerous requests for guidance from communities. Because of the widespread interest, study sites will be added during the 2004-05 year.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 5.05 Children, Youth, and Families at Risk
Title: FAMILY AND WORK IDENTITIES DURING TIMES OF TRANSITION

Description: California considered the transition of youth into a work world. A California researcher worked closely with an Oregon colleague to revise a manuscript (now ‘in press’) by adding a section on ways people define work to highlight the need for youth to understand these options. Work can be experienced as a vocation, career, or simply a job. Viewing one’s job as a vocation means viewing one’s work serves more than oneself, as contributing to a larger good. Viewing one’s work as a career means viewing work as a means to increased status and power. Viewing one’s work as a means to purchase things (e.g., food, clothing, sometimes to take care of basics in order to pursue a non-lucrative passion). ANY paid work has the potential to be viewed as a vocation, a career, or a job. While there is no right or wrong way of experiencing paid work, viewing one’s work as a vocation The consequences of one’s view of work, however, appears to have varying outcomes. Individuals who view their work as a vocation report both higher work satisfaction and higher satisfaction with life in general than those who view their work as a career (i.e., for status rewards) or as a job (for a paycheck).’ Viewing one’s work is important to more than oneself but for a greater good also appears linked to greater job commitment. Youth are more likely to have this experience by engaging in volunteer work rather than the kind of work they get for pay. Other accomplishments: examined the next steps for this project, wrote the first draft of the critical review, with Oregon, Wyoming, and Utah, developed the proposal for continuation of this project. Revision on a manuscript now ‘in press’ was completed. Other

accomplishments are reported in Hatch progress report linked to this project; wrote the first draft of the critical review of accomplishments of the entire W-167 project during the past 5 years; with Oregon, Wyoming, and Utah, developed the proposal for continuation of this multi-state project. Together with Oregon and Utah, supplemented by a minor contribution by Montana, California researchers designed a media coding template, coded several current publications, and wrote a theoretical paper using these data to examine issues relevant to the proposed new W-167 project that will be discussed this month. Workshop Presentation resulted: A critical look at messages concerning family, work, and personal fulfillment in popular women's magazines: A working paper. Prepared for the Pre-conference on Theory Construction & Research Methodology, National Council on Family Relations, Orlando, Florida.
Impact: The 4-H monograph has implications for youth development programs aimed at fostering quality citizenship (e.g., 4-H groups) and other vocational program development. In particular, youth need to be made aware of the choices they have in how they perceive their work lives, including the option available regardless of type of work obtained.

Funding Source: Multistate Research and State
Scope of Impact: CA, ID, MT, NM, OR, UT, WY

Theme: 5.07 Community Development
Title: ASSESSMENT OF AN EMERGING LATINO COMMUNITY

Description: The project involved the conceptualization, design and implementation of a community wide assessment of the SLT Latino community. This joint study incorporated personnel from the LAC Commission, the El Dorado County Cooperative Extension and faculty from the University of California, Davis. The assessment team developed a triangulated approach to research that used existing census and other secondary data, a series of key informant interviews of Latino and other residents, and systematic observations. Periodic updates of findings and key points were provided to the LAC members, to local newspaper and radio outlets, and to the community. These interim reports in turn provided more information and details on the Latino community while raising the public=s awareness of the challenges. A written and bi-lingual report, now in final production, will be further shared with the larger community and public and private sectors.
Impact: The outcomes and outputs of this project include a mix of concrete impacts. The increase in public awareness has been visible. Accomplished through presentations, consultations with public officials, newspaper articles, and the release of the report, the level of public awareness of the issues and of the role of the Latino Affairs Commission has risen. The local UCCE roles in the community have also been enhanced and impacted. The UCCE office has been directly engaged with a new community, it has developed collaborative research with new partners, and it has undertaken new strategies for building local capacity. This project has also provided the means to create networks and an on-going dialogue with both the Latino community and with previously unconnected organizations and agencies. This project has also catalyzed the El Dorado Community Foundation to begin to address the issue of Latinos in the county and to raise it to a higher level on their program priorities. This Foundation is now expanding the assessment process to a countywide level and committing resources to the area. This project also demonstrates the power and utility of creating

meaningful linkages between county based Extension staff, campus Extension personnel and graduate students. These linkages have not only benefited the University and local Extension systems but have led to greater attention to local issues and the mobilization of community resources.

Funding Source: Hatch, Smith Lever, State and USDA Rural Development Act
Scope of Impact: State Specific

Theme: 5.07 Community Development
Title: ART, VISION AND REALITY: THE LANDSCAPE OF PUBLIC PARKS

Description: During the past year California researcher continued working on a book on urban, public parks, completing a prospectus, which is currently under review for a book contract. Large, urban parks proliferated internationally in the nineteenth century, 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. This book is a socio-cultural history of the nineteenth-century parks movement in Europe and the Americas. It includes studies of nineteenth-century parks in Paris, New York and Mexico City. Each of these cities is unique, in terms of the social, political, cultural and ecological context for urban parks, yet strong themes and significant similarities emerge through comparison of parks in these different settings. Together these studies support the thesis that urban parks, with their idealized representation of rural scenery, represented the interests and values of an emerging, international, bourgeoisie in the nineteenth century, spanning national boundaries.
Impact: Nineteenth-century urban public parks simulated an idealized rural landscape and 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 history of these parks will lead to a better understanding of the public park as a cultural institution today. It will also contribute to better understanding of the rural-urban dichotomy as a powerful force in modern
western culture.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 5.16 Impact of Change on Rural Communities
Title: NEW IMMIGRANT POLITICAL INCORPORATION PATTERNS AND TRANSNATIONAL PRACTICES OF MEXICAN MIGRANTS IN CALIFORNIA

Description: Interviews were conducted with leaders of the Zacatecan federation of migrant home town associations in Southern California about economic development in communities of origin and Latino politics in Southern California. A UC MEXUS grant helped support travel to Zacatecas to interview Mexican state government officials about migrants in Mexican politics and to conduct interviews and participant observation during the campaign of a tomato grower from Winters,California who was elected mayor of Jerez, Zacatecas in July 2004. An article on this election was accepted for publication.

Impact: The study reveals dynamics of new modes of cross-border community economic development, electoral politics, and transnational citizenship. It enables California researchers and policy makers to observe the consequences on both sides of the U.S-Mexican border of practices of dual citizenship. Findings continue to show that migrant civic engagement in Mexico is not incompatible with engagement in state and local politics in the U.S. The study informs immigration policy-making.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H
Title: EDUCATORS ENGAGE IN EXPERIENTIAL LEARNING TRAINING

Description: The Science, Technology, and Environmental Literacy (STEL) Workgroup develops and supports programs that increase the public=s understanding of science, technology and environmental education, and enhances peoples= abilities to apply these disciplines in their lives. One goal of STEL is to increase educators= understanding and application of Experiential Learning methods. A subcommittee of the workgroup developed, pilot-tested and evaluated a series of three Experiential Learning workshops. Workshop 1: Understanding Experiential Learning- Participants learn the methods and philosophy behind Experiential Learning by experiencing the process themselves. By engaging in a problem-solving activity with little or no help from the teacher, participants go through the steps of Experiential Learning, reflect upon the process, and discuss how they can apply the knowledge to their programs. Workshop 2: Inquiry-Based Teaching Methods- Using a fun, interactive format, participants engage in inquiry-based teaching methods and learn how asking effective questions can help improve instruction. These processes help develop individuals= critical thinking and problem-solving skills and are important to Experiential Learning. Workshop 3:Developing and Adapting Curricula to Integrate Experiential Learning and Inquiry- In this workshop, the participants learn how to adapt existing curricula or activities in ways that incorporate Experiential Learning and inquiry strategies.
Impact: Workshops 1, 2, and 3 have been tested by STEL Workgroup members with 4-H volunteer leaders, after school child care providers, and classroom teachers. Surveys and interviews were used to evaluate impacts. Data indicated that 94 percent of the participants had learned information on Experiential Learning that they could use in their programs or classrooms, and 60 percent had actually changed their teaching practices because of their participation. Areas where the workshops had the greatest impacts included: understanding and applying Experiential Learning methods, inquiry-based teaching methods, questioning strategies and curriculum adaptation.

Funding Source: Smith Lever and State
Scope of Impact: State

Theme: 5.28 Youth Development/4-H
Title: VERSATILITY IN 4-H PROJECTS IS VALUABLE FOR TEENS

Description: In Mendocino, the nonprofit Mendocino Youth Ball Park Association built and maintains a community ball park and family facility called "Friendship Park." The association operates a small concession stand at the park to raise funds. For the past 8 years, Mendocino County 4-H Youth Development has collaborated at "Friendship Park" by having youth help operate the concession stand during the 10-week Little League season. Several weeks before the season begins, 12 to 14 middle-school youth attend several training sessions led by the project leader and concession stand manager, introducing them to the basics of food service and food safety. An emphasis is placed on customer service, working as a team, leadership and reliability. The youth volunteers commit to working no less than 10 four-hour shifts in the concession stand, for a total of 40 community service hours. Additionally, after successful completion of the project, the association awards the participants a small stipend for their contribution.
Impact: This is a winning situation for both "Friendship Park" and for the youth in the project. In addition to volunteering in their community, the youth are drawn to involvement because the experience is real and the work is fun. This forum enables them to acquire valuable job skills, such as operating a cash register, serving the public, product inventory, basic food preparation, and responsibility. Some of the participants use this experience for their 4-H personal community- service profile and 90 percent listed it as work experience when they applied for their first jobs.

A survey found that 85 percent of those who had been involved in the project were hired at restaurants as waiters, waitresses, and busboys; and in delicatessens, bakeries and fast food restaurants as clerks and prep cooks. The remaining 15 percent found jobs in food stores and retail shops as retail clerks, and some were hired as receptionists or worked in their families' businesses. All of the participants noted that learning to run the cash register and to handle currency gave them a great deal of confidence.

Funding Source: Smith Lever and State
Scope of Impact: County

Theme: 5.28 Youth Development/4-H
Title: POND MAPPING: EXPLORING WHAT IS BELOW THE POND=S SURFACE

Description: In 2003-04, a 4-H Youth Development Advisor, taught 30 5th and 6th grade students from Bidwell Elementary School in Red Bluff about watersheds, different types of maps and uses, how to use a compass, and how to measure the perimeter and depth of a pond. The year-long course culminated with a field trip to actually map a pond and explore the pond=s habitat. Discovery Center Interns from the Red Bluff High School Natural Resources Regional Occupational Program assisted the younger students. The students learned how to use the tools of the trade and mapped Ben=s Pond at the Red Bluff Recreation Area of the Mendocino National Forest. Using the data they collected, the students wrote and distributed a flyer about the pond with a topographical map.
Impact: The students learned how to use different tools to map a pond i.e. compass, alidade, sounding line, measuring tape and plane table. In addition to learning how to map a pond, the youth explored nature and investigated what was around and below a pond=s surface. The

Pond Mapping curriculum is in the process of further review and pilot-testing nationwide. The intended audiences are 4th-6th graders with teens as teachers. This project has the potential to increase math and geometry skills. Teachers indicated that students who participated seemed to have a better understanding of geometry concepts.

