UNIVERSITY OF CALIFORNIA
DIVISION OF AGRICULTURE AND NATURAL RESOURCES
AGRICULTURAL EXPERIMENT STATION AND COOPERATIVE EXTENSION

ANNUAL REPORT OF ACCOMPLISHMENTS AND RESULTS FY 2002

SUBMITTED TO USDA-CSREES
FEBRUARY 28, 2003

TABLE OF CONTENTS

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" (Lincoln's words) with Experiment Stations established to develop "useful and practical information...and to promote scientific investigations and experiments," and a Cooperative Extension program to "aid in diffusing...useful and practical information."

UC-ANR is 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 23 statewide special programs and projects, and supported by 9 Research and Extension Centers and 34 sites of the Natural Reserve System.

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 150 specialists and 260 advisors.

UC-ANR's mission, "... is to serve California through the creation, development and application of knowledge in agricultural, natural and human resources."

The following reports on California's planned programs for the five National Goals represent a sample of the research and extension efforts conducted by UC faculty, advisors and 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 agriculture is arguably the most diverse in the nation, producing more than 350 major crop or animal commodities. University of California Division of Agriculture and Natural Resources (ANR) researchers, extension specialists, and extension advisors continued to develop and extend research-based knowledge to address the issues facing California's producers. The State's changing demographics, new markets, globalization of many agricultural commodities, resource constraints (particularly water availability), introduced invasive species and regulatory issues drive the need for entrepreneurial farming that combines improved efficiency with development of new products and markets.

Last year, over 530 local extension programs were delivered in this program area. In addition, 47 statewide collaborative workgroups composed of both AES and CE academics planned and conducted research and extension projects. California academics received 29 patents, and published 400 peer-reviewed articles that addressed Goal 1.

FY 2001-2002 Allocated Resources

Extension Federal Funds (Smith Lever 3 b&c)	Extension State Match	Research Federal Funds (Hatch)	Research State Match
$3,129,723	$22,092,302 [172.46 FTE]	$2,730,805	$62,915,420 [228.93 FTE]

UC-ANR's Agricultural Resources Programs Covering:

- **Agricultural Productivity and Efficiency**
- **Handling, Storage and Processing Agricultural Products**
- **Pest and Disease Management**

If agriculture is to remain a robust part of California's economy, significant changes will need to be instituted in what we produce, how we produce them, and how we sell them. Overproduction, global oversupply, invasive species, competition for water and labor, and the pressure for urbanization of prime agricultural areas threaten the future profitability of the nation's most productive agriculture. Responding to these threats requires the development of innovative marketing strategies, new crops and products, and new ways to produce them. In the future we may expect a challenging paradigm shift in which the agricultural 'commons' is no longer exploited in the interest of maximizing production, but is licensed so as to balance supply and demand, to maintain prices at a level adequate to ensure profitability and sustainability for California's farmers, and thus maintain the rural amenities that agriculture provides. In a global marketplace, this strategy will only be successful if California's agricultural products are clearly differentiated from those of other producers. Researchers need to provide research-based information to support the development of premium-quality grade standards, speed the transition to organic agriculture, develop new techniques of processing and packaging familiar products, and exploit the potential of a wide range of 'new' products and crops. Strategic enhancement of breeding programs for high value crops could provide a future stream of intellectual property that could be licensed to the benefit of California growers. Additionally, we should explore

opportunities to harness the power of the information revolution for agriculture, both through the use of informatics, and through the development of smart 'tools' based on microchips, robotics, and machine vision.

Key Theme: 1.01 Adding Value to New and Old Agricultural Products
Title: The Effect of Natural Polymer Composition and Structure on the Textural Quality of Foods

Description: The low value of some U.S. commodities is often related to poor quality factors. These factors include texture and consistency of foods and food ingredients. The purpose of this project is to develop measures of these factors and to understand the relationship between the factors and food composition and structure. Our objective was to devise a rheological test that would provide texture information on cooked California rice. Two types of compression testing procedures were developed and evaluated. The first was a simple compression/extension test with six cooked rice kernels. The texture analyzer (model TA-XT2, Texture Technologies Corp., Scarsdale, NY, USA) was used to perform this compression/extension test. The six kernels were compressed to a final thickness of 0.5mm with a compression plate (4 cm-diameter). The extensional test was conducted by returning the plate to its original position. The second test was an oscillatory compression (model CP20, TA Instruments, Dover, DE) that measured the G prime and G double prime of cooked rice kernels. Ten California rice varieties were cooked and tested. They included waxy, short, medium, and long varieties. Statistical analysis was carried out using SAS (version 8.2, Cary, NC, USA). The PROC ANOVA was used for multiple class variance analysis. For the simple compression testing, the most significant variable was "modified balance" that was defined as the ratio of compression area to extension area under the force versus strain curves. For the oscillatory testing the most significant variable was the ratio of G double prime/G prime. When comparing the two testing methods, the oscillatory method showed a better statistical differentiation among varieties and with regard to amylose content.

Impact: Milled whole rice and rice flour are finding increasing uses, particularly in the area of processed foods, in the U.S. and in international markets. For whole rice, texture is considered the most important quality factor. Being able to quantify texture is an important part of being able to market and add value to California rice. California is the second largest rice producing state in the U.S.

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

Key Theme: 1.01 Adding Value to New and Old Agricultural Products
Title: Fibers and Polymers: Structure, Modification, and Novel Functional Properties

Description: This project has embarked on two new aspects of research during 2001. They are studies of transgenic modification on cotton fiber quality and electrospinning of functional fibers. The declining quality and quantity of domestic cotton production coinciding with the introduction (1996) and increasing share (>70%) of genetically modified cultivars in the U.S. raises question on whether genetic modification to achieve herbicide and/or insect resistance affects fiber development, thus quality. The effort in the first year focuses on the establishment of sampling and measurement

protocols. Exploration of electrospinning of several natural polymers have generated fibers in the hundreds nanometers of diameters. These fibers are ultra-fine and possess unique porous and fibrous structures with highest surface-to-volume characteristics. Work on cotton fiber quality also continues in the area of dyeing quality of cotton species, employing three cultivars of cotton representing *Gossypium hirsutum, G. arboreum*, and *G. barbadense* and a reactive blue dye.

Impact: Our work on cotton fiber quality shows that dyeing behavior varies among developmental stages as well as differences among species. Novel porous and fibrous materials have been created with natural and biobased polymers and have long term implications for high value-added applications.

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

Key Theme: 1.02 Agricultural Competitiveness
Title: Hexose Fermentation Rates in *Saccharomyces cerevisiae*: Genetic Construction of Wine Yeast Strain

Description: Premature arrest of juice fermentation is a chronic problem for the wine industry. The yeast *Saccharomyces* responds to stress in the environment by reducing fermentative capacity. The goal of this project is to define the stress parameters most critical to arrest and identify markers of an impending physiological crisis. The markers will be used to diagnosis the type of stress present. This is a long-term project utilizing functional genomic techniques. There are two types of problems associated with the production of fermented beverages by *Saccharomyces*: off-character formation and slow or incomplete sugar conversion. We are using the techniques of functional genomics to evaluate both processes in order to identify means to genetically construct strains producing little to no off-odors that are less susceptible to environmental stress and ethanol intolerance. Several genes regulating sugar uptake have been identified. There are four known signal transduction pathways in yeast that are sensitive to external sugar. We are characterizing three of these signal pathways, the hexokinase pathway, the SNF3/RGT2 sensors and adenylate cyclase. Current work indicates that these pathways are interacting producing signals that are convergent as well as also regulating specific cellular activities. Cells that arrest fermentation prematurely appear to produce a protein that inhibits adenylate cyclase signaling. With respect to off-character production, we have identified allelic differences in some of the genes of sulfur metabolism between high and low hydrogen sulfide producers. These genetic differences would lead to the production of altered proteins that may explain the differences in efficiency of sequestration of reduced sulfur.

Impact: The wine industry is a multibillion dollar business making grapes an important value added crop. Problem fermentations lead to net losses in production volume, and are likely completely avoidable if appropriate strains are matched to the production conditions. The goal of this project is to define the genetic basis of off-character production so that strains may be designed or identified from the wild that will be useful commercially for the elimination of these problems.

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

Key Theme: 1.02 Agricultural Competitiveness
Title: Production and Delivery of High Quality Stone Fruit

Description: 'Dr. Davis' and 'Belle of Georgia' peaches were crossed in 1996. Fruit quality of the progeny was evaluated for the second time this season. Of the 196 progeny, approximately half were found to have fruit susceptible to internal breakdown. Genomic DNA was extracted from each selection in the population for development of a molecular marker profile. We will use information from the *Prunus* molecular marker-based map that we have developed to screen for segregation of as many of the mapped loci as possible. The long-term goal of this line of research is to isolate the genetic basis for internal breakdown and eliminate it from future breeding programs. During the 2000 season, unusually high numbers of canning peaches were damaged during mechanical pit removal. Once mechanical causes were ruled out, it was believed that this damage could be attributed to soft fruits. We investigated potential mechanical pitting damage that may occur over a range of firmness for several cultivars of clingstone peach. For this evaluation we used both a prototype non-destructive firmness tester and the traditional penetrometer. Using the non-destructive firmness device, the percentage of 'Andross', 'Carson', and 'Ross' fruit with pitting damage increased rapidly as firmness index values fell below 7.0. Using the destructive penetrometer, the percentage of 'Andross', 'Carson', and 'Ross' fruit with pitting damage increased as fruit cheek firmness fell below 4.0 lbf. Our results will help processors better estimate processing losses. Additionally, automated systems of non-destructive firmness measurement may allow processors to quickly quantify the firmness of large amounts of fruit. Information about the firmness distribution of fruit samples at the receiving area could be useful for predicting potential problems during processing. Bruising development during cling harvest reduces the quality and quantity of processed clingstone peaches. We investigated how fruit temperature (morning harvest versus afternoon harvest) influences preprocessing bruise development. Also, bruise development of fruit stored postharvest at 0C (32F), 5C (41F), 10C (50F), or outside ambient temperature was observed during a 24-hour period. Fruit harvested in the afternoon had darker bruises than fruit harvested in the morning after 24 hours incubation. Bruise incidence, bruise intensity and bruise color on 'Ross' fruit was not significantly affected by postharvest storage temperature.