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: In 2000, California advisors examined the outcome of a homework assistance program for 57 third- through fifth-grade children in a rural school in Orland, CA. Participating students were referred by teachers because they were performing below grade level, not making a consistent effort outside the classroom to complete homework or needed special assistance with assignments. The goal of the after-school program was to enhance the educational experience with adult tutors and provide activities to encourage positive parent-child interaction. The full text of the study can be found at http://www.cyfernet.org/ by searching for author Jeanette George.
Impact: The results showed the homework club increased the amount of homework turned in by 43%. 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).

The advisors feel the Homework Club was successful because it encouraged students to do homework in three ways: 1. It is more interesting to do homework in a group setting than alone 2. Students were able to get individual help 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. Students participating in the homework club showed a more positive self-image and attitude toward school. Parents' attitudes toward homework improved, as well as toward their children as students.

Funding Source: USDA-CSREES (CYFAR Project), Smith Lever and State
Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H
Title: YOUTH EMPOWERMENT AND SELF-SUFFICIENCY

Description: Participants are given a knowledge pre/post test to evaluate the effectiveness of the program in an out of school setting. Demographics, setting, and attendance are also considered in the evaluation.
Impact: Over 350 youth, ages 8-11 years, have participated in Mini Society at 12 different sites in Tehama and Glenn counties. The pre/post tests revealed an increase in knowledge and some improvement in simple math skills for all ages. Everyone learned some solutions

to solve scarcity of a product and nearly 70% could determine if a business made a profit by reviewing the income and expense ledger.
The journals were a great tool to keep track of the student=s activity and emphasize the importance of record keeping to determine the profit margin. Most had difficult at first understanding the concept of buying raw materials, making a product and then selling it for a profit. Having the program once a week for 12 weeks or daily for 3 weeks did not affect the attendance or learning.

Funding Source: Smith Lever and State
Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H
Title: CAMPING AND OUTDOOR ADVENTURE

Description: A 4-H Youth Advisor served in an advisory role to the volunteer camp directors and 4-H Program Representatives. Position descriptions were developed for adults and teens based upon acceptable expectations. An application process with interviews was established. Mandatory 10 hour staff training is held. A code of conduct for campers, adults and teens was also developed. Training and activities about stages of development, behavior management, age appropriate activities, etc. were developed. The camps are open to all youth to participate and local agencies provide scholarships for low income youth. The camping experience is an ideal setting for environmental education, community and social responsibility, building self-esteem, and the wise use of leisure time. Adults and teens can play a major role in planning, implementing, and evaluating a camping program. Teens also serve as role models to younger youth.
Impact: The Tehama and Glenn County 4-H camping programs continue to be popular with over 100 youth, ages 8-13, attending annually with 25 or more teens accepting leadership positions at each camp. A 2002 teen staff evaluation teens responded that the camp experience helped them to improve their ability to organize and carry out tasks and had a positive impact on how their work with other teens (4.4 on a 1-5 scale; 5 being strongly agree). Since 2001, Migrant Education has provided over 50 scholarships for youth in Glenn and Tehama counties to attend the local 4-H camps. This collaboration shows the strength of the county 4-H camp programs in meeting the needs of youth from diverse cultures.

Funding Source: Smith Lever and State
Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H
Title: LESSONS FROM CALIFORNIA - A CASE STUDY OF FOUR YOUTH ASSET-DEVELOPMENT COMMUNITY INITIATIVES

Description: The specific desired outcomes of the research project are:

- $ Adults will see that they can have a positive effect on how youth in their communities develop,
- $ Youth will be seen as valuable resources within the community,

$ Youth will become more active participants and well-connected in their communities, and
$ There will be positive effects on measures of youth development within the counties participating.

The four community initiatives that have been studied are in Pasadena, Sacramento County, San Luis Obispo County, and Santa Clara County. These four community initiatives in California were formed for promoting a positive approach toward youth development in their communities. Employing a multi-method qualitative approach, including the use of adult interviews, teen photo documentary notebooks, youth focus groups, and document review, the strategies utilized in building and sustaining the collaboratives were explored. The study found that even though the collaboratives are very different in many respects and are located in very different communities, the same five steps were employed by three of the collaboratives (one of the collaboratives is still under study) to build, sustain, and bring about change in their geographic areas. This approach is potentially useful for other similar initiatives. In addition, perceptions of youth in these communities illustrate the impacts of these initiatives= efforts on their lives.
Impact: The results of the Applied Developmental Science Workgroup will very likely assist many collaboratives or initiatives throughout the United States in the years ahead. The information already generated by the research of the workgroup is being used by groups throughout the country in assisting them in the start-up phase. In addition, the results of the research will contribute to the growing body of knowledge on positive youth development and community collaboratives.

Funding Source: Smith Lever and State
Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H
Title: TO BULLY-PROOF OR NOT TO BULLY-PROOF: THAT IS THE QUESTION

Description: Using a psycho-social theory of development (Erikson, 1950), where the focus of adolescence in identity formation, California researchers hypothesize that it is possible for youth to be both a bully and victim as part of their development process (May, 2001). Second, a youth could have been bullied, and, in response, he/she would bully others. Both could have implications in the way researchers intervene and design youth violence prevention programs. In the study discussed here, researchers examined the relationship between a youth=s sense of safety and bullying and victimizing behaviors.
Youth in three middle schools in a diverse urban city in California were surveyed.

- Questionnaires were administered to 3542 students; 1137 (45%) were completed and returned.
- The majority of the youth were ages 14 (29%), 13 (31%), 12 (28%), and 11 (12%).
- Fifty-seven percent were females; 43% were males.
- Ethnically, 35% identified as African-American, 36% as Hispanic/Latino, 13% as Asian, 12% Mixed/Other, 2% American Indian, 1% Pacific Islander, and 1% White non-Hispanic.

- School grade level showed that 36% were in eighth grade, 29% in seventh grade, and 35% in sixth grade.
- Youth self-reported most frequently received letter grades were A=s (22%), B=s (39%), C=s (32%), D=s (5%), and F=s (2%).

The questionnaire was anonymous and confidential. It was translated into Spanish and Vietnamese. Teachers administered the questionnaire during a class period at the respective middle schools. The focus was on whether the middle school youth engaged in the following behaviors within the past 12 months:

- School perpetrator/bully behaviors (been in a physical fight, used a weapon to threaten or bully someone, sold drugs to someone, been arrested by the police or sheriff)
- School victimization (been offered, sold or given illegal drugs, been teased or Apicked on@ because of race, gender, disability, been threatened or injured with a weapon, had things stolen or deliberately damaged)
- Safety issues (how safe do you feel in school, how safe do you feel in your neighborhood).

Researchers hypothesized that a youth could be a bully and a victim as part of the developmental process. The correlation analyses indicate that there is indeed a significant relationship suggesting that a youth can be a bully and a victim in a continual cycle. This finding lends support to the notion that adolescent youth, in the process of the struggle between social/cultural issues and the individual, may exhibit both bully and victim behaviors. In addition, the data suggests that adolescent bully and victim behaviors may be coping responses to the youth=s lack of a sense of safely. It is interesting to note that school and neighborhood safety were negatively correlated with all the youth perpetrator and victim behaviors. Perpetrators do not feel any safer than their victims do. It is most likely because they know their victims may retaliate.
Impact: Both findings have distinct programmatic implications. The first finding implies that programs that simply label youth as victims or bullies and then seek to Afix@ the bullies will not work. Depending on the situation, both behaviors may be exhibited by the same youth. A more effective approach may be to monitor the youth=s development (e.g., process of youth identity formation) over time and across incidents. The focus should be supporting and providing youth with positive youth development activities that allow them to try out a variety of roles and challenge norms without the use of bullying behaviors. The second finding indicates that programs that focus on youth bully and youth victimization may not be effective. Instead, researchers suggest that programs should focus on increasing all youth=s sense of safety because sense of safety decreased both youth perpetrator/bully behaviors and victimization behaviors.

Funding Source: Smith Lever and State
Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H
Title: CALIFORNIA 4-H CAMP EVALUATION

Description: In the summer of 2005, the Task Force initiated an evaluation of five California 4-H camps in Orange, Sacramento, San Joaquin and Tehama counties, and Operation Purple Camp for children with parents deployed in the military. A survey, administered to 455 youth, measured five constructsCrelationships, safety, youth involvement, challenging and engaging activities, and community involvementCall important elements in youth development programs. Focus groups for campers, teen staff and adults augmented the survey data. The 2005 evaluation verified the power of the camp environment to nurture youth development, especially in building relationships. Eighty-six percent of youth surveyed receive optimal emotional support, and 79% are optimal in each of the guidance and practical support constructs. It also illuminated areas for improvement, especially in youth involvement (where 51% of youth rate insufficient in leadership) and environmental education.
The five participating camps sent teams of 4-H staff, volunteers and youth to a retreat in September where they received the data from their sites and developed strategies to improve their future camp programs. The Task Force will re-survey the sites in summer 2006 and measure what difference these strategies have made. Results of the 2005 evaluation have been shared with 4-H volunteers and staff at the California 4-H Leader=s Forum.
Impact: Thus far project has successfully:

- Provided rich data leading to insights for the California 4-H Camping Task Force on the strengths and weaknesses of 4-H camp experiences.
- Generated camp improvement plans for camps participating in the 2005 study.
- Created greater understanding of, and buy-in to, the need for program evaluation among 4-H volunteers and staff.
- Produced greater understanding for 4-H camp program providers about the link between 4-H camp experiences and 4-H Essential Elements.

Funding Source: Smith Lever and State
Scope of Impact: State

Theme: 5.28 Youth Development/4-H
Title: EL DORADO COUNTY YOUTH COUNCIL B YOUTH EMPOWERMENT FOR COMMUNITY ACTION

Description: The El Dorado County Board of Supervisors adopted the Youth Council Concept for an18 month trial period, during which time they are providing partial funding for the 4-H Program Representative coordinating the project. The Board also provides support for meetings, communication, and travel. The Youth Council proposal presented to the Board indicates that the youth would generate their own financial support following the start up period. The Division of Agriculture and Natural Resources provides staff for overall leadership and evaluation of the project. This project brings together a coalition of youth serving agencies interested in providing youth with a significant voice in their community. It has connected a diverse cross section of agencies (Boys & Girls Clubs, High School Homeless Liaison, Latino Family Resource Center, church youth groups, 4-H, etc.) for the first time. These outcomes will result in a powerful lobby for community issues based on the ideas, opinions, hopes, and vision of the youth who will grow up to inherit this local landscape. Through the Youth Council formation and operation youth gain knowledge and experience in local leadership and governance. They also develop the self esteem and confidence to

become informed and respected partners in local community development. The project creates the atmosphere for active lifelong citizen engagement. El Dorado County, like many California communities, is rapidly developing, where the physical landscape and social fabric change almost monthly. The Highway 50 corridor from the county line to Placerville is transformed daily as houses, retail centers (strip malls) corporate offices and casinos seem to emerge overnight. These changes will have a relatively short term impact on the adults in the community, but the children of El Dorado County will inherit the landscapes and communities California researchers are creating now, and must manage and sustain them for future generations. The youth voice in this changing landscape has been missing and this project corrects that omission.
Impact: The project holds the potential to change the way researchers view youth=s role in the community and how researchers develop, manage, and sustain hanging landscapes.

Funding Source: Smith Lever and State
Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H
Title: GARDEN BASED LEARNING IN CALIFORNIA SCHOOLS AND COMMUNITIES: PHILOSOPHICAL ROOTS, HISTORICAL FOUNDATIONS, BEST PRACTICES AND PRODUCTS, OUTCOMES, IMPACTS AND FUTURE DIRECTIONS.

Description: California has over 8,900 public schools with over 6 million students enrolled in 2003. There are 5,423 elementary schools where science education has traditionally been a weak component in the curriculum. In 1997 the State Superintendent of Public Instruction suggested the vision of AA Garden in Every School.@ The goal was to improve science education, student nutrition, and environmental education. Staff from the University of California Agriculture and Natural Resource (UCANR) were a part of the statewide planning group appointed by the Superintendent to implement the vision. In 2003 there are just over 3,000 school gardens in the state and the number grows each year. ANR Advisors continue to provide academic leadership to the effort and continually speak to issues relative to garden based learning (GBL). In the past year, UC-ANR staff have collaborated with faculty from Oregon State University to expand the GBL approach to natural resource stewardship.
Impact: Providing a practical strategy (school gardens) for elementary educators to use in implementing hands-on science education has significantly improved the practice of experiential education in California elementary schools. Early research (Harvard Medical School study at Martin Luther King Jr. Middle School in Berkeley) indicates that school gardens can affect the eating habits (diet) of middle school children, which should result in better nutrition literacy and health. This study along with research done by the State Environmental Education Roundtable suggests that academic performance can also be improved by these experiential strategies. Educators and administrators in California and around the world now have a benchmark study with which to evaluate their garden-based learning programs. The ABest Practices@ and ACore Uses@ identified will reshape how experiential education is applied in educational settings. There is also now an international network of scientists, educators, and policy makers to strengthen the role of garden-based learning in basic education. This study has also generated global efforts to re-look at experience-based environmental education and the role it plays in schools.

Funding Source: Smith Lever 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 Design Teams

Seven ad hoc design teams composed of AES faculty, CE Specialists and CE county-based advisors were convened in the fall of 2005. Each was organized around one of the priority issues identified by the Division's Program Planning Advisory Committees and Program Council. The seven issues were: Sustainability and Viability of California Agriculture, Sustainable Use of Natural Resources, Pest Management/Invasive Species, Environmental Quality, Food Safety, Human Nutrition, and Youth Development. The charge to each team was to identify the role of ANR in research, development and delivery to meet the needs of California relative to the issues in the next 20 years; and to develop concepts for building the continuum to carry out this role.

Over a two month period, each design team identified the significant challenges for the program area over the next twenty years and proposed ways in which ANR programs can address these challenges. Each team then focused on how the ANR continuum could address research, development and delivery. After review and consultation with the Division's administrative councils, the Executive Council members (Vice President, Associate Vice President and four Deans) gathered feedback from over 50 key external stakeholders on the challenges that would be facing their industry and/or clientele in the next years.

This information will be used in the next cycle of program planning within the Division and may be used to seek budget augmentations through the state budgeting process.

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. There were 76 Divisionwide workgroups and 8 Coordinating Conferences with a total membership of over 3,200.

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. ANR workgroups involved 1,217 external stakeholders in their program planning process and workgroup activities and projects. 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. 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.

The Garden-based Learning Workgroup is an excellent example of external stakeholder involvement in the Division's program planning and program implementation processes. The Garden-based Learning (GBL) Workgroup is unique among ANR workgroups not only because of its size (historically between 60-80 members, but currently 119 members), but because of the unique composition of its membership, 57% of the workgroup membership lies outside of the University. A key strength of the workgroup is that its membership is not just from DANR, but includes key leaders of other major organizations and agencies with the same goals. It also has a broad range of issues that it attempts to address under the umbrella of garden-based learning. These issues have evolved from the original school-garden focus to include food security, community-supported agriculture, farm-to-school programs, and issues in environmental education. Like its membership, the scope of the workgroup's interest has grown in the last five years. GBL is a dynamic field, and our membership reflects that dynamism. The UC- based GBL membership contains many academics that are active in other workgroups, and they apply the work of those workgroups to GBL.

The goal of one of the workgroup's projects is to increase garden based learning in grades 6-9 as part of the development of a healthy school environment by assessing what resources are currently available, and providing that information to educators in draft lesson form. The project team will collect and disseminate educational materials that support academic instruction and a healthy school environment in grades 6-9; publicize garden based learning programs for grades 6-9; link garden based learning to school wellness, nutrition and physical activity policies; identify gaps in education materials and training programs for grade 6-9 teachers; recommend next steps.

The elementary level has numerous materials available for linking the garden and academic instruction. As students matriculate from elementary school into middle and junior high school there are fewer materials, gardens, and teachers trained in using gardens for garden-based learning. Students who learned through instructional gardens lose a connection with this method of learning upon graduation from elementary school.

The California Department of Education conducted a gardening survey of middle schools in 2002. For all schools, the greatest barriers to using a garden were time (81%) and lack of curriculum materials linked to academic standards (74%.) The workgroup will identify, using the data from this survey the schools that are using garden, based learning and interview them. In general, there is less known about middle/junior high school use of garden based learning than at the K-5 level**.** This workgroup project will provide the basis for understanding what materials are being used in the existing middle/junior high school gardens, and how the gardens are being used to support academic instruction and create a healthy school environment so these efforts can be replicated or enhanced. Given the additional concern about nutrition at the middle/ junior high school level, there is an important role for garden based learning at these grades so the project will look at how the gardens are linked to nutrition education and the school lunch program, in addition to supporting academic subjects. The statewide list of Garden Based Learning Resource Centers has been updated and a project prospectus has been developed Workgroup members have

conducted interviews of school districts in each county to an interview to assess/survey resources for this age group; information has been sent to the CA Department of Education and compiled there.

Due to its breadth of the organizations represented in this workgroup's membership, the GBL Workgroup is becoming a very well-known entity not only in California, but nationwide. This has been accomplished through the work, presentations, and advocacy by a number of GBL members including California Department of Education staff members, UCCE advisors and other workgroup members at conferences and meetings. GBL issues have been raised with legislators and their staff, including Senator Barbara Boxer's staff.

UC ANR Coordinating Conferences.
Coordinating conferences bring together 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.

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 have 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 MUTI 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:

Key Theme: 3.03 Human Nutrition
Title: PREVENTING CHILDHOOD OBESITY: A TEAM EFFORT

Description: The issue of childhood obesity has increasingly captured interest and generated concerns among health experts. In September 2004, the Institute of Medicine concluded that Achildhood obesity is a serious nationwide health problem requiring urgent attention and a population-based prevention approach so that all children may grow up physically and emotionally healthy.@ Over the last 30 years, the incidence of obesity has more than doubled for preschool children and adolescents, and it has more than tripled for children ages 6 to 11 years old. Today approximately 9 million children over age 6 are obese. As part of UC Berkeley Center for Weight and Health=s Children and Weight: What Communities Can Do! Project, UC Cooperative Extension in Riverside County initiated a grassroots coalition for the Corona-Norco community in June 2002. The Corona-Norco Children and Weight Coalition (CN-CWC) has brought together agency representatives and people from various backgrounds in the community to work toward raising childhood obesity awareness and prevention.
Impact: The coalition conducted a health habits survey of Head Start families. The survey found that unhealthful habits that can lead to childhood obesity were common, and underscored the need to engage parents in changing the home environment. For example, more than 80 percent of respondents said they fed at least one fast food meal to their children each week. Fifty-seven percent of parents said their children spent two or more hours watching TV or playing video games every day. More than 90 Head Start parents participated in the childhood obesity awareness sessions. The presentation and displays raised awareness about fast food, soda and unhealthy snacks, and educated parents about healthier options that they could make available to their children at home.
Funding Source: Smith Lever and State
Scope of Impact: State

Theme: 3.03 Human Nutrition
Title: FAMILY, FOOD, FUN, AND FITNESS: FOOD STAMP FAMILIES TEAM UP FOR HEALTHIER LIFESTYLES (ALSO KNOWN AS EAT SMART. PLAY HARD. SAN LUIS OBISPO COUNTY!)

Description: Over the last two years the program has been offered three times in San Luis Obispo County to families who participate in the USDA Food Stamp Program and/or the USDA Free and Reduced School Meal Program. Currently, the program is being pilot tested as a train-the-trainer program with educational and community-based organizations in four counties. Results of the train-the-trainer component will be available July 2006. At the end of this program, participants will 1) demonstrate a positive knowledge gain regarding healthy snacking and being physically active, 2) more often select fruits and/or vegetables for snacks, 3) reduce the consumption of sweetened beverages for snacks, 4) increase the consumption of water during snacks, and 5) set goals for healthy snacking and physical activity.
Impact: Evaluation data collected over a two-year period indicated that child and adult participants (n=38) showed an average 19 percentage point knowledge gain through pre/post tests (pre= 68%; post=87%). Participants used stickers to identify snacking and activity habits at the beginning and end of the program. The sticker assessment indicated that 98% of participants made at least one positive behavior change regarding healthy snacking or being physically active. Reported healthy behavior change included:

20% drinking less soda for snacks
5% drinking less fruit drinks for snacks
15% drinking less sports drinks for snacks
33% drinking more water for snacks
38% being more physically active.

One and two month in-person, follow-up interviews for the 2005 class (N=19) indicated that all participants continued to use the program in their daily lives. Program participants indicated continuing to make healthy fruit and vegetable snack recipes and to use physical activity games demonstrated during the program. Additionally, participants indicated walking more and sharing the information with family members.