Impact: Internal breakdown of stone fruit is the basis of most consumer complaints. We are working to isolate the genetic basis for this disorder so it can be eliminated from future breeding programs. Elimination of this problem may increase stone fruit consumption, which would be healthful for consumers and profitable for the supplier.

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

Key Theme: 1.02 Agricultural Competitiveness
Title: Cotton Variety Evaluation For the San Joaquin Valley Cotton Districe

Description: Over the last five-year period a total of 171 experimental cottons, 133 Acalas and 38 Pimas, have been tested. Extensive field evaluations under diverse environments, followed by detailed laboratory measurements of fiber and yarn quality, resulted in eventual approval of 18 of the Acalas and five of the Pimas under the San Joaquin Valley's High Quality Law. Growth, yield, and quality characteristics of each of these cottons are detailed in a series of reports to the San Joaquin Valley

Cotton Board. Compared to the standards that were in place 20 years ago, these cottons show significant improvements in fiber and yarn quality, especially in fiber, length, strength, uniformity, and fineness characteristics. This was translated into improved processing efficiency, resulting in yarns having greater strength and uniformity. Included among the most recent releases are, for the first time, high-quality Acala transgenics conferring Roundup herbicide tolerance and BT insect tolerance.

Impact: The availability of an array of high-quality varieties with differing growth characteristics will provide Acala and Pima growers with greater flexibility in planting and management decisions, particularly with regard to the new transgenics. Improvements in fiber and yarn quality will help to maintain and increase markets in the highly competitive worldwide textile industry.

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

Key Theme: 1.02 Agricultural Competitiveness
Title: Enhancing the Global Competitiveness of U.S. Red Meat

Description: The prediction system for ruminant animal growth and composition was developed with the Australian Cattle and Beef Cooperative Research Centre (CRC), Armidale, New South Wales, Australia, and AgResearch, Ruakura Station, Hamilton, New Zealand uses parameters for energy transactions that vary with animal genotype. Also, protein growth of muscle and viscera vary differentially. The model predicts body fat accretion as the difference between metabolizable energy intake and protein accretion. Therefore, accurate predictions of energy use are critical. Previous work with a sheep dataset from Nebraska and a cattle dataset from California have shown that the model, previously calibrated for sheep, provides adequate predictions. However, the parameters for growing steers were not identified with the current dataset, as they were for the extensive dataset used for sheep. Future work will require additional cattle data be used for calibration.

Impact: : Sheep growth and composition can be accurately predicted with the new model, which represents body protein in two pools, one closely associated with carcass muscle - the economically useful component. The model provides the structure for predicting composition of growing cattle as well, but has yet to be completely parameterized and tested.

Funding Source: Hatch Multistate Research and State
Scope of Impact: AZ, CA, CO, ID, IA, KS, NE, NV, NM, OK, SD, TX, UT, VA, WA, WY, USDA /ARS, USDA/ERS

Key Theme: 1.02 Agricultural Competitiveness
Title: Muscle Growth and Development in Transgenic Animals

Description: The callipyge gene has been known to have a large phenotype effects, increased muscle growth and lean carcass but with poor meat quality. In order to improve the meat tenderness of callipyge lamb the effects of chemical, biochemical and structural attributes to the meat toughness of ribeye muscle during postmortem aging were investigated. A significantly higher protein content,

lower intramuscular fat content, more compact fiber structure, reduced postmortem proteolysis, and reduced myofibril fragmentation were significantly related to the greater toughness of ribeye muscle from callipyge lambs. After 14 days aging, a specific breakdown near I-band and Z-disk junction was observed for the normal ribeye muscle; whereas, a few random degradation of thick and thin filaments was observed for the callipyge ribeye muscle. One of the factors affecting postmortem structural changes and meat tenderness was found to be ultimate muscle pH. A high muscle pH resulted in significantly improved meat tenderness even at 1 day after slaughter; whereas, muscles with normal pH showed a gradual tenderization during prolonged aging period. This tenderness-enhancing effect of high muscle pH was investigated with callipyge muscles to improve tenderness. Callipyge lambs were injected with epinephrine to deplete glycogen and to induce high muscle pH. After 14 days of aging high pH loin chops had an average shear value of 4.2 kg/1.27-cm core samples, which was close to an acceptable shear value of 4.0 kg. A high pH muscle showed an extensive degradation at the Z-disk - I filament junction, resulting in a greater fragmentation of myofibrils. The manipulation of ultimate muscle pH is one alternative method to improve meat tenderness of callipyge lamb to the acceptable level.

Impact: The sheep industry in the U.S. has been losing its competitive edge to other countries because of high production cost. The callipyge gene can greatly improve meat yield and production efficiency if we can find method to alleviate meat toughness problem. This research addresses to the improvement of meat tenderness of callipyge lamb.

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

Key Theme: 1.02 Agricultural Competitiveness
Title: An Economic Analysis of the Impacts of Marketing Order Programs on California Fruits, Nuts and Vegetables

Description: Project activities began with assembling data on Federal and State mandated marketing programs for California commodities. Research then focused on the economic effects of generic commodity advertising programs for California avocados, table grapes, prunes and almonds. Marketing order provisions for grading standards for prunes and minimum maturity standards for California kiwifruit were also examined. Research to estimate producer benefits from producer funded generic commodity advertising and promotion documented significant positive returns in both the short- and long-run. For table grapes, the short-run marginal benefit-cost ratio was estimated at over 80:1 and, with producer supply response factored into the analysis, the long-run marginal benefit-cost ratio was about 5:1. This latter figure means that for every $1 spent on advertising and promotion, the industry gained returns of $5. The estimated short- and long-run returns from advertising and promotion for avocados were 5.3:1 and 1.7:1, respectively. In the case of prunes, the estimated benefit cost ratio was 2.65:1 for the four-year period, 1992-1996. Marginal benefit-cost ratios for almond industry advertising were estimated to range from 2.9 to 6.9, depending upon the specification of the almond supply model. Suspension of the promotion program for the 1994/95 through 1996/97 crop years was estimated to have reduced grower profits by an amount ranging from $90 to $234 million. The federal marketing order for prunes authorizes the industry to regulate and set standards for the prune grading system. The screen-grading system used to grade prunes is subject to asymmetric grading errors, due to the fact that small prunes may fail to fall through screens that correspond to their

grade, while larger prunes cannot fall through a screen that corresponds to a lower grade. The result is that higher grades of prunes are "contaminated" by smaller prunes, reducing market prices for top grades. The result is that incentives to engage in production practices such as shaker thinning are reduced. The effects of minimum maturity standards on the average price differentials between kiwifruit from California and from New Zealand were examined. The analysis of terminal market data found evidence of a "lemon" type problem for eight out of 20 cases for which data sets were available. Results were consistent with the proposition that minimum maturity standards corrected a lemon problem of asymmetric information on sweetness of California kiwifruit in the Boston, Los Angeles and Philadelphia terminal markets. The early season price premium that New Zealand fruit enjoyed over California fruit decreased significantly after the imposition of the minimum maturity standards.

Impact: California producers have recently spent well over $100 million annually on marketing programs for their commodities with the majority of expenditures for generic advertising and promotion programs. Results of this project indicate for the four commodities studied, that aggregate producer benefits from generic advertising and promotion are substantially greater than their costs. Details on the methodology employed in the analyses are outlined and explained to facilitate studies for other commodities and time periods. Evidence on the benefits of government sponsored marketing programs are important to the producers who finance the programs and to government officials, who are charged with administering the programs.

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

Key Theme: 1.02 Agricultural Competitiveness
Title: Agricultural Policy, Trade and Economic Welfare

Description: China is applying for World Trade Organization (WTO) membership, and this process is being carefully monitored around the world because China is the globe's largest potential economy. Issues of China's succession to the WTO are of concern to both developing and developed countries alike and agricultural policy and trade plays a critical role in the negotiations. Work on this project involves the analysis of how the expansion of China's agricultural trade will affect factor markets in China, especially the labor market. There is disagreement in the literature over the impact of WTO entry on returns to farm labor. Traditional trade theory suggests that real farm wage rates might fall and farmers would be worse off with freer trade. However, if we account for current immobility of rural labor, then theory predicts a rise in real labor wage rates with trade liberalization. Current government policy supports non-agricultural wages at the expense of returns to farm labor. When China joins the WTO, an increase in the relative price of agricultural goods will raise the agricultural wage rate. If WTO entry also leads to labor market reform, this will serve to reduce the gap between urban and rural wages and dramatically boost the gains to agricultural labor. This result is supported with numerical simulation results using a general equilibrium model. If 35% of China's agricultural labor force exits agriculture after WTO accession, it is estimated that the current 3:1 urban/rural wage gap would close.

Impact: An analysis of the effects of China's entry into the WTO will provide U.S. producers and policymakers with a better understanding of future characteristics of world food trade and the implications for U.S. agriculture.

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

Key Theme: 1.02 Agricultural Competitiveness
Title: Vegetable Variety Trials in Santa Barbara County

Description: New varieties of vegetables are continually being developed by University and USDA plant breeders, and by private seed companies. The new cultivars are bred with improved horticulture characteristics and improved disease resistance. These cultivars must be field-tested in various growing areas to see if they are adapted to the area, and in which growing season (spring, summer, fall) they will perform best. Disease resistance ratings also need to be made. Tests under commercial growing conditions in Santa Barbara Co. were done to compare new cultivars against cultivars in current use and to check their horticultural and disease resistance characteristics. Design: Potato trial - one per year; carrot trials - two per year; celery trials - three per year; Napa - one trial. All trials were set up in a randomized complete block design with four replications. Each trial was advertised to local growers, and a field day was held at or near harvest. All data, which included weight, size, length, color, defects, disease ratings, shape, taste, texture, etc., was analyzed and submitted to the various commodity boards to be published in their annual reports. Presentations of the data were also made at board meetings. Results were published in the Santa Barbara County Agriculture Extension newsletter.

Impact: Variety trials done by Cooperative Extension in grower fields provided growers, seed producers, and agribusiness an opportunity to view and compare new cultivars under local conditions. This is a head-to-head, stalk-to-stalk, etc., unbiased evaluation of new cultivars. The trials provided a service to the local grower commodity and also aive plant breeders an opportunity to see how their material stands up to the competition. These trials have led to the introduction and use of a number of new cultivars by commercial growers on the Central Coast (Santa Barbara and San Luis Obispo Counties).

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

Key Theme: 1.03 Agricultural Profitability
Title: Breeding, Genetic, and Agronomic Studies of Barley in California

Description: Barley is grown under a wide range of environmental conditions in California. The crop is subject to multiple stresses, including diseases and drought. Cultivars must be developed for each ecological niche in order for barley production to be successful. Spring barley will be improved in order to: 1)make a forage barley available to the dairy industry located in the San Joaquin Valley, 2) produce a malting barley for the brewing industry, and 3) improve currently available feed barleys. Incorporation of resistance to barley stripe rust (Puccinia striiformis) in high yielding genotypes is the primary goal of the UC Davis barley breeding program. Progress towards meeting this goal was made as three resistant varieties (UC 933, UC 937 and UC 960) were released. Additional sources of resistance to stripe rust were incorporated into segregating populations because of the uncertainty of

the durability of the resistance found in these new varieties. An early maturing variety, UC 969, also was released. The early maturity of UC 969 allows it to escape damage from stripe rust.

Impact: Three new semi-dwarf, stripe rust resistant spring barley varieties (UC 933, UC 937 and UC 960) are now available to growers in the Central Valley and Klamath/Tulelake Basin. These three varieties will replace the older susceptible varieties and allow growers to again produce a profitable crop. An early maturing spring barley, UC 969, also has been released and should replace UC 603.

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

Key Theme: 1.03 Agricultural Profitability
Title: A Time Series and Econometric Analysis of Marketing and Food Demand Systems

Description: Major revisions were completed on, "A Time Series Approach to Measuring the Effects of Advertising" and the paper is being resubmitted to the Journal of Business and Economic Statistics. Techniques based in time series analysis, specifically intervention analysis and transfer function model specification procedures, are combined with a unique high frequency data set to determine the form and magnitude of the linkages between advertising and sales. The goal is to closely link in time and actual campaign presence in the market to the shipment response, in contrast to studies that assume particular utility functions and necessarily operate at a more aggregate level using annual budgeted advertising expenditures.

Impact: Several flexible demand systems using 8 different commodities, are developed and estimated to determine whether globally flexible demand systems perform better than their locally flexible counterparts. Monthly time series data are being employed in the estimations. The goal is to closely link in time and actual campaign presence in the market to the shipment response, in contrast to studies that assume particular utility functions and necessarily operate at a more aggregate level using annual budgeted advertising expenditures. A case study involving market development programs of California walnuts in Japan was found to be successful. A unique feature of this work is that we found a much longer advertising duration interval than typically reported in the advertising literature.

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

Key Theme: 1.04 Animal Genomics
Title: Advanced Technologies For the Genetic Improvement of Poultry

Description: Studies on the molecular organization and cytogenetic localization of the chicken 5S ribosomal RNA gene complex were completed. The 5S rRNA is a highly conserved component of the ribosome, the organelle responsible for protein translation. It was determined that the 5S genes map to chromosome 9 by genetic linkage mapping and fluorescence in situ hybridization analysis. The 5S array maps to the q arm, adjacent to the centromere, and its location allows for the correct orientation

of the entire linkage group of genes mapped to 9 (E36). The 5S array is approximately 200 Kb in size and consists of a predominant 2.2 Kb repeat (120 bp coding, 2.1 Kb spacer) with about 170 genes per diploid genome. A 0.6 Kb repeat was also found to segregate in some genetic lines of chicken. Both repeat types were sequenced and comparisons to other vertebrate sequences were undertaken. A manuscript is in preparation and new collaborative research was initiated to integrate the genetic and physical map of chicken chromosome 17. BAC clones are being used as probes in fluorescence in situ hybridization studies. Preliminary studies are underway to characterize the genetic diversity in foundation populations of broiler and layer commercial chickens and breeds of chickens held in the U.S.

Impact: Improved understanding of the molecular organization and cytogenetic localization of coding genes in the chicken genome is essential for improvements in poultry production, in particular for the application of marker assisted selection. Biotechnology applications, e.g., genome manipulation, development of stem cells and extended lifespan somatic cells, require improved understanding of coding genes as well as knowledge of extant genetic diversity. It is important to understand the molecular organization of the genomes selected for animal breeding or biotechnology development. Diversity studies will allow the information-based assessment of extant genetic variation and rational selection of populations for conservation.

Funding Source: Funding Source: Hatch Multistate Research and State
Scope of Impact: ALX, AR, CA, ANADA, DE, IL, IA, MD, MA, MI, MN, NC, OH, IN, VA, WI, USDA/ARS, TX

Key Theme: 1.05 Animal Health
Title: Retroviruses and Animal Diseases

Description: Dairy cattle are widely infected by bovine leukemia virus in the U.S., resulting in economic losses. To reduce numbers of infected animals, effective vaccines and anti-viral therapies are needed. Project goals are to investigate the earliest stages of infection in lymph nodes and to learn how different parts of the viral envelope protein contribute to the ability of the virus to infect cells. Within 11-14 days after sheep are injected with bovine leukemia virus (BLV), very small numbers of peripheral blood mononuclear cells contain the BLV provirus. In short-term culture, the cells manifest infection by expressing viral genes and producing infectious virus. Between d18-28, the number of infected blood mononuclear cells increases sharply and transiently, and is accompanied by a rapid rise in neutralizing antibodies. The level of virus-infected peripheral blood cells then drops and can remain low for a year or more before beginning to increase gradually. In the majority of infected sheep, clonal B-lymphocyte tumors eventually occur with latencies of up to 9 years after initial infection. The appearance of infected lymphocytes in blood during early infection is believed to result from previous virus spread within organized lymphoid tissue. In an investigation of very early BLV replication in sheep, efferent lymph cells were used to determine the kinetics and magnitude of viral spread within the lymph node that drained the region into which BLV was injected. An efferent lymphatic duct emerging from the prescapular lymph node was cannulated. After recovery from surgery, sheep were injected with BLV-infected cells in the skin of the corresponding shoulder. Virus-infected cells first emerged from the node 4-6 days later, increased 100-fold in frequency within 2 days, and reached a plateau frequency by d9. The appearance of virus-infected cells in peripheral blood lagged behind export of infected cells from the node. However, much higher levels of BLV-positive cells were

eventually present in the peripheral blood. This pattern suggests that infected cells leaving the lymph node after the first wave of BLV replication initiated another round of infection at other sites, which was then followed by the characteristic massive release of infected cells into the blood. IgM+ B cells, the predominant hosts for BLV, were present at greater than expected frequencies on d9-12 in lymph and after d13 in blood. The first release of BLV-infected cells from the prescapular node was followed by the release of large numbers of blasts. The DNA of lymphocytes proliferating in the infected node at this time was labeled by intravenous injection of 5-bromo-2'-deoxyuridine (BrdU). Percentages of efferent lymphocytes that had been in S phase of the cell cycle during the pulse were increased relative to those from mock-infected sheep.

During early infection, enhanced levels of BrdU-positive CD8+ T cells were present in efferent lymph as well as in peripheral blood. Together with the increase in blasts, the proliferative activity of CD8+ T cells indicates that BLV-infected sheep rapidly generated an immune response to BLV infection.