Funding Source: USDA Food Stamp Nutrition Education Program, Smith Lever and State
Scope of Impact: State Specific

Theme: 3.03 Human Nutrition
Title: VALIDATION AND APPLICATION OF HOLOTRANSCOBALAMIN II AS A NEW MEASURE OF VITAMIN B-12 ABSORPTION

Description: Vitamin B-12 deficiency affects 30-40% of elderly in the USA, and individuals of all ages in developing countries. It is probably because they fail to absorb B-12 from food. However, this malabsorption is usually undetected because the usual test for malabsorption is too expensive, too difficult and requires radioactivity. The purpose of this study is to develop, validate and apply a novel, non-radioactive test for detecting vitamin B-12 malabsorption in human populations. California 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, researchers 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. Researchers 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: 4.01 Agricultural Waste Management
Title: THE SCIENCE AND ENGINEERING FOR A BIOBASED INDUSTRY AND ECONOMY

Description: New opportunities exist for producing and processing biomass resources and engineering novel biocatalysts, reactors, and industrial processes to support the development of bioindustries in energy and bioproducts. The purpose is to expand research and education in biomass, bioenergy, and bioprocessing leading to enhanced feedstock supplies, conversion processes, and systems utilizing renewable biological materials. Modeling and experimental efforts are underway to investigate chemical and biochemical mechanisms of spontaneous combustion in stored rice straw and other biomass materials. Phytoremediation techniques are being developed for producing large amounts of biomass for bioenergy and bioproducts from agricultural lands that are drainage impaired and have high salt content. Properties of this biomass are being investigated, as are thermo- and biochemical conversion and manufacturing of particle boards and other products. Objectives 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. 2) Expand the scientific knowledge leading to significant economic improvements in biofuel production processes.
Impact: Energy and products from biomass produced as part of phytoremediation programs will help offset the costs of remediation. Improved resource assessments are being used to design incentives and policies to enhance sustainable biomass development in California. High rate anaerobic fermentation/digestion systems for waste conversion will reduce the cost of bioenergy production, making distributed energy generation more economically attractive for both rural and urban communities and also reduce the environmental impact by these waste streams.

Funding Source: Multistate Research and State
Scope of Impact: AR, AZ,CA-D, 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: 4.01 Agricultural Waste Management
Title: STRUCTURE, FUNCTION, AND REGULATION OF CLOSTRIDIUM CELLUVORANS CELLULASE

Description: A large amount of agricultural biomass such as corn stalks, rice straw, and wheat straw is produced annually in the USA. If these agricultural waste products could be converted to utilizable energy and/or organic compounds, it would help to reduce air and water pollution and provide value-added products. Furthermore the amount of energy produced could be substantial and lead to less dependence on foreign energy sources. This research is concerned with studying the properties and functions of cellulases and hemicellulases produced by an anaerobic microorganism, Clostridium cellulovorans. This strategy may be used to convert many valuable industrial non-cellulose utilizers that currently use expensive carbohydrate substrates into utilizers of inexpensive biomass. This will reduce the cost of producing valuable organic compounds.
Impact: The conversion of agricultural cellulosic waste to ethanol will have a significant impact on the energy requirements of our state and country. It will also lead to a better environment, since there will be less pollution of streams and the air. The use of enzymes for biomass conversion will benefit farmers as well as the general public.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 4.23 Water Quality
Title: OAK MANAGEMENT IMPACTS ON WATER YIELD AND NUTRIENT CYCLING IN ANNUAL RANGELAND

Description: Annual rangelands occupy three million hectares in California, and represent the landscape where California's urban-wildland-agricultural interface is most pronounced. Grazing and prescribed fire are critical vegetation management tools allowing managers to maintain economically feasible agricultural enterprises, maintain open space, reduce fuel loads, improve habitat for certain wildlife species, and manage weed infestations. Grazing and prescribed fire are the most cost effective vegetation management tools available to most rangeland managers. However, the watershed-scale impacts of grazing and prescribed fire on water quality, hydrology, nutrient cycling and plant community dynamics have become the subject of intense debate on these rangelands. Public concern is fueled by recent events such as the listing of various aquatic dependent species on the Federal Endangered Species List, development and enforcement of numeric water quality standards (Total Maximum Daily Loads-TMDLs), litigation concerning grazing impacts on municipal drinking water quality, and costly wildfires due in part to unmanaged fuel loading. A large number of stakeholders have an interest in the resolution of this debate including ranchers, watershed groups, regulatory agencies, land management agencies, municipal drinking water districts, consultants, and environmental groups.
Impact: There is paucity of information concerning the influence of rangeland management practices on water quality in California oak woodlands. Long-term water quality records that can be used to assess natural variability in water quality constituents, assess the impact of management practices on water quality, and guide regulatory processes to safe-guard water resources are particularly rare. This project helps to fill this void, leading to improved water quality in California oak woodland systems.

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: All cognitive abilities are dependent upon world knowledge (semantic memory). Thus, an understanding of the extent to which access and utilization of world knowledge in Alzheimer's disease is impaired versus spared is important for the assessment, treatment, and management of Alzheimer's disease (which affects about 8% of all individuals over 65 years of age). The prevailing methods of assessing semantic memory (world knowledge) in Alzheimer's disease (AD) have involved tasks which require attention skills, strategy implementation, and/or word retrieval, in addition to semantic memory knowledge. The hypothesis in this study is 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. Researchers have recently completed the data collection for a comprehensive study of semantic memory in AD compared to normal aging. Pathfinder network analyses showed that the AD group showed very similar semantic networks to the elderly control group, who in turn showed very similar semantic networks to the young control group. This indicates that neither AD nor normal aging is associated with impairments in semantic memory organization. Multidimensional scaling analyses, as well as Pathfinder analyses, converged on the conclusion that task and domain effects are much larger than subject group effects, in terms of semantic memory organization.
Impact: These findings of relatively normal semantic networks in AD, across a number of semantic domains and tasks, are highly relevant to the assessment, treatment, and management of AD (which affects approximately 8% of individuals over 65 years of age). For instance, daily activities for AD patients should be set up to depend as much as possible on semantic memory ability, rather than episodic/event memory ability.

Funding Source: Hatch 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: There is general consensus that homework can boost academic achievement and the development of positive personal characteristics and habits of youth. However, many parents feel homework detracts from family time and limits their child's participation in other activities so students may not get homework support at home. Most after-school programs assist students with their homework, but do they help students succeed in school?

Researchers examined the outcome of a homework assistance program for 57 third- through fifth-grade children in a rural school in Orland, CA. Participating students were referred by teachers because they were performing below grade level, not making a consistent effort outside the classroom to complete homework or needed special assistance with assignments. The goal of the after- school program was to enhance the educational experience with adult tutors and provide activities to encourage positive parent-child interaction.
Impact: The results showed the homework club increased the amount of homework turned in by 43%. 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). Students participating in the homework club showed a more positive self-image and attitude toward school. Parents' attitudes toward homework improved, as well as toward their children as students.

Funding Source: USDA-CSREES (CYFAR Project), Smith Lever, and State
Scope of Impact: County

Theme: 5.04 Child Care/Dependent Care
Title: LEARNING AND PROBLEM SOLVING IN YOUNG CHILDREN

Description: Issues related to young children's learning processes are critical aspects in human cognition and intelligence, and examining these issues will help link research on cognitive development during infancy and during later childhood. A great deal of research has examined toddlers' and preschoolers' abilities to understand symbol-referent relations and use the information about the hiding locations of a source space (e.g., a scale model, picture, or map) to guide searches in a target space (e.g., a room). Although young children have demonstrated impressive abilities, relatively little is known about how children come to accomplish such feats. California researchers conducted two studies to examine whether and how young children acquire strategies involved in mapping spatial arrays with experience. Even younger children (2.5- to 3-year-olds) showed the ability to acquire a new strategy, using the hiding information in the source spaces to guide their searches in the target spaces. They also transferred the acquired mapping strategy to solve novel problems involving new special arrays. Researchers have designed further experiments and are currently working on a conceptual model of the processes that underlie young children's acquisition of mapping strategies. Three key components - namely, encoding locations within each space, noticing the general relations between spaces, and detecting precise mapping correspondences - are hypothesized to contribute to children's proficient mapping between spatial arrays.
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: 1.34 Urban Gardening
Title: LANDSCAPE TREE CARE PROGRAM

Description: The landscape tree care program was developed by the Urban Horticulture Workgroup because of the observed need in communities to improve the urban forest and the general lack of knowledge about tree care. Twenty-three counties with Master Gardener Programs participated in the Landscape Tree Care Training Program.

Impacts: Based on an impact survey conducted by the Urban Horticulture Workgroup, 70% of the participants said the training improved their expertise in tree care. 41% said they increased the level of outreach in landscape tree care since attending the training with 52% of those providing up to three efforts a year and 30% providing up to 9 outreach efforts a year.

Funding Source: Hatch, Smith Lever and State
Scope of Impact: State Specific

Theme: 2.03 Food Quality
Title: RICE QUALITY WORKSHOP

Description: Members of the Rice Workgroup have been working closely with industry, state and federal personnel to evaluate grain grade appraisals at the CDFA laboratory in Sacramento. The workgroup collaborated to produce a one-day workshop on Rice Quality for over 100 farmers and agricultural professionals. The 15 chapter workbook written specifically for and used for instruction at the workshop has become an industry standard.
Impact: Attendance of the workshop is required training by some rice farms and processors for employees. Over 1300 of the Rice Quality Manuals have been distributed to clientele in California, other states and six countries.

Funding Source: Hatch, Smith Lever and State
Scope of Impact: State Specific

Theme: 5.19 Literacy
Title: SCIENCE, TECHNOLOGY AND ENVIRONMENTAL LITERACY

Description: The Science, Technology and Environmental Literacy (STEL) Workgroup collaborated and addressed the need to increase scientific literacy among the youth and adult populations. This workgroup held workshops utilizing hands-on activities to allow for discovery of the SET (Science, Engineering and Technology) concept, a technology-based curriculum. The workgroup also developed and disseminated effective three experiential learning workshops: Understanding the Experiential Learning Cycle, Inquiry-Based Experiential Learning Cycle, and Developing and Adapting Curricula to Integrate Experiential Learning.
Impact: 138 individuals participated in SET Robotics trainings and workshops and indicated a positive response to the materials. 121 individuals participated in Experiential Learning trainings. A post-training survey indicated that 93 % of the respondents indicated that they learned useful information and 84% said they felt confident applying what they had learned.

Funding Source: Hatch, Smith Lever and State
Scope of Impact: State Specific

Theme: 1.28 Plant Production Efficiency

Title: AGRICULTURAL PRACTICES FOR WALNUTS
Description: The Walnut Workgroup addressed high priority clientele concerns including emphasis on improvement (breeding), integrated pest management (insect, disease, and alternatives to methyl bromide for fumigation for nematodes, etc.), and efficient orchard management (high density planting, irrigation management, nitrogen use, etc.). A research needs survey among walnut growers suggested that there was a greater need for research in the areas of codling moth, blight, irrigation, canopy management and cultivar improvement.
Impact: Examples of activities that originated and were mediated through this workgroup include Walnut Production Short Courses, videos on husk fly and crown gall management, the Walnut Production Manual and the revision of the Walnut IPM Manual. Their work on pheromone mating disruption coordinated through the codling moth coordinating group and refined by the Pest Management Alliance field work showed more environmentally friendly methods of managing codling moth.

Funding Source: Hatch, Smith Lever and State
Scope of Impact: State Specific

(2) Did the planned programs address the needs of under-served and under-represented population of the State(s)?
Listed below are several examples of California's efforts to address the needs of under-served and under-represented populations in the state.

Theme: 1.32 Small Farm Viability
Title: OPEN-AIR CLASSROOM FOR SMALL SCALE GROWERS

Description: Small-scale farmers face many of the same issues as their larger counterparts. However, from pest management to fertilizer application, small-scale growers often have to do it alone--without the benefit of a private consultant. With their limited resources, they have very little chance to get away to attend training sessions and workshops. UCCE Santa Clara County, with support from UC's Small Farm Program and with the participation of several farm advisors from neighboring Monterey and Santa Cruz counties, has launched a program to train a group of Hispanic growers of organic crops on their cooperative farm. The program (Open-Air Classroom) was initiated last fall. UC advisors specializing in various disciplines (entomology, plant pathology, irrigation, fertility, berry and vegetable plant/variety selection, simplified farm management and marketing) visit with the growers and go with them on a tour of the ranch. The series of classes began with two sessions on entomology. Growers collected insects to identify, considered each one's pest/beneficial contribution to the farm, and discussed control strategies. Upcoming sessions will help growers with basic marketing strategies as well as irrigation, fertilizer and other economic inputs. The sessions will continue from late spring through summer 2003.
Impact: With this program, UCCE is filling a gap by supporting small and limited-resource farms with quality training and timely, needed information. The growers are enthusiastic and thankful to have these sessions offered on their land, addressing their specific problems. The growers' desire to learn more has increased several fold and they are
eager for additional topics and classes. This program is clearly enhancing their land stewardship and better preparing them to comply with tightening environmental regulations.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 1.32 Small Farm Viability
Title: LIMITED RESOURCE FARMERS LEARN HOW TO SAVE WATER AND ENERGY

Description: Southeast Asian growers are important in the Merced County strawberry industry. Strawberries are so sensitive to water stress that there is a tendency to over-irrigate, wasting valuable water and increasing pumping costs. Using a simple device called a tensiometer which measures soil moisture and is easy to understand and use, we have been helping small Southeast Asian growers learn how to irrigate more efficiently. After recruiting growers to participate in the project, we placed the tensiometers in two locations in each of their strawberry fields. The growers were provided with training in reading and recording the results, and with very simple guidelines for applying water as indicated by the readings. Information demonstrating that tensiometers can be a useful tool for managing irrigation in strawberries also has been shared at meetings in Sacramento, Stockton and Fresno.
Impact: Interviews indicate that growers have used the tensiometers in attempts to cut back on water applications, and believe they have seen some savings in electricity usage. In any case, most of the farmers have learned to wait a bit longer before turning on their pumps. This has saved both water and electricity.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Theme: 3.03 Human Nutrition
Title: THE RELATIONSHIP OF POVERTY, FOOD SECURITY, AND FOOD ASSISTANCE TO CHILD NUTRITION IN LATINOS

Description: During the past year, the Principal Investigator continued to analyze data from household surveys conducted in 1998 and 2001 and conducted a new pilot study among low-income Latino households. Four manuscripts were published this year. In manuscript #1, California researchers examine the relationship between food insecurity and body weight among adult Latino women. Prevalence of food insecurity and obesity in these low-income Latino women was 60% and 37%, respectively. Controlling for years spent in the U.S., per capita income, and parity, food insecurity with hunger, measured by the 10-item adult scale of the Food Security Supplement was significantly increased the risk of obesity (Odds ratio: 1.98; 95% C.I.1.14, 3.53). However, in the same sample, food insufficiency, measured by a single item, was not related to risk of obesity. In U.S. born Latinas, past food insufficiency was also associated with greater risk of obesity. In the second manuscript, researchers reported that biological and socioeconomic factors are more strongly related to overweight among Latino preschoolers than most of the self-reported child feeding strategies. Notably, participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is associated with lower risk of overweight among preschool Latino children. The third publication indicates that the effect of food insecurity on preschooler food patterns is mediated by household food supplies in Latino households. The fourth publication explores the possible explanations for a linkage between food insecurity and obesity and some

strategies for interventions. The pilot study was a follow-up to the focus group research conducted in the previous year. The purpose of the pilot study is to explore the influence of past food deprivation on child feeding strategies. A graduate student, working on this project, developed and cognitively tested instruments to measure level of past food insecurity and child feeding strategies. In addition, she developed a set of food portion photo cards for dietary evaluation. In the analysis phase, researchers will test the hypothesis that mothers who have experienced severe food deprivation in the past use more indulgent child feed strategies and choose larger portion sizes as appropriate for young children, compared to other low-income women who did not experience severe deprivation.
Impact: Current food insecurity is associated with increased risk of obesity in Latino women. In U.S. born Latinas, past food insufficiency is also associated with increased risk of obesity. In food insecure Latino households, lower food supplies are negatively related to preschooler intake of fruits, vegetables, dairy products, meat, and grains. WIC participation is associated with lower risk of childhood overweight. These findings underscore the importance of continuing to monitor food insecurity in the U.S. and to maintain or increase funding for the WIC program as a strategy to prevent overweight in children.

Funding Source: Hatch, Smith Lever 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: There were two crucial objectives for the study during the past year. First, analyses were conducted with the goal of confirming the existence of the intergenerational transmission of competent behaviors from the family of origin to young adults entering into romantic relationships. Second, efforts were made to identify pathways of risk and resilience during the transition to young adulthood. Specifically, California researchers investigated the degree to which early life adversities increased risk for psychiatric disorder during the transition to adulthood as well as social supports that reduced risk to adversity. The results suggested that nurturing and involved parenting in the first generation leads to a warm and supportive interaction style in early adult romantic relationships. The second study showed that traumatic life events during the adolescent and early adult years increase risk for psychiatric disorders such as depression. Support from family and friends increased resilience to disorder even in the face of significant adversity.
Impact: The findings generated from the second year of this project are among the first to demonstrate the major influences of the family of origin on the social 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 negative life events and parenting problems 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: YOUTH STYLE AND IDENTITY DEVELOPMENT: ARTICULATING CULTURAL AMBIVALENCES AND ANXIETIES

Description: This study focuses on appearance style as a vehicle to analyze how youth become the subjects and the objects of cultural ambivalences and anxieties. The research involves multi-method approaches to determine the relations between (a) dominant cultural discourses about youth (e.g., children's apparel advertising, children's apparel industry publications, popular literature characterizing children as growing up too fast) and (b) the negotiation of identities among youth
Impact: In the analysis of cultural discourse, as well as our interviews with 'tween' girls, researchers have found that they are both beneficiaries of and are subjected to a 'trickle down' fashion process of increasingly sexualized versions of femininity. Further, research with African American youth, also presented in publications below, shows how the intersections between gender and ethnicity further complicate dominant construction of 'youth style.' Interviews with young people with diverse gender, ethnic, and sexual identities reveal how they navigate and even shape cultural ambivalences and anxieties through everyday processes of appearance style. As they do so, they cross boundaries of age, gender, ethnicity, in a complex and nonlinear way---one that is difficult (especially for adults) to put into words. Popular publications ranging from Seventeen to Tiger Beat, Essence, and the Sacramento Bee have interviewed the PI in articles that continue to grapple with issues related to this project: parental anxieties about the sexual maturity of tween girls' clothing styles, the specific challenges that African American girls face in terms of clothing choices, concerns about gang-related (or what is perceived by adults as such) attire, and the influence of celebrity style on youth.

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: 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 California sample is predominantly Hispanic (88 percent). 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. 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.
Impact: These analyses suggest 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: Multistate Research and State
Scope of Impact: CA-D, CA-R, IA, IN, KY, LA, MA, MD, MI, MN, NE, NH, NYC, OH, OR, SD

Theme: 5.07 Community Development
Title: ASSESSMENT OF AN EMERGING LATINO COMMUNITY

Description: The project involved the conceptualization, design and implementation of a community wide assessment of the SLT Latino community. The assessment team developed a triangulated approach to research that used existing census and other secondary data, a series of key informant interviews of Latino and other residents, and systematic observations. Periodic updates of findings and key points were provided to the LAC members, to local newspaper and radio outlets, and to the community. These interim reports in turn provided more information and details on the Latino community while raising the public=s awareness of the challenges
Impact: The outcomes and outputs of this project include a mix of concrete impacts. The increase in public awareness has been visible. Accomplished through presentations, consultations with public officials, newspaper articles, and the release of the report, the level of public awareness of the issues and of the role of the Latino Affairs Commission has risen. The local UCCE roles in the community have also been enhanced and impacted. The UCCE office has been directly engaged with a new community, it has developed collaborative research with new partners, and it has undertaken new strategies for building local capacity. This project has also provided the means to create networks and an on-going dialogue with both the Latino community and with previously unconnected organizations and agencies. This project has also catalyzed the El Dorado Community Foundation to begin to address the issue of Latinos in the county and to raise it to a higher level on their program priorities. This Foundation is now expanding the assessment process to a countywide level and committing resources to the area. This project also demonstrates the power and utility of creating meaningful linkages between county based Extension staff, campus Extension personnel and graduate students. These linkages have not only benefited the University and local Extension systems but have led to greater attention to local issues and the mobilization of community resources.

Funding Source: USDA Rural Development Act, Smith Lever, and State
Scope of Impact: State Specific

Theme: 5.16 Impact of Change on Rural Communities
Title: NEW IMMIGRANT POLITICAL INCORPORATION PATTERNS AND TRANSNATIONAL PRACTICES OF MEXICAN MIGRANTS IN CALIFORNIA

Description: Interviews were conducted with leaders of the Zacatecan federation of migrant home town associations in Southern California about economic development in communities of origin and Latino politics in Southern California. A UC MEXUS grant helped support travel to Zacatecas to interview Mexican state government officials about migrants in Mexican politics and to conduct interviews and participant observation during the campaign of a tomato grower from Winters, California who was elected mayor of Jerez, Zacatecas in July 2004. An article on this election was accepted for publication.
Impact: The study reveals dynamics of new modes of cross-border community economic development, electoral politics, and transnational citizenship. It enables California researchers and policymakers to observe the consequences on both sides of the U.S-Mexican border of practices of dual citizenship. Findings continue to show that migrant civic engagement in Mexico is not incompatible with engagement in state and local politics in the U.S. The study informs immigration policy-making.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H
Title: CAMPING AND OUTDOOR ADVENTURE
Description: The 4-H Youth Advisor served in an advisory role to the volunteer camp directors and 4-H Program Representatives. Position descriptions were developed for adults and teens based upon acceptable expectations. An application process with interviews was established. Training and activities about stages of development, behavior management, age appropriate activities, etc. were developed. The camps were open to all youth to participate and local agencies provided scholarships for low income youth. The camping experience is an ideal setting for environmental education, community and social responsibility, building self-esteem, and the wise use of leisure time. Adults and teens can play a major role in planning, implementing, and evaluating a camping program. Teens also serve as role models to younger youth.
Impact: The Tehama and Glenn County 4-H camping programs continues to be popular with over 100 youth, ages 8-13, attending annually with 25 or more teens accepting leadership positions at each camp. In a teen staff evaluation, teens responded that the camp experience helped them to improve their ability to organize and carry out tasks and had a positive impact on how their work with other teens (4.4 on a 1-5 scale; 5 being strongly agree). Since 2001, Migrant Education has provided over 50 scholarships for youth in Glenn and Tehama counties to attend the local 4-H camps. This collaboration shows the strength of the county 4-H camp programs in meeting the needs of youth from diverse cultures.