Impact: The cellular and molecular events occurring during the earliest phases of infection by a retrovirus such as bovine leukemia virus establish a life-long relationship between the virus and a host animal. Understanding these events is critical to be able to design vaccines and effective anti-viral therapies. BLV causes cancer in cattle and is related to the human pathogen, human T-cell leukemia virus. Thus, this work has impact on the economic and social consequences of both animal and human disease.

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

Key Theme: 1.05 Animal Health
Title: Interactions Between the Immune System, Growth and Nutrition of Poultry

Description: Experiments in chickens demonstrated that pro-inflammatory cytokines, such as interleukin -1 are released in large amounts by leukocytes engaged in fighting an infectious challenge. The pro-inflammatory cytokines are important for coordinating the various biochemical, cellular and endocrine responses that direct substrates to the immune system and other protective pathways. For example, the amount of lysine intake used for immunocompetence in a healthy animal is about 1.2 percent. During a robust challenge, this increases to about 6.7 percent and most of the increase is due to the production of acute phase proteins by the liver. Because these same pro-inflammatory cytokines decrease food intake, a portion of the nutrients redirected toward the immune system arises from pathways related to growth, skeletal muscle accretion or reproduction. For example, nutrient repartitioning results in an increased rate of protein turnover, which leads to increased body temperature and basal metabolic rate. This process permits greater detection of intracellular pathogens. In some tissues, such as skeletal muscle, increased proteolysis is not matched by augmented protein synthesis causing decreased tissue accretion that is manifested as impaired growth in young animals or negative nitrogen balance in mature animals. In general, an immune stress results in decreased nutrient intake, increased nutrient excretion, and repartitioning of nutrients away from production towards immune-related functions. In addition, production of effector molecules, such as reactive oxygen intermediates, may increase requirements for certain nutrients, such as antioxidants. The immune system can be manipulated by nutrition. The immune system must compete for nutrients with growth

and reproductive processes and is a component of the maintenance costs of an animal. Nutritional status during embryonic development may affect immunocompetence for the life of the animal, while post-natal nutritional status may affect cell proliferation, responsiveness, phagocytic capacity, and effector molecule production. A nutrient deficiency or excess may result in increased susceptibility to disease due to these modifications.

In addition, nutritional deficiency or excess may enhance the virulence or pathogenicity of certain infectious micro-organisms. Furthermore, many nutrients can modulate the immune system by influencing fundamental decisions in the complex series of cellular interactions and intracellular messenger pathways that are required for a coordinated and effective response to a pathogen. Specifically fatty acids and antioxidants, may modulate the immune response depending on their rate of dietary inclusion.

Impact: We have found that sick animals grow slower and less efficiently due to the immune response to opportunistic bacteria. Nutrition can minimize the negative effect of immune responses on performance. With consumer and legislative pressure to minimize the use of antibiotic growth promoters, an understanding of the connections between immune responses and animal productivity becomes critical.

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

Key Theme: 1.05 Animal Health
Title: Analysis of the V-Erb a Oncogenic Gene of Avian Erythroblastosis Virus

Description: Two genes encoded by AEV, termed the v-erb A and v-erb B oncogenes, participate in the cancer-inducing abilities of this virus. We have continued our investigation of the molecular mechanisms of action of these genes, and the proteins they encode, by use of genetic and biochemical approaches. This past year we focused our research on the transcriptional properties of the v-erb A protein. The v-erb A protein is a defective version of a thyroid hormone receptor. Thyroid hormone receptors, and the closely related retinoic acid and retinoid X receptors, function as hormone-regulated transcription factors. V-erb A can repress, but cannot activate, transcription, and functions in cancer by inhibiting the actions of the normal receptors. Our work has included studies on how cancer induction by v-erb A is related to defects in the interactions of v-erb A with auxiliary proteins, denoted corepressors. We have also studied how the normal versions of these nuclear hormone receptors play a role in normal physiology, and how defects in retinoic acid receptors similar to those found in v-erb A are involved in human cancer. The results from these studies include: An understanding of how different protein kinase signaling pathways in cells can regulate the interaction of corepressor with nuclear hormone receptors. An elucidation of how the DNA recognition properties of abnormal retinoic acid receptors may contribute to leukemogenesis.

Impact: Nuclear hormone receptors regulate the growth, reproduction, and health of animals; for these reasons our studies have the potential to improve the health and agricultural yield of domesticated animals. In addition, defects in nuclear hormone receptor function can lead to endocrine disorders and cancer in both animals and humans-our studies help our understanding of how oncogenes and nuclear

hormone receptors function, and suggest ways of treating or preventing these disorders.

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

Key Theme: 1.05 Animal Health
Title: Improved Diagnosis and Control of Bovine Neosporosis

Description: A POLYGEN-adjuvanted killed *Neospora caninum* tachyzoite preparation was previously found to induce significant production of interferon-gamma (IFN-g) in non-pregnant cattle. IFN-g is a cytokine known to be critical for resistance of mice to *N. caninum* infection. However, a first trial showed that the POLYGEN-adjuvanted preparation failed to prevent vertical transmission of *N. caninum* in pregnant cattle challenged by intravenous/intramuscular inoculation of tachyzoites. We speculate that the artificial route of challenge and the high dose of tachyzoites used may have overwhelmed the immune capacity of the dams and affected the efficacy of the POLYGEN-adjuvanted preparation. A natural route of challenge infection through transplacental transmission in naturally infected cattle is a more realistic model for the evaluation of vaccine efficacy. Consequently, the present study, co-funded by CFAH, CDRF and Bayer Corporation, was devised to test whether the POLYGEN-adjuvanted preparation would be able to prevent/or reduce the incidence of vertical transmission of *N. caninum* in naturally infected pregnant cattle. Twenty-eight naturally-infected heifers were selected and randomly assigned to 2 groups of 14 animals each, group A immunized and group B unimmunized. Heifers from group A were immunized subcutaneously with the POLYGEN-adjuvanted preparation at breeding, at pregnancy check (around 35 days of gestation) and 28 days after the second immunization (63 days of gestation). Heifers from group B served as unimmunized controls. Eleven pregnant heifers from group A and ten pregnant heifers from group B were retained for the experiment. Blood samples were collected every two weeks until fetal death or until calving, and used to assess *N. caninum*-specific immune responses (antibody production, IgG subclasses, lymphocyte proliferation, IFN-g production) in the 2 groups of heifers. This analysis will be completed by May 2002. Fetal infection and death was also compared in the 2 treatment groups. One unimmunized heifer aborted at week 19 of gestation. However, the cause of the abortion is not known as the fetus was not recovered. Another unimmunized heifer delivered a stillborn calf at 43.5 weeks of gestation. The remaining 8 unimmunized heifers, as well as all 11 immunized heifers, delivered live full-term calves. All full-term calves from unimmunized and immunized heifers, including the stillborn one, had elevated precolostral *N. caninum* ELISA titers, suggesting in utero exposure to the parasite. All live full-term calves from unimmunized and immunized heifers had histopathological lesions characteristic of *N. caninum* infection.

The stillborn calf, which had severe congenital heart defects, did not have any inflammatory lesions typical of *N. caninum* infection. *Neospora caninum* parasites were detected by immunohistochemistry in 4 out of 9 calves from unimmunized heifers and 7 out 11 calves from immunized heifers. No other pathogens were detected in any of the calves. In conclusion, the POLYGEN-adjuvanted killed tachyzoite preparation failed to prevent vertical transmission of *N. caninum* in naturally-infected heifers.

Impact: Neosporosis, caused by the protozoan parasite *Neospora caninum*, is a major cause of infectious abortion in cattle. There is no prevention or treatment available for bovine neosporosis. To

stop the cycle of vertical transmission and reduce the economic impact of *N. caninum* abortion, we must investigate methods for increasing protective immune responses in naturally infected cattle. We report here the first vaccine efficacy trial in naturally infected cattle. Our results show that a POLYGEN-adjuvanted killed *N. caninum* tachyzoite preparation, previously shown to induce significant production of IFN-g, failed to prevent transplacental transmission of the parasite in heifers naturally infected with *N. caninum*.

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

Key Theme: 1.05 Animal Health
Title: Reproductive Performance in Domestic Ruminants

Description: Although no prospective studies have been reported, congenital BVDV infection (CI) in late pregnancy has been thought to be rare and to manifest mainly in abortion, stillbirths, or weak calves that died shortly after birth. Our study aimed to clarify the prevalence of BVDV CI, the factors that contribute to CI, and how CI might manifest after the calf was born. On two dairies practicing BVDV vaccination, 400 calves were tested precolostrally for evidence of BVDV and of SN antibodies, and health status was followed for 15 months. BVDV CI was found to be more prevalent than expected (about 10%), and was more likely in calves of first calf heifers than in cows and more likely in dams with high SN titers. Calves with CI were twice as likely to experience a severe illness, compared to calves without CI.

Impact: These results indicate that a reasonable proportion of apparently normal calves on typical California dairies can have BVDV CI that can have a negative impact on calf health. Results also indicate that BVDV CI is not being prevented by the vaccination programs typically in place on California dairies.