Funding Source: Migrant Education, Smith Lever and State
Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H
Title: TO BULLY-PROOF OR NOT TO BULLY-PROOF: THAT IS THE QUESTION

Description: Using a psycho-social theory of development, where the focus of adolescence in identity formation, California researchers hypothesize that it is possible for youth to be both a bully and victim as part of their development process. Second, a youth could have been bullied, and, in response, he/she would bully others. Both could have implications in the way researchers intervene and design our youth violence prevention programs. In the study discussed here, researchers examined the relationship between a youth=s sense of safety and bullying and victimizing behaviors.
Youth in three middle schools in a diverse urban city in California were surveyed.

- Questionnaires were administered to 3542 students; 1137 (45%) were completed and returned.
- The majority of the youth were ages 14 (29%), 13 (31%), 12 (28%), and 11 (12%).
- Fifty-seven percent were females; 43% were males.
- Ethnically, 35% identified as African-American, 36% as Hispanic/Latino, 13% as Asian, 12% Mixed/Other, 2% American Indian, 1% Pacific Islander, and 1% White non-Hispanic.
- School grade level showed that 36% were in eighth grade, 29% in seventh grade, and 35% in sixth grade.
- Youth self-reported most frequently received letter grades were A=s (22%), B=s (39%), C=s (32%), D=s (5%), and F=s (2%).

The questionnaire was anonymous and confidential. It was translated into Spanish and Vietnamese. The correlation analyses indicate that there is indeed a significant relationship suggesting that a youth can be a bully and a victim in a continual cycle. This finding lends support to the notion that adolescent youth, in the process of the struggle between social/cultural issues and the individual, may exhibit both bully and victim behaviors. In addition, the data suggests that adolescent bully and victim behaviors may be coping responses to the youth=s lack of a sense of safety. It is interesting to note that school and neighborhood safety were negatively correlated with all the youth perpetrator and victim behaviors. Perpetrators do not feel any safer than their victims do. It is most likely because they know their victims may retaliate.
Impact: Both findings have distinct programmatic implications. The first finding implies that programs that simply label youth as victims or bullies and then seek to Afix@ the bullies will not work. Depending on the situation, both behaviors may be exhibited by the same youth. A more effective approach may be to monitor the youth=s development (e.g., process of youth identity formation) over time and across incidents. The focus should be supporting and providing youth with positive youth development activities that allow them to try out a variety of roles and challenge norms without the use of bullying behaviors.

Funding Source: Smith Lever and State
Scope of Impact: State Specific

Theme: 5.28 Youth Development/4-H
Title: COMMUNITY FORUM PILOT PROJECTS FOR ADOLESCENTS

Description: The purpose of this project was to create a mechanism for rural youth to participate and build connection in their communities. These accomplishments included building teams of adults and youth from rural communities and the publication of a how-to guide on issue framing,

Impact: As a result of this project, teams of youth and adults acquired sufficient skills to successfully convene, moderate and facilitate community forums in California and Arizona. The Adolescent workgroup held five forums attended by 188 people including those in underserved groups. One county team moderated a forum on a contentious community issue around a skateboard park and was able to bring the community to consensus. The decision was ultimately adopted by elected officials.

Funding Source: Smith Lever and State
Scope of Impact: State Specific

Theme: 5.11 Family Resource Management
Title: LOW-INCOME FAMILIES LEARN HOW TO FILE FOR EARNED INCOME CREDIT

Description: The Family and Consumer Science Advisor worked on a new program this year which enabled hundreds of new families to get help with Earned Income Credit preparation. Four new Volunteer Income Tax Assistance Sites were started in low-income neighborhoods and communities serving primarily Hispanic families. This program was in collaboration with the Kern County Department of Human Services and Community Action Partnership of Kern through the Family Self-Sufficiency Coalition.
Impact: As a result, more low-income families learned how to gain the most from their tax filings. This will help them in their filings for future years.

Funding Source: Smith Lever and State
Scope of Impact: State Specific

Theme: 1.19 Invasive Species
Title: EDUCATION OF SUDDEN OAK DEATH SYNDROME

Description: A California advisor has made a major effort to get the Native Americans involved in the sudden oak death (SOD) project. In 1995 a new disease of forest trees and shrubs was recognized in the Bay Area. In 2001 the organism was identified and named Phytophthora ramorum. In the short time since the disease has been recognized, it has been found in 13 California Counties, in Curry County in SW Oregon and in a handful of European countries. The host list has grown to include approximately 25 native species (including redwood and Douglas-fir, two highly valuable timber species) and ~25 ornamentals. State, National and International quarantines have been put in place to prevent the spread of the disease. Because of the range of impact, Sudden Oak Death has received considerable press and now is perhaps one of the most known plant disease of our time. The disease has affected the timber and horticultural industries and anyone that has the capacity to move host vegetation or infected soil.
Impacts: The advisor along with other collaborators offered workshops for plant gatherers on the impacts of Sudden Oak death. These were offered on or near tribal reservations. They also translated two educational guides into Spanish for arborists and for residents in the SOD affected areas (14 CA counties).

Funding Source: Hatch, Smith Lever and State

Scope of Impact: State Specific

Theme: 3.02 Human Health
Title: ANEMIA PREVENTION FOR HIGH RISK GROUPS IN CALIFORNIA

Description: The purpose of the Anemia Prevention workgroup was to bring together professionals from the nutrition and health community to identify risk factors associated with iron deficiency anemia and to develop, implement and evaluate an intervention program aimed at reducing iron deficiency anemia. Results from their study concluded that iron deficiency is an example of a prevalent nutrition-related health problem in California.
Impacts: The Anemia Prevention workgroup developed and implemented a focused education intervention program based on the problems and lifestyles of the clientele. The method resulted in behavior changes among mothers; specifically, they tried new practices to prevent iron deficiency anemia in their toddlers. A one-month follow-up was conducted. Participants were still enthusiastic about the changes they were making, and some had gone on to try additional goals. The results of this part of the anemia prevention project were presented at the Nutrition Update at UC Berkeley in June 2005.

Funding Source: Hatch, Smith Lever and State
Scope of Impact: State Specific

Theme: 5.20 Parenting
Title: CULTURE AND PARENTING GUIDEBOOK

Description: The Family with Young Children Workgroup has completed the development of a new resource for paraprofessionals working with culturally diverse groups of parents. Initial reviews of parenting curriculums conducted by the workgroup found that issues of diversity were often ignored or inadequately addressed. However, recent research on the effects of immigration and acculturation on parenting suggest that culture assumes a primary role in shaping parenting goals and behaviors.
Impacts: The Culture and Parenting Guidebook offers research based information on the influence of culture on parenting behaviors and provides tips to use when working with families.

Funding Source: Smith Lever and State
Scope of Impact: State Specific

Theme: 1.32 Small Farm Viability
Title: SMALL FARM WORKGROUP EXPANDS OUTREACH EFFORTS

Description: Several Small Farm Workgroup members have focused on IPM research and training, emphasizing weed management, alternative pest control, biological and non-chemical pest management and pesticide safety in response to pressing needs of non-English speaking clientele. In some regions, water quality has taken center stage and

growers face regulatory restrictions and training requirements. UCCE was selected as the training agency for cultural practices at several training workgroups for growers, which are provided in English, Spanish and several Asian languages. Over 30 meetings and workshops were conducted statewide dealing with specialty crops/ commodities, pesticide safety and risk management.
Impacts: Over 2500 clients, mostly Asian, Hispanic and women benefited from these workgroups. Most of the workshop either included translation to different dominant languages for clientele or were conducted in the language of the targeted group. Some of the outreach efforts include:

- Marketing Specialty Crops (Spanish)
- Pesticide Safety Seminars (Spanish)
- IPM training (Hmong)
- Pest management (Hmong, Thai, Cantonese)
- Water Quality (Cantonese, Spanish)
- Fertigation Classes (Spanish)
- Pepper Management (Spanish)
- Risk Management seminars (Spanish)
- Labor Management (Hmong, Lao)

IPM has helped several growers with limited English skills (Hmong, Thai, Lao, Chinese and Spanish) address critical areas of management in their operations and comply with the local regulations, thus avoiding unnecessary litigations and fines. Water quality training has helped non-English speakers comply with the Regional Water Quality Control Board mandates.

Key Theme: Other
Title: SPANISH LANGUAGE MATERIALS AND CLASSES IMPROVE SERVICES TO LATINO POULATION

Description: Many efforts have been made by advisors and workgroup members to increase outreach to the Latino population in California. Outreach efforts have included the development of Spanish-language training videos, workshops/ trainings, publications and presentations.
Impacts:

- The Building Food Security Workgroup developed a Spanish-language survey instrument to assess food security among farm worker populations, consisting of seven modules: 1) Spanish language version of the Block Rapid Food Screener, recently developed for use among Latino populations, 2) general barriers to food security among farm workers, 3) access and barriers to public sector food assistance programs, 4) assets contributing to food security, 5) Spanish language version of the complete 16-item USDA Household Food Security Module, 6) income and employment data, and 7) respondent demographic characteristics. The survey was administered to over 200 farm worker families in Fresno County.
- The California Communities Workgroup held a conference entitled: “Cooperative Extension and California’s Latino Communities: Is There a Partnership in our Future?” The conference focused on Latino community outreach, Latinos and the media, and ways to better serve the Latino population in California.

- The Food Safety Workgroup taught classes on food safety education to 37 Hispanics, all of whom became Certified Safe Food Handlers.
- The Money 200+ for Teens Workgroup translated two newsletters into Spanish: *Savings Account Strategies* and *The E-Banking Experience.* They also completed a Spanish version of the credit video *Taking the Road to Good Credit*.
- The Water Quality Workgroup delivered 34 Farm Water Quality Short Courses educating more than 1150 producer participants including 140 Spanish-language participants on water quality issues associated with irrigated agriculture including non-point source pollution.
- An advisor collaborated with a colleague at the University of Arizona to address Latino/a Teen Pregnancy Prevention. They wrote five articles that were published in peer reviewed journals and created a practical handbook for practitioners. As a result of the published articles, the workgroup members are viewed as experts in this topic area, providing additional information and resources on teen pregnancy prevention to students, faculty and practitioners across California and the nation.
- An advisor continued to provide information to the public through Spanish Radio Stations in the central and southern valleys of California. The Spanish Radio Group Inc. invited him to start a Spanish radio program in 2002. They created “Agri-Noticias” which is made up of five radio cuts on agricultural issues that affect Hispanic audiences in the San Joaquin Valley. One of the topics focused on how to prevent heatstroke while working in the hot summer sun.
- An advisor trained 200 Spanish speaking farm-workers in grape and pear IPM and riparian vegetation management for preventing Pierce's disease. She has conducted 18 Spanish Language Workshops on Vine Mealybug Identification and Prevention.
- An advisor provided information in Spanish at the Farm Safety Day sponsored by the Farm Bureau. He also provided a "Train the Trainer" program on pesticide safety in Spanish.
- An advisor offered a Spanish language seminar for 100 Hispanic field workers at the Professional Turf and Landscape Exposition Educational Seminars.

(3) Did the planned programs describe the expected outcomes and impacts?

The planned programs described achieved many of the expected outcomes 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 colleagues in other agencies, institutions and other states result in improved program effectiveness by maximizing the use of available expertise. In addition, the Division’s strong external stakeholder input into the program priority setting process in ANR workgroups and through the various external stakeholder feedback processes. With declining numbers of academics to do research and conduct extension programs, it has become even more critical to be able to focus on the highest priority needs of the citizens of California.

Theme: 4.02 Air Quality

Title: CONSERVATION TILLAGE WORKGROUP ACTIVITIES
Description: The Conservation Tillage workgroup has successfully positioned itself as the premier vehicle for information related to conservation tillage systems in California and increasingly served as the consistent provider of conservation tillage knowledge and information resources to the people of California. The core work of this workgroup addresses fundamental economic and environmental or resource conservation issues that are critical to the Central Valley. Conservation tillage can significantly reduce PM emissions relative to conventional tillage in dairy forage systems in the San Joaquin Valley and can reduce surface water runoff in the Sacramento Valley.
Impact: The Conservation Tillage workgroup has established a well-known and well-received annual conference series that has provided information on various conservation tillage issues to a growing audience that numbers more than 1200 participants. Other activities by the workgroup included farm demonstration activities in 6 counties, five published articles on conservation tillage and on-going research at two San Joaquin Valley dairy sites.

Funding Source: Hatch, Smith Lever and State
Scope of Impact: State Specific

Theme: 4.23 Water Quality
Title: FLORICULTURE AND NURSERY WORKGROUP

Description: This workgroup, in addition to coordinating statewide water research and education efforts, conducted a statewide needs assessment of ornamental crop producers to identify needs throughout the state. The two high priority issues that were addressed were pest management and water quality. The workgroup held in-service trainings on how to communicate effectively, innovative methods for disease management in greenhouses and nurseries and industry tours in commercial greenhouses and nurseries.
Impact: More than 1000 clientele have been trained and given tools to come into compliance with new water quality regulations. As a result of these trainings, growers have made changes to their grower operations procedures and infrastructure to minimize or eliminate the impact of ornamental crop production water runoff on California water resources. Growers have also developed plans to continue to make improvements in water management strategies over time, so that these important environmental impacts will actually increase over time. Workgroup activities also continued to support IPM research.

Funding Source: Hatch, Smith Lever and State
Scope of Impact: State Specific

Theme: 5.19 Literacy
Title: GARDEN-BASED LEARNING

Description: The California Department of Education (CDE) conducted a gardening survey of middle schools in 2002. For all schools, the greatest barriers to using a garden were time (81%) and lack of curriculum materials linked to academic standards (74%). Project Two will identify, using the data from this survey, the schools, which cover grades 6-9 throughout

California using garden-based learning and interview them. In general there is less known about middle school use of garden-based learning than at the K-5 level. Project Two will provide the basis for understanding what materials are being used in the existing middle school gardens, and how the gardens are being used to support academic instruction and create a healthy school environment. Given the additional concern about nutrition at the middle school level, there may be an important role for garden-based learning at these grades, the project will look at how the gardens are, or could be, linked to nutrition education and the school lunch program, in addition to supporting academic subjects.
Impact: Workgroup members have conducted interviews of school districts in each county. They also have an interview to assess/ survey resources for this age group. Draft curriculum should be available before school begins next fall. The workgroup has aligned with organizations to secure First Lady Maria Shriver's support in promoting youth gardening/ nutrition as a statewide project.

Funding Source: Hatch, Smith Lever and State
Scope of Impact: State Specific

Theme: 5.20 Parenting
Title: SECOND TIME AROUND GRANDPARENTING
Description: This research focused on the number of minor children being raised by their grandparent in California. This research has been used by providers and consumers to establish funding for programs, support groups, respite care, advocacy and legislative support for grandparenting needs. A Northern California planning group convened two conferences entitled Grandparent Parenting Resources and Grandparent Resources for Maximizing Educational Opportunities.
Impacts: Participants of the conferences learned about how to obtain state and local health, social and legal resources.

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, we 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.

As part of this project, the California research group is completing a comprehensive inventory of recommended nutrition competencies for children, preschool through grade 12, in coordination with the California Department of Education, other state agencies, and experts in education and nutrition. The team developed a model program that incorporates agriculture into the school environment. It includes every part of the school environment, from gardens, to the cafeteria, to the classroom, as part of a consistent and repetitive message to students, that healthy eating habits can be learned through participation in the full cycle of life from seed to table and back again. California principals and teachers have been surveyed with respect to their use of gardens as part of the school environment. Results from these studies suggest that fourth grade teachers predominately use school gardens to enhance academic instruction, which is in strong agreement with principal responses obtained previously. It is encouraging that some teachers are using the garden in teaching core subject areas such as science (65%), language arts (42%) and math (46%). This indicates that these subject areas may be taught with linkages to standards in the core academic subjects. In the next academic year, this model program will be implemented and evaluated in selected schools in California and will include teacher and staff training to establish the following program components: 1) salad bars, 2) nutrition and gardening education, 3) composting and waste reduction and 4) development of a school food, nutrition and health policy.
Impact: Agricultural, nutritional and environmental literacy have surfaced as important next steps in creating a community climate that supports the concept of improving children's health. Recent data suggest that teachers perceive nutrition education as somewhat to very important; however they also perceive it to be somewhat to only moderately feasible to incorporate into the classroom. This project will provide the in-service educational training that will allow teachers to appreciate that nutrition and agriculture can be a part of the educational program and actually enhance the child's ability to meet the state standards for core subject areas. The reduction of childhood obesity requires a multifaceted approach; a coordinated comprehensive school health and nutrition program can help meet this need and provides an effective means for addressing this critical health issue. A district food policy can bring individuals together to support a common vision, therefore facilitating focused efforts on a healthy nutritional environment.

Funding Source: Hatch and State
Scope of Impact: State Specific

Theme: 1.03 Agricultural Profitability
Title: ALFALFA AND FORAGE WORKGROUP

Description: The California Alfalfa and Forage Association was started through the UC-ANR Alfalfa Workgroup and is the state's only grower-representative group for California's 2 million acres of irrigated forage crops. Members are working to develop long-term sources of funding for vital water quality problems facing the industry. Workgroup activities range from educational efforts to research projects, to forward "think-tank" types of activities to formulate directions for forages.
Impact: Variety choice-The workgroup coordinates the state alfalfa variety trials, ranging from Tulelake to El Centro, and points in-between. Differences in yield between varieties range between 5% and 25% based only upon the differences between variety. Individual growers can realize potentially $100 to $500/ acre for a 3-4 year stand based purely on variety choice. The workgroups has recommended for many years the planting of alfalfa during an optimum time of year. **Early seeding-** This recommendation has been incorporated into its education programs and can result in .5 to 2 tons/ acre increase in yield during the seeding year. Many growers have switched to "winter planting" based on these recommendations. **Water quality-** The workgroup began working on water quality issues in the mid 1990s when it became apparent that some of the chemicals being used on alfalfa were appearing in well water and in surface water. These studies, along with close ties and frequent discussions with growers on water quality, have contributed to developing an overall strategy for solving the water quality problems caused by alfalfa. Some growers have already switched their pesticide use in alfalfa away from OP pesticides based upon our work on water quality.

Funding Source: Hatch, Smith Lever, and State
Scope of Impact: State Specific

Theme: 1.03 Agricultural Profitability
Title: CLING PEACH WORKGROUP ACTIVITIES

Description: The Cling Peach industry is facing dire circumstances. Huge increases in labor costs, coupled with increased competition from overseas and flat prices for canned peaches has put a real economic strain on north San Joaquin and Sacramento Valley peach growers. This workgroup identified research priorities that could lead to an orchard production system that would be much less labor intensive. Some of the projects are: spray thinning, mechanical thinning, mechanical harvesting and low profile orchards. Several farm advisors met with six growers and industry representatives for a round table meeting on addressing the reducing hand labor requirements in cling peach production. Outlines for future chemical and mechanical fruit thinning trials were discussed. There were two main education events: Sacramento Valley CE Cling Peach Day and North San Joaquin Valley Cling Peach Day. Other farm advisors held regional pest management field days in the central valley for local growers and pest control advisors.
Impact: The workgroup evaluated various methods of reducing hand labor costs in cling peach production. The workgroup identified potential chemical and mechanical means of pre-thinning the fruit, resulting in reduced hand labor costs. Preliminary results have also

been obtained for mechanical harvesting. All results have been disseminated at local grower meetings. Some growers have begun using chemical thinning agents.

Funding Source: Hatch, Smith Lever and State
Scope of Impact: State Specific

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: 1.27 Plant Health
Title: Identification of spinach downy mildew races
Cooperating State: California and Arkansas
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 than 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: 4.12 Integrated Pest Management
Title: Strategy to advance IPM for celery in Michigan, California and Florida
Cooperating State: California, Michigan and Florida
A California advisor worked with a Michigan State and University of Florida colleague on developing an integrated pest management system for celery. The goal of the project is to develop an additional means of controlling celery diseases and reduce growers' dependence on pesticides. The results of their work will assist the industry in remaining competitive and in producing high quality, high yielding produce while reducing the impact on the overall environment.

Theme: 1.27 Plant Health
Title: Codling Moth Mating
Cooperating State: California and Michigan
A California advisor worked with a Michigan State colleague to determine if codling moths in California walnuts have the same mating behavior cues as codling moths in other states and crops. The goal is to get better adoption of mating disruption in walnuts and decrease the use of broad spectrum pesticides, particularly those found in water.

Theme: 4.14 Natural Resources Management
Title: Sage Grouse Conservation Planning
Cooperating State: California and Nevada
Northern California advisors continued to work with Nevada colleagues on the development of a conservation plan that will prevent the need for a threatened and endangered species designation for sage grouse. The goal is to develop conservation plans for the three population management units that cross the California/ Nevada line. Stakeholders include the Governor of Nevada, The Nevada Department of Wildlife, the California Department of Fish and Game, ranchers and sportsmen.