Funding Source: Hatch Multistate Research and State
Scope of Impact: AK, AZ, CA, CO, HI, ID, KS, MI, MN, MO, MT, NV, NM, OH, OR, TX, WA,WY, USDA/ARS, NE

Key Theme: 1.05 Animal Health
Title: Genetic Bases For Resistance and Immunity To Avian Diseases

A: Genetically Produced Rice: Two experiments were conducted to determine if rice that has been genetically produced to express human lactoferrin (LF) or lysozyme (LZ) protects the intestinal tract similar to sub-therapeutic antibiotics (bacitracin + roxarsone; Antibiotics). Experiment one compared ten corn-soy diets containing 20% of various proportions of LF, LZ, or conventional rice (CONV). Chicks fed 5% LF + 10% LZ + 5% CONV had significantly better feed efficiency and thinner lamina propria in the duodenum than those fed 20% CONV. Experiment two compared five corn-soy diets containing experimental rice combinations totaling 15% rice. Chicks fed 10% LZ + 5% CONV or 5% LF + 10% LZ had significantly lower feed intake and significantly better feed efficiency than those fed 15% CONV. Chicks fed 10% LZ + 5% CONV, 5% LF + 10% LZ, or Antibiotics had significantly

greater villus height in the duodenum compared to chicks fed 15% CONV. The lamina propria of the ileum was thinner and contained fewer leukocytes in chicks fed 10% LZ + 5% CONV or Antibiotics compared to those fed 15% CONV. Another method to replace dietary antibiotics is to enhance natural immunity in the intestines. Betaine is a good candidate because it used by cells to defend against changes in osmolarity that occurs in the gut. We examined relationships between betaine, osmolarity, and coccidiosis. In the first experiment, broiler chicks were fed corn-soy diets containing either 0.0, 0. 5, or 01.0 g/kg betaine and half were challenged at 14 d with Eimeria acervulina (Cocci). Cocci decreased weight gain and feed efficiency, while betaine did not affect either. Cocci increased OS of the duodenal and jejunal mucosa. Betaine decreased OS of the duodenum, especially in Cocci challenged birds. Cocci increased the thickness and number of leukocytes in the duodenal lamina propria. The increase in leukocyte numbers was greatest at high betaine levels. The height of duodenal villi was decreased by Cocci and this effect was ameliorated by 1.0 g/kg betaine. Intraepithelial leukocyte numbers were increased by Cocci and this increase was greatest with 0.05 and 0.10% betaine. In a second experiment, peritoneal macrophages (Macs) or peripheral blood heterophils were incubated in media with an osmolarity of either 200, 310, 600, or 900 mOsmol and either 0.0, 0.1, 0.5 or 1.5 mM betaine (4x4 factorial). E. acervulina were added to cultures after 6 hrs exposure to media. In general phagocytosis and NO release were decreased and IL-1 and IL-6 release were increased in hyperosmotic media (600 Osmol) compared to isosmotic media (310 Osmol). Betaine (0.1 mM) increased NO release by heterophils and tended to increase NO release from macrophages. In a third experiment, the chemotaxis of monocytes towards chemotactic factors released by heterophils was increased by betaine in hyposmotic (200 Osmol) and isosmotic (300 Osmol) media. Increased chemotaxis of monocytes and NO release by macrophages explains the decreased intestinal pathology but increased leukocyte numbers observed when betaine is fed during a Cocci infection.

Impact: Feeding antibiotics to animals will eventually be unfeasible. The results from these experiments demonstrate a potential of genetically produced LF and LZ rice to be used as a substitute for antibiotics in broiler diets. Furthermore, dietary additives such as betaine may facilitate natural immunity in the intestines and promote animal health in the absence of dietary antibiotics.

B. MHC in Early Embryogenesis: New collaborative research was undertaken to establish the developmental profile of expression of major histocompatibility complex (MHC) genes during embryonic development, prior to organogenesis. The main hypothesis under study is that MHC-encoded proteins serve as cell-recognition elements guiding early embryonic morphogenesis and differentiation. The status of the research is too early to provide definitive results statements. The University of California-Davis collection of specialized poultry genetic populations, which are useful for studies in developmental biology, genetics/genomics and immune function, were maintained and made available to researchers on request.

Impact: Research with model organisms and in humans, indicates that MHC proteins may have important non-immune signaling functions during early embryogenesis. Our research will establish the potential of a new role for the MHC, during early embryogenesis in chicken. Cell recognition may affect impact cellular interactions prior to and during morphogenesis and thus the success of several biotechnology efforts (culture of embryonic blastodermal cells and creation of germline chimeras from blastodermal cells) may hinge on MHC-controlled recognition. As agricultural research at many institutions has changed and the advent of significant growth of molecular biology research, it is important that the specialized genetic populations developed during the previous 50 year are

maintained for research. The specialized genetic lines are not likely to be re-created in the future and these hold important promise for the future understanding of avian and poultry biology. Many of these lines are not available except from UC-Davis and are made available to other researchers on request.

Funding Source: Hatch Multistate Research and State
Scope of Impact: AL, AR, CA, CTS, DE, GA, IA, Framingham, ARS/BARC, ARS/ADOL, NH, NYC, NC, PA, SC

Key Theme: 1.05 Animal Health
Title: Avian Lung Fluid Balance

Description: Pulmonary edema is a serious problem associated with respiratory diseases in poultry and the mechanisms of lung fluid balance which help prevent pulmonary edema are not understood in birds. This study will attempt to elucidate how liquid which leaks out of pulmonary blood vessels and could cause edema, gets removed from the tissues of lung so that it does not create edema and interfere with gas exchange. Studies have been completed which utilized scanning electron microscopy (SEM) to examine the interparabronchial septum as a potential site of lymphatic drainage in the lungs of anesthetized chickens (Gallus domesticus) subjected to moderate and extreme volume loading in order to produce pulmonary edema. In both conditions adjacent parabronchi of normal control lungs were closely opposed by a minimal septal space while those of volume-loaded birds were measurably thickened and engorged. The results of this study are consistent with data from mammals and suggest that the interparabronchial septum may be a potential route of lymphatic drainage in the avian lung. An additional study reports that the visceral air sac mesothelium of volume loaded chickens presents an increased density of bulbous or swollen microvilli as compared to controls. This is also similar to changes observed in the visceral pleura of mammals subjected to hydrothorax. Two manuscripts have been submitted for publication.

Impact: The results of this research suggest that birds may be protected against pulmonary edema by mechanisms which are similar to those in mammals. Particularly with respect to the role of loose interstitial spaces serving as routes of lymphatic drainage or as potential spaces for fluid accumulation outside of the gas-exchanging region of the lung. The studies are relevant to poultry husbandry, avian veterinary medicine, and comparative pulmonary physiology in general.

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

Key Theme: 1.05 Animal Health
Title: Development of Virus-Like Particles For Large Scale Production of Potential Domestic Animal Diagnostic and Vaccine Reagents

Description: Considerable economic loss is encountered by cattle producers as a result of "shipping fever" caused by several viruses. This project will allow development of a new approach to the production of diagnostic reagents and vaccines to alleviate this problem. The baculovirus expression vector system (BEVS) is being used to generate recombinant proteins for use as diagnostic and vaccine

reagents. We have constructed recombinant baculoviruses containing the core gag genes for the simian immunodifficiency virus (SIV) and for the feline immunodifficiency virus (FIV). The recombinant viruses have been used to infect insect cells in culture. Analysis of the supernatant culture fluids have revealed that the infected cells are releasing virus-like particles (VLP) containing the respective SIV or FIV gag proteins. Although the optimal conditions for harvest are currently being evaluated the yield of VLP is substantial. In order to quantitate the yield of VLP gag protein we have devised a process of phospho-imaging fluorescence scanning of proteins separated by polyacrylamide gel electrophoresis. Yields of gag protein in the mg/liter range are now typically found. Evaluation of VLP production in three insect cell lines has indicated that significant differences exist depending on the recombinant protein being expressed. Study of the optimization of VLP expression in the several cell lines under different infection conditions is currently in progress.

Impact: Development of cost effective diagnostic and vaccine reagents for infectious diseases of domestic animals remains a continuing need. Application of the in vitro baculovirus expression system for the production of recombinant proteins appears to provide an economical means for the production of critical reagents

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

Key Theme: 1.05 Animal Health
Title: Preparing For Reintroduction of Brucellosis in California: Evaluation of Serologic Tests in Non-Bovine Reservoirs

Description: Understanding brucellosis in non- or semi-domesticated non-bovine reservoirs is important to protect cattle from the disease. The critical first step toward this understanding is to improve our ability to reliably detect the disease in these reservoirs. We believe that methodology recently developed for a disease of fish can be adapted for this purpose. In addition, it is important to develop increased brucellosis expertise among California scientists, in order to adequately evaluate future reintroduction of the disease to the state. A brucellosis control program has been instituted in Trinidad utilizing RB51 whole-herd vaccination on three heavily infected farms of cattle and domestic water buffalo (Bubalus bubalis) and a test-and-slaughter program without vaccination in other livestock populations. Appropriateness of BPAT for screening cattle and water buffalo of Trinidad for brucellosis was confirmed by results of these studies. This conclusion was based on evaluation of four serologic tests-standard plate agglutination (SPAT), Card, buffered plate agglutination (BPAT), and standard tube agglutination (STAT). The BPAT was found to be the most appropriate screening test based on high sensitivity and Youden index (sensitivity + specificity - 1). However, this test does not function with the same degree of accuracy in these two species.

Specificity of this test was significantly better in cattle (98.1%) compared to water buffalo (90.7%) and this will result in a higher percentage of false-positive test results in water buffalo specimens. Sensitivity of the BPAT was calculated to be better in water buffalo (96.3%) compared to cattle (88.1%), but this difference was only 90% probable based on simulation modeling. Screening tests with high sensitivity result in fewer false-negative classifications and can therefore be more efficient at finding infected animals for the test-and-slaughter program. The brucellosis c-ELISA has been

introduced to Trinidad for use as a confirmatory test in the control program developed for cattle and water buffalo. Accuracy of this test had been evaluated in cattle, but no previous research had been performed investigating use in domestic water buffalo. Outcome of this test is a continuous result of percent inhibition of test sample compared to conjugate control without serum or competing antibodies. The best cutoff point for cattle and buffalo was determined to be 35% inhibition based on peak Youden index and correspondingly high specificity. This cutoff yielded estimates of sensitivity and specificity, respectively, of 83.3% and 96.2% for cattle and 88.0% and 97.4% for water buffalo. High specificity is an important criterion for confirmatory tests. A single cutoff value for both species that maximized average Youden index was chosen because areas under ROC curves for cattle and water buffalo were not statistically different suggesting equal diagnostic potential in both species.

Impact: Domestic water buffalo (Bubalus bubalis) are members of the bovidae family and are related to cattle and bison. The animals in Trinidad are managed with minimal human contact and herds contain an approximately equal sex distribution. They also have a social structure that more closely resembles free-ranging ungulates than domestic cattle - they are seasonal breeders and the dominant and territorial bulls protect small herds of receptive females. Results obtained from these studies of domestic water buffalo provide information important for managing brucellosis in free-ranging wildlife populations of the United States.

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

Key Theme: 1.06 Animal Production Efficiency
Title: Management Systems For Improved Decision Making and Profitability of Dairy Herds

A. ENDEAVOR for Herd Management: We have continued work with the New Zealand computer program ENDEAVOUR. This dairy farm mapping and data recording program allows extensive database management for both land and livestock. It has a visual, object-oriented interface based on a farm map that facilitates both ease of learning and use. It is unique, and extends computer database capability beyond current record based databases used in cow herd analysis; it integrates land use with animal production. After a formal California review of ENDEAVOUR, we are working with AgResearch, Ruakura Research Centre, Hamilton, New Zealand, to adapt the program for U.S. producers. To make ENDEAVOUR2 more widely applicable, the following changes were considered advantageous based on a comprehensive review. First, not only metric but also imperial units (lb, acre) should be available, and some nomenclature should be changed to common American terms (e.g. herd for mob). Multiple calving seasons should be accommodated, as well as an option to define stock-units as cattle instead of sheep. The vegetation, soil class, noxious weed, and fence type choices need expanding.

Impact: The impact of the adoption of ENDEAVOUR for herd management will provide producers with improved pasture management and records of animal efficiency of forage use.

B. Metabolism of Lactating Cows: The environmental impact of dairy cows has become an increasingly important factor driving decisions on commercial dairies. A previously developed model of the metabolism of lactating dairy cows, including description of feedstuffs based upon chemically

analyzable components, that evaluates the nutritional status of dairy cows on commercial dairies (SHIELD is being used in initial research to predict nutrient outputs of dairy cows in milk, meat, urine and feces. The model continues ongoing testing by comparison of predictions against actual data collected on commercial California dairies. A metabolic model of non-lactating cows, with particular emphasis on predictions of the impact of ration decisions during the non-lactating period, is also being tested in California and in the UK.

Impact: The focus of this project is changing as environmental concerns have a greater impact on decision making at the farm level and have a greater impact on dairy profitability. Parts of the dairy cow metabolic model are now being used by the Committee of Consultants in its efforts to better predict nutrient flows on commercial dairies. The model has the potential to impact environmentally sound decisions relative to dairy herd management in California.

C. Periparturient Disease Prevention/Treatment: A collaborative relationship has been established with Iowa State University. We will use a data set on periparturient diseases to determine costs of various diseases in terms of milk yield and reproductive inefficiency. These costs will be used in a decision support system to help determine high risk cows which can be observed more closely to prevent further problems. Preliminary results will be reported at the 2002 ADSA meeting with a journal article to follow. A locomotion scoring guide was done in collaboration with Zinpro Inc. The guide illustrates and describes a system whereby abnormalities in cows locomotion can be detected at an early stage, and cows presented to the hoof trimmer for maintenance trimming saving the producer money and improving animal welfare.

Impact: The project should help dairy producers, managers, and herd veterinarians make rational decisions about prevention and treatment of periparturient diseases in dairy cows. The locomotion scoring system is intuitive and easy to learn. It will allow veterinarians, nutritionists, and other personnel to monitor the level of lameness in the herd. If the level starts to increase, then the management can take steps to improve the conditions causing the lameness. Producers and herd managers can also use the system to identify mid-lactation cows that are slightly lame and present them to the hoof trimmer for functional trimming which should, in many cases, prevent more severe lameness and increased economic loss.

Funding Source: Hatch Multistate Research and State
Scope of Impact: AL, AZ, CA, FL, GA, IL, IN, IA, KS, LA, MI, MN, MO, NE, NH, NM, NYC, OH, PA, SD, TN, TX, VA, WA, WI

Key Theme: 1.06 Animal Production Efficiency
Title: Reproductive Performance in Domestic Ruminants

A. Efficacy of a Modified Live Dna Adenine Methylase Deficient Salmonella Enteritica Serovar Typhimurium Vaccine in Calves: The objective of this study was to determine the safety and efficacy of a modified live DNA Adenine Methylase deficient Salmonella enteritica serovar Typhimurium vaccine in calves. Three experiments were conducted. The first to evaluate vaccine safety, the second to establish an acquired immunity challenge model, and the third to evaluate vaccine efficacy. The vaccine safety trial was conducted to determine an appropriate vaccine dose to

administer to calves in the efficacy trial. In the safety trial calves were assigned to one of 3 vaccine dose groups, 10*6, 10*8, and 10*10 CFU. Each vaccination group included three calves ranging from 1-3 days of age. Six non-vaccinated calves served as controls. Clinical data was collected on all fifteen calves for ten days post-vaccination. Calves administered 10*6 and 10*8 DAM- S. Typhimurium remained healthy. Two of the three calves administered 10*10 DAM- S. Typhimurium became depressed and anorexic 5 days following vaccination and one died on day 8 post-vaccination. A vaccine dose of 10*7 was selected for the following efficacy study. To establish an appropriate challenge dose to use for assessing protective efficacy twenty-one 4-5 week old calves were randomly assigned to one of three challenge groups. Each group of 7 calves were challenged with either 10*6, 10*8 or 10*10 colony forming units (CFU) of virulent S. Typhimurium. Clinical data and fecal cultures were collected for seven days post challenge. All surviving calves were euthanized and necropsied 7 days post-challenge for collection of tissues to evaluate salmonella colonization. All calves in the 10*6 and 10*8 challenge groups survived until day 7 while only 57% of the calves in the 10*10 group survived. Induction of clinical disease and salmonella fecal shedding was inconsistent with the 10*6 and 10*8 challenge doses. Consistent clinical disease (diarrhea, depressed mentation, fever) and salmonella fecal shedding was observed with the 10*10 challenge dose. In the following vaccine efficacy trial 20 vaccinated and 15 control calves were challenged with 10*9 cfu of virulent S. Typhimurium at 4.5-5.5 weeks of age. Outcome assessments in this experiment included fecal shedding, clinical parameters, and necropsy tissue cultures. Vaccination with DAM- S. Typhimurium reduced the incidence of fever following challenge, decreased the proportion of calves with diarrhea and reduced the number of salmonella shed in feces. A significant reduction in colonization of the gastrointestinal tract (ileum and cecum), mesenteric lymph nodes and visceral organs (spleen, liver and lung) was also observed when the calves were necropsied. In a second smaller efficacy trial involving 10 calves, 5 vaccinated and 5 non-vaccinated control calves were administered 10*11 cfu of virulent S. Typhimurium. All 5 non-vaccinated control calves died whereas 3 of 5 vaccinated calves survived. The results of the efficacy trials suggest that Salmonella Dam minus strains have significant potential as vaccine candidates in cattle.

Impact: Vaccination of calves with DNA adenine methylase deficient Salmonella Typhimurium attenuated disease severity, tissue colonization, fecal salmonella shedding, and mortality. The DAM minus attenuation presents an exciting prospect for the development of a protective salmonella vaccine for livestock.

B. Failure of Interspecies Pregnancy: Experiments were conducted toward understanding the failure of interspecies pregnancy in ruminants. The experimental model used was the sheep-goat hematopoietic chimera produced by transplanting sheep hematopoietic stem cells into approximately day-60 goat fetuses that subsequently were allowed to develop to term. More that 100 fetal surgeries were completed to determine the effectiveness of sheep stem cells colonizing the bone marrow of fetal goats. Hematopoietic chimeras were detected by polymerase chain reaction analysis for sheep DNA sequences in goat blood. Results demonstrated that production of chimeras was feasible, but the observed level was in line with previous descriptions of microchimerism; only a small percentage of the host's blood cells was determined to be of sheep origin. The appearance of anti-sheep antibodies in maternal serum during pregnancy of does that carried to term interspecies chimeras demonstrated the hypothesized but heretofore unproven migration of fetal lymphocytes into maternal circulation. When sheep embryos were transferred to the reproductive tracts of hematopoietic chimeras, the interspecies pregnancies were lost at times similar to sheep pregnancies in control goats, despite that some

chimeras showed an attenuated immune response to the sheep pregnancy.

Impact: These results support earlier suggestions and more definitively demonstrate that classical immune rejection is not the primary cause of interspecies pregnancy failure in ruminants. Efforts to use interspecies pregnancy, including when combined with somatic cloning, to propagate rare and endangered species will benefit from greater understanding of the mechanisms that operate as barriers to successful interspecies pregnancy.

Funding Source: Hatch Multistate Research and State
Scope of Impact: AK, AZ, CA, CO, HI, ID, KS, MI, MN, MO, MT, NV, NM, OH, OR, TX, WA, WY USDA/ARS, NE

Key Theme: 1.06 Animal Production Efficiency
Title: Animal Health Economics Including Cost-Benefit Analysis of Control Issues

Description: The objective of this project was to assess the cost-effectiveness of preemptive herd slaughter and ring vaccination as a means of controlling transmission of foot and mouth disease virus (FMDV). The sample population-2,238 herds and 5 sales yards- was located in the Fresno, Kings, and Tulare county region of California. Procedure-The effectiveness of various FMD eradication strategies from a previous study was considered with expected costs for various eradication strategies, including indemnity payments to producers for slaughtered livestock and feedstuffs, for cleaning and disinfecting livestock premises, and for vaccination, when a ring vaccination strategy was considered. Cost-effectiveness was calculated as cost per herd infection averted. The results showed average herd indemnity costs were $2,607,800 and $109,561 for dairy and non-dairy herds, respectively. Cost to clean and disinfect livestock premises ranged from $16,857 to $60,205. The average vaccination cost was $2,360 per herd. Total eradication cost ranged from $59 million to $541 million, with the baseline eradication strategy costing $92 million. Cost per herd infection averted when considering supplemental eradication strategies was lowest ($3.1 million) for a 50 km ring vaccination strategy and highest ($56 million) for a strategy to slaughter all herds within 5 km of each known infected herd.

Impact: Use of ring vaccination should be considered if it is possible to rapidly vaccinate herds. Otherwise, a strategy to slaughter selectively the five highest-risk herds is preferable to other preemptive slaughter strategies. Indirect costs can be expected to contribute substantially more than direct costs to the total eradication program.

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

Key Theme: 1.06 Animal Production Efficiency
Title: Germ Cell and Embryo Development and Manipulation For the Improvement of Livestock

Description: This project is aimed at applying technology currently in use to genetically modify plants to agricultural animals. Procedures allied with bovine embryo transfer but requiring prolonged periods of embryo culture can be associated with high births weights and other health problems in resulting

calves. This unexplained anomaly limits to some extent the practical use of techniques involving in vitro fertilization, cloning and production of transgenic animals. Researchers studying embryo and fetal development in concepti that develop from manipulated bovine embryos frequently focus on the embryo or fetus. Since the aberrant growth pattern appears to be limited to the prenatal period, examination of placental development and function might also contribute to understanding of causes of the so-called large calf syndrome. We used ultrasonography to examine embryonic, fetal and placental growth in bovine concepti resulting from in vitro fertilization and culture. In vivo controls were contemporaneous pregnancies produced by artificial insemination. Results demonstrated that in vitro-produced embryos were smaller than controls in early pregnancy but by late pregnancy were larger than controls. Birthweights of calves from in vitro-produced embryos were higher than in vivo controls. During pregnancy, differences in placentome development during pregnancy were observed by ultrasonography. At birth, the number of placentomes was smaller, but placentome size was larger in concepti from in vitro-produced embryos. Measures of placental function, e.g., transport of xylene from maternal to fetal circulations, also showed differences between in vitro- and in vivo-produced embryos.

Impact: These results demonstrated significant abnormalities in placental development and function in calves resulting from in vitro fertilization and culture. Placental abnormalities likely contribute to aberrant prenatal growth, resulting in "the large calf syndrome." Unraveling the causes of this faulty development is essential before technology involving embryo manipulation can be fully exploited and find practical use.

Funding Source: Hatch Multistate Research and State
Scope of Impact: AR, CA, CO, CT, IA, IL, LA, OK, OR, UT, WA, WI

Key Theme: 1.06 Animal Production Efficiency
Title: Metabolic Relationships in Supply of Nutrients For Lactating Cows

Description: The major California contribution to this MRF project has been the development of the dynamic, mechanistic computer model of digestion and metabolism in lacating cows called Molly. This model has served as a means for integration of the experimental results of other investigators in the group in a format which can be utilized in support of animal agriculture and the dairy industry. Our major experimental contribution to the project the conduct of 80 arteriovenous difference studies across the mammary glands of cows differing in genetic potential at different stages of lactation with and without rBST administration.

Impact: The model has been adopted by a number of academic groups and feed companies around the world to evaluate bioeconomic effects of alternative feeding strategies upon full lactation dairy cattle performance.

Funding Source: Hatch Multistate Research and State
Scope of Impact: AL, AZ, CA-D, FL, IA, IL, IN, KS, MD, MI, MN, MO, ND, NH, OH, PA, SD, UT, WA, WI

Key Theme: 1.06 Animal Production Efficiency
Title: Ecology and Management of Arthropods in Poultry Systems

Description: Recent poultry studies have focused on ectoparasites (northern fowl mite, body louse) and house fly resistance to toxic baits. Northern fowl mites employ taxis (not kinesis) to orient to heat cues at close range. Their orientation behavior was studied in detail by analysis of digitized video and use of circular statistics. Mite fecal deposits and feather extracts also contain materials used by mites in orientation and/or arrestment. House flies in the field are very resistant to toxic baits used for their control. Choice tests, no-choice tests and topical bioassays demonstrate the resistance has a behavioral component. Current studies examine production effects (body weight, egg number and weight, feed consumption) of northern fowl mites. We also are obtaining information on establishment and spread of parasites within a house and on interactions between lice and mites.

Impact: Mites can and do spread among hens even without direct contact. Off-host survival and dispersal is important to consider in a management plan. Host orientation cues might yield clues to managing mites. Knowledge of fly resistance should influence existing regulations regarding continuous bait station use and yield clues to possible altered bait formulations.

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

Key Theme: 1.06 Animal Production Efficiency
Title: Bluetongue Virus Infection of Ruminants in California: Pathogenesis and Epizootiology

Description: The goal of this project is to define the pathogenesis of bluetongue virus (BTV) infection of cattle, and to characterize the evolution of BTV. We have investigated the interaction of BTV with its insect vector (Culicoides sonorensis) in the Chino Basin area. Molecular genetic analyses of individual BTV gene segments indicate that different virus strains co-circulate on specific farms, thus we compared these strains to those associated with outbreaks of bluetongue disease in ruminants elsewhere in California.

Impact: Bluetongue remains the only OIE List A disease that is endemic in the U.S.. Accurate determination of the epidemiology of BTV infection in endemic areas such as California is prerequisite to rationalization of current international non-tariff trade barriers pertaining to bluetongue, and to development of improved diagnostic and vaccine technologies for BTV.

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

Key Theme: 1.06 Animal Production Efficiency
Title: Social Behavior, Stress and Well-Being in Laying Hens

Description: The specific objectives outline in this project were to: 1) assess the effects of familiarity during rearing on affiliative and competitive interactions, disease incidence, production indicators, and physiological measures of stress in laying hens; 2) determine whether hens show consistent preferences for, or consistently avoid, particular social companions during the performance of different

behaviors; and 3) determine whether the preference of preferred or avoided companions is stress-buffering or stress-enhancing when hens are exposed to a fear-inducing situation. The results can be summarized as follows. Mixing unfamiliar hens when they are sexually mature, which is common practice in the industry, has little long-term negative effect on the welfare of hens, as measured by corticosterone levels, aggressive behavior, health, productivity, and patterns of spacing. Hens do show active preferences for individuals when they are required to make an active choice among flockmates. However, these preferences are generally not highly repeatable when the hens are tested over several months. Observations of spacing behavior in the home pen also do not reveal consistent preferences for, or avoidance of, particuar hens. Hens do show a clear ability to discriminate among familiar flockmates, hens from adjacent pens that they are visually familiar with, and unfamiliar hens. A period of social isolation of feed restriction increases the tendency of birds to approach flockmates. We could not conduct the studies as outlined under objective 3, since preferences were not clearly established. However, in total our results suggest that hens in small groups are able to recognize other individuals, form strong stable bonds with all of their flockmates, and can be mixed with little negative effect on their welfare.

Impact: Our results indicate that the industry practice of mixing unfamilar pullets together when they are transferred to the laying house has little long-term effect on behavioral, physiological and performance measures, and therefore does not compromise the welfare of the hens, as long as they are placed in relatively small groups. This project also provided basic information about hen social behavior that will be of use in evaluating commercial production practices.

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

Key Theme: 1.06 Animal Production Efficiency
Title: Reproductive Behaviors in Domestic Sheep and Goats

Description: The East Friesian breed of sheep has been artificially selected for milk production and can readily support (feed) three lambs per lactation. Fostering a third lamb on twin-bearing East Friesian ewes constitutes a more efficient use of the ewe's milk resources. The objective of this study was to determine the success rate of fostering a third alien lamb on 13 East Friesian ewes bearing twin lambs. Twenty cc of neatsfoot oil was smeared on each ewe's twin lambs and the alien lamb to be fostered within 12 hours of parturition. An oil-soaked stockinette jacket was then placed on each of the twins and two jackets were fitted on the alien lamb. On the second day, jackets were exchanged between the twins and the alien lamb and the alien was placed with the foster ewe. Eleven of the 13 test ewes accepted alien lambs; two rejected aliens ($P<0.01$). Five ewes accepted aliens immediately, two on the second day and four on the third, fourth and fifth day. It was concluded that the odor transfer and novel odorant fostering techniques can be used to successfully foster a third alien lamb on ewes with naturally-born twins.

Impact: Hand rearing of orphaned lambs is no longer cost-effective. Demonstration that East Friesian ewes bearing twin lambs will successfully adopt a third alien lamb using a combination of the odor transfer and novel odorant techniques provides sheep breeders with an additional tool to maximize the efficiency of their sheep reproductive management system.

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

Key Theme: 1.06 Animal Production Efficiency
Title: Effect of Nutritive Status on Reproductive Efficiency in Domestic Animals

Description: The objective of our studies is development and implementation of management techniques that will improve the well being of domestic species. One aspect of our research examines the effect of stress on fertility in sheep. In this regard, most producers recognize that prolonged stress, such as exposure to temperature extremes, isolation and/or restraint, transportation, or repeated laparoscopy, delays or suppresses estrous behavior and reduces ovulation rate in sheep. Short-term or acute stress may have a similar consequence. To examine the effect of an acute stressor (bacterial infection) on the magnitude and duration of the preovulatory surge of LH the estrous cycles of sheep (n = 11) were synchronized by use of lutalyse (PGF2) and intravaginal progesterone release devices (CIDR). The effect of stress on follicle maturation and ovulation was assessed by administration of saline or bacterial endotoxin [lipopolysaccharide (LPS; 200 ng/kg, iv)] beginning at the onset of behavioral estrus. Animals received saline or LPS at 2 h intervals for 12 h. The preovulatory surge of LH was evident in control (n = 5) animals 48.5 2.1 h after CIDR removal. In contrast, surge-like secretion of LH was not evident during the 5 d period following CIDR removal in 67% (4 of 6) of sheep receiving LPS. Moreover, the onset of the surge was significantly delayed in those LPS-treated ewes that showed surge-like secretion of LH. Collectively, these data indicate acute or short-term stress can block or delay follicular development and the preovulatory surge of LH in sheep.

Impact: The fertility of domestic species is reduced during periods of stress. Thus disease, stressful management practices, and/or adverse climatic conditions suppress follicular maturation and block or delay ovulation. The long-term goal of our studies is to define the physiological basis for stress-induced infertility in domestic species. We hope that these studies will lead to the development and implementation of management strategies that will reduce the incidence of stress and lessen the impact of unavoidable or inadvertent stress.

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

Key Theme: 1.06 Animal Production Efficiency
Title: Control of Carcass Composition and Meat Quality in Livestock

Description: In May of 1997, 1998 and 1999, 60 Angus-Hereford steers from the Sierra Foothills Research and Extension Center were allocated at weaning to three groups. Calf-fed steers (CF) were sent to the UCD feedlot immediately, short-yearlings (SY) remained on irrigated pasture until September, then sent to the feedlot, and long yearlings (LY) remained on irrigated pasture until September, then on native range until May of the following year, then sent to the feedlot. All steers were fed on a high-energy corn-based ration until average ultrasound backfat for the group reached 10 mm. Average days on feed (DOF) for the CF, SY and LY were 188, 158 and 94 days. The variation in DOF between years for the long yearlings was very small (83-107 days). On the other hand, between-

year variation in DOF for steers in both CF and SY groups ranged from 144 to 228 days and 114 to 213 days, respectively. Although a significant year by group interaction was observed for the feedlot ADG, there was a general trend to increase the ADG as the backgrounding time (and thus age and weight entering the feedlot) was increased. In addition, the major increase in backfat occurred during the feedlot period rather than during the grazing period. This large increase in backfat thickness was due to the high energy intake of the animals on feed, rather than their maturity, because CF, SY and LY entered the feedlot at different weight and ages but similar backfat. Interactions between group and year were observed for almost all of the carcass traits evaluated. Animals in the LY group tended to be the heaviest and those in CF tended to be the lightest. In spite of the variation observed, there was a general tendency to increase dressing % with time on feed. The amount of intramuscular fat as well as marbling score tended to increase with time on feed, therefore CF tended to have higher amounts of intramuscular fat and quality grades relative to the yearling groups. Both yield grade and % retail cuts were higher for CF and LY in 1998, but did not vary among groups in 1999 and 2000. Therefore, these data suggest that when animals are fed to a constant final body weight, DOF is an important factor affecting the amount of carcass fat, subcutaneous fat, marbling score and LD fat but not the amount of internal fat. Increasing the backgrounding period reduced time on feed and total feed requirements of Angus-Hereford steers. Older cattle reached market finish at heavier weights. Grazing animals gained weight without increasing backfat, which only increased in the feedlot. Prolonged backgrounding may impair animals' ability to deposit intramuscular fat, and reduce quality grade.

Impact: This information will support decisions by cattle producers as to the optimum methods for raising and marketing their cattle for best performance, carcass quality and profitability.

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

Key Theme: 1.06 Animal Production Efficiency
Title: Diagnosis and Control of Bovine Viral Diarrhea Virus Using Molecular Techniques

Description: The goal of this study was to improve the ability to routinely diagnose BVDV infections by differentiating antibody produced in response to vaccine from antibody produced in response to field infection. The hope was that genomic sequence analysis of two surface protein genes; BVDV E1 and/or P7 could be used to identify a BVDV surface marker that would differentiate BVDV vaccine strains from BVDV variants. If such a marker could be identified, it would be used to form the basis for a differential antibody detection assay. However, among the reference viruses, vaccine viruses, and California field isolates studied, a predictable and stabile genetic sequence of sufficient size and antigenic character could not be identified. Though disappointed by the lack of success for the project goals, the study provided confirmation of the diagnostic accuracy and reliability of the 5'UTR region of the BVDV genome currently used to detect BVDV in clinical material and used to differentiate BVDV type I from BVDV type II.

Impact: Long-term studies conducted by this group on the epidemiology of BVDV transmission and on the association of the infection to herd health have shown that despite vaccination, BVDV frequently becomes established in dairy herds and results in subclinical, but costly, endemic infection and related herd health problems.

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

Key Theme: 1.06 Animal Production Efficiency
Title: Comparative Studies on Limits To Efficient Ovarian Estrogen Synthesis in Pigs and Cattle

Description: A clear and complete appreciation of mechanisms regulating gonadal function in livestock species will be necessary to sustain reproductive efficiency, animal production and to conserve natural resources in the coming century. The long-term goal of this research is to understand how steroidogenesis is integrated in cells and tissues that influence reproductive efficienty. To date we have determined some of the unusual catalytic characteristics of the gonadal form of P450aromatase that are unique to the pig using cell lines we have engineered to over- express either the gonadal or the placental isozyme. In addition, we have developed techniques that enable us to express and purify high levels of recombinant P450arom for both porcine isozymes and for the bovine P450arom using baculovirus. We have cloned porcine reductase, and have generated recombinant reductase in E.coli, which has enabled us to reconstitute enzyme activities in vitro. We are in the process of preparing the final paper arising from those studies. In addition, we have recently identified differences in the steroid products of testosterone metabolism when catalyzed by the gonadal P450arom compared with the porcine placental isozyme. Specifically, having now analyzed the products of androstenedione and testosterone metabolism in reconstituted assays, we have recognized a steroid product of testosterone metabolism that is uniquely synthesized by the gonadal P450arom. We are in the process of obtaining data from analysis by gas chromatography-mass spectrometry (GC-MS) that will help to identify this steroid. Our studies to define the levels of microsomal P450 enzymes and other redox partner proteins (Specific Aim 2) have also progressed. We have established the required methods to complete this Aim using porcine neonatal testes.

These studies have shown that there are substantial differences in the levels of P450arom and P450c17 in porcine ovarian as well as in testicular interstitial tissues. P450c17 is as much as 300 fold higher than P450arom in porcine testicular and theca microsomes. The studies in porcine neonatal testis were important in establishing and validating an assay for directly measuring 17,20-lyase activity, as well as adding a comparative view of potential differences between the male and female gonad. In addition, our experiments also examined reductase levels which appeared to be saturating for both P450s in follicular and testicular tissues. Both observations suggest that the activity of each P450 is unlikely to compete with the other for redox partner support.

The paper describing this work is currently in review. These data support the premise that P450arom levels are truly rate- limiting in estrogen synthesis by these cells with important physiological ramifications. In porcine gonadal tissues, the levels of estrogen synthesis from androgens are so much lower than is the rate of androgen synthesis that even very significant changes in estrogen production are unlikely to have an impact on overall androgen production by these tissues. In fact, we propose that the disparity in the levels of P450c17 and P450arom in porcine gonadal tissues allows for the regulation of estrogen synthesis independent from the production of androgens which in the test is, and the theca of the porcine follicle wall, is occurring in the same tissue or cellular compartment.

Impact: Estrogen synthesis is associated with a variety of reproductive diseases or problems that impact fertility in cattle, pigs and other domestic species. The results of this research will greatly improve our ability to diagnose and treat reproductive disease and thereby to improve or maintain