Theme: 4.12 Integrated Pest Management
Title: High Lysine Wheat as a Trap Crop for Glassy-winged Sharpshooter
Cooperating State: California and Montana
The glassy-winged sharpshooter is a major pest in California, particularly affecting yields in grape, olive and citrus fruits. Currently sprays are applied to crops to control this. Two California Advisors are working with a colleague at the University of Montana to look at alternative ways to control these pests by planting high lysine wheat as a trap crop. This could be a less expensive way for small farmers to control the pest and reduce the use of pesticides.

(2) Did the planned programs address the needs of underserved and under represented population? The programs described below involved underserved/ under represented stakeholders with specific needs.

Theme: 1.17 Home Lawn and Gardening
Title: Master Gardener Training
Cooperating State: California and Nevada
A California advisor continued his work with his Nevada colleague and trained master gardeners about growing fruit and nut trees in the home garden. He continued to train master gardeners and home horticulturalists in southern Nevada. Many of the participants were senior citizens and area gardeners. They learned how to grow nutritious fruits and nuts which helped them improve their eating habits.

Theme: 1.17 Home Lawn and Gardening
Title: Experimental Orchard and Master Gardener Training
Cooperating State: California and Nevada
A California advisor continued his work with his Nevada colleague and trained the local extension specialist, volunteer crew and master gardeners on pomological and viticultural practices. They also reviewed and recommended practices for the Cooperative Extension experimental orchard. As a result, a large number of urban families are starting grow their own fruits and nuts. This has contributed to better nutrition and family well-being.

Theme: 1.23 Organic Agriculture
Title: Soil biofumigation and solarization for weed management
Cooperating State: California and Idaho

There is a continued demand for organic or sustainably raised produce by consumers. This heightens the need for growers to use effective, sustainable agriculture or organic production methods. A California advisor is working with Idaho colleagues to reduce growers' dependence on synthetic pesticides. Their goal is to provide them with guidelines for using Alluim biofumigation and/or solarization in lieu of soil fumigation to provide weed control. They are also researching how to improve field worker safety. Many of the smaller scale specialty crop farms in the central valley that would be implementing these techniques are operated by ethnic growers.

Theme: 1.27 Plant Health
Title: Lettuce Drop Control in Low Desert Production Areas
Cooperating State: California and Arizona
A California advisor has been working with growers and consultants in the low desert production to research lettuce drop in Imperial Valley. It is particularly a problem in the eastern portion of Imperial County where lettuce production is more intense. The goals of this project are to: evaluate biological control agents' activity against Sclerotinia sclerotiorum (fungus that causes lettuce drop); evaluate chemical control agents at unconventional application timings; evaluate relative susceptibility of lettuce types to drop; and assess the influence of irrigation method (sprinkler vs. furrow) on incidence, severity and performance of biological and chemical control agents. Quechan Native American land is particularly impacted by this disease. Collaborators on this project are waiting until the second season results before recommending the alteration of current control strategies.

Theme: 1.28 Plant Production Efficiency
Title: National Sweet Potato Collaborators Trial
Cooperating State: California and Nevada
The objective of this on-going collaboration is to evaluate new breeding lines and varieties of sweet potatoes in commercial production fields in multiple locations in states where this crop is produced. California is the number three producing state for sweet potatoes. California supplies all sweet potatoes consumed in the western US and also exports to Canada, yet there is no breeding program in the state, either commercially or in association with UC. The Collaborators Trial allows academics in California to evaluate potential new lines from other states to determine their potential use in this environment. The data from the trials are combined and analyzed yearly to determine the potential of new varieties before they are officially released. This helps keep California producers competitive by having ready access to the newest breeding material. Many Asian and Latino 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.

Theme: 1.30 Rangeland/ Pasture Management
Title: Livestock Distribution Practices in Grazed Watersheds
Cooperating State: California, Oregon, Montana
According to US GAO, USDA FS, USDI BLM and US EPA, livestock grazing adversely affects the majority of riparian/stream systems in the western US. Nonpoint source pollution, biodiversity, endangered species, fish and wildlife habitat and other livestock grazing concerns can be addressed with management practices that alter livestock distribution on the landscape by attracting them away from environmentally sensitive areas. Policy makers,

regulators and land managers, however are often uncertain about the effectiveness of livestock distribution practices and, therefore, gravitate to the certainty of excluding livestock by fencing or lease termination. This can devastate the economic viability of range livestock enterprises, reducing their competitive ability and adversely impacting the economy of rural communities. Furthermore, livestock exclusion limits the ability to use grazing to manage wildlife habitat, fire fuel loads and weed infestations. It is crucial that managers and community watershed groups understand how livestock can be predictably and effectively redistributed so that they do not have undesirable effects in grazed watersheds. Several California Advisors along with colleagues from Oregon State and Montana State Universities have been researching grazing patterns in cow herds. The results from this study will help ranchers understand cattle movements in a watershed and will allow them to develop non-exclusionary methods of distribution away from sensitive riparian/stream areas. Most of the ranchers dealing with water quality issues on rangeland are Native American and Hispanic.

Theme: 5.28 Youth Development
Title: Destination Success: 4-H Cooperative Curriculum System
Cooperating States: CA, ID, PA ME, MN, KA, CO, MO, WA TN
A California advisor along with several colleagues from other states are working to develop an elementary-aged youth group management curriculum that incorporates research-based information and experiential activities that will assist youth workers and volunteers in managing and teaching groups of children. The 2001 National 4-H Strategic Plan established a priority for the preparation of adult leaders who empower youth members. An evaluation conducted in 2004 by 4-H CCS indicated that seventy-four percent of the respondents were "really interested" or had "high" interest in a curriculum that would help them work with youth. There are currently no other 4-H CCS products addressing the specific needs of elementary-aged youth group management. The anticipated outcome would be that youth workers statewide would enhance their youth management and leadership skills by using this curriculum. There are currently over 7,000,000 youth enrolled in 4-H across the United States and approximately 89,600 4-H Clubs nationwide according to 2003 4-H data. In addition, there are over 145,000 school enrichment groups and 102,000 special interest groups that are potential users of this curriculum.

Theme: 5.11 Family Resource Management
Title: Rural Low-Income Families: Tracking their Well-being and Function in an Era of Welfare Reform
Cooperating State: CA, IA, KY, LA, NE, NH, NY, MD, MA, OH, OR, SD, MI, MN, WV
A California advisor has been working on a project that will improve welfare policy at the federal and state levels that address the needs of rural families and communities. The objectives of this project are: to analyze the interactions among public assistance and informal social supports, community context, and individual and family characteristics and their relation to the functioning and well-being of rural low income families with children over three years time; 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; to assess over time, how families have adapted to policy and economic changes to achieve self-sufficiency (household adaptive strategies and well being that are associated with economic, food security, family functioning and policy); 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 result of these findings will provide improved outreach, education and professional practice in serving the needs of rural low-income families and Latino populations in several states.

Theme: 5.25 Tourism
Title: Agritourism
Cooperating States: California, Utah, New York, Texas, Iowa and Vermont
Many minority agriculture producers and rural families are interested in tourism as a means to increase their profitability. Two California advisors served on the National Extension Tourism Design Team with extension colleagues form several other states including Utah, New York, Texas, Iowa and Vermont. They met by phone quarterly to share resources and information nationally. Recent economic impact studies conducted in New York and Hawaii indicate that this is a growing activity among small farms, that the net value has increased, and that individual operators have increased their profitability.

(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 faces 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: Cotton Entomology
Cooperating State: California, Arizona, Texas, New Mexico, North Carolina State, Arkansas, Tennessee, Louisiana, Mississippi and Florida
Cotton entomologists from various states meet several times a year to discuss current pest management issues, review research and extension developments and compile insect loss statistics. The latter are published annually as part of the Proceedings of the Beltwide Cotton Conferences. Cotton producers in CA are faced with economic limitations in managing pests. During group meetings, growers and pest control advisers have provided important input on the direction of IPM in cotton. These meetings have established important contacts between growers, elevated research and extension activities, created grants and increased organic production practices.

Theme: 1.03 Agricultural Profitability
Title: Fourth International Rose Symposium
Cooperating State: California and Arizona
This symposium provided a forum for the dissemination of recent research results pertaining to field-grown rose plants and green-house grown rose flowers. The goal of the symposium was to share information to improve rose breeding, production and marketing practices. This meeting was sponsored and supported by the Garden Rose Council composed of rose growers located in California and Arizona.

Theme: 1.06 Animal Production Efficiency
Title: Sheep Shearing School

Cooperating State: California and Oregon
A California advisor along with a colleague at Umpaqua College in Roseburg, Oregon coordinated a sheep shearing class. The class covered the following topic areas: animal health, animal well-being (welfare), animal productivity, and production systems analysis (both computer based and diagnostic). Participants learned about proper shearing and skirting techniques and how to handle wool. Qualified shearers help to maintain range productivity and small flock sheep operations. Training people in shearing also creates a new marketable skill that adds income to the individual or the ranch owner/ operator.

Theme: 1.06 Animal Production Efficiency
Title: California, Oregon, Idaho, Nevada Livestock Programs (C.O.I.N.)
Cooperating State: CA, OR, ID, NV
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 and has allowed members to be able to access a larger network of expertise in responding to clientele questions.

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 Livestock Production Systems Workgroup is one example of the integration of the Division's research and outreach functions. The group includes AES faculty and CE Specialists from the Animal Science, Population Health and Reproduction, Medicine and Epidemiology, Pathology, Microbiology and Immunology departments at UC Davis and CE advisors from 18 counties. The workgroup also includes animal science colleagues from the California State University system and representatives from the California Farm Bureau and the California Cattlemen's Association.

The beef cattle industry in California is the 7th largest in the United States and the beef industry is the largest agricultural industry in the U.S. Consumers are interested in high

quality, low cost, safe meat that is grown in a sustainable manner. The livestock producers have production and regulatory challenges that include disease control, reproductive efficiency, animal identification, international market maintenance, water quality, pasture and range management, CAFO regulations, and practical nutrition problems--just to name a few.

.A specific example of the workgroup's research and outreach accomplishments is in the area of the cattle disease Epizootic Bovine Abortion (EBA). Last year an EBA economic survey was performed by over 20 workgroup members. It was found that EBA costs California producers more than $6 million in out-of-pocket losses and is one of the most troublesome diseases for livestock producers. Workgroup members met with 14 other researchers and commodity representatives in the spring to share results of current research efforts and to plan for future activities. Several projects were summarized and presented to the group. Workgroup efforts have resulted in significant research over the last 3 years and have included funding from USDA grants to UC researchers. The ultimate impact of this workgroup is that livestock production is still viable in an increasingly urbanized state that is having difficulty attracting small businesses of any kind. The UC presence provides the cattle and sheep industry science-based resources to develop solutions for its many and varied problems and the outreach resources to disseminate and adapt the research to the local problems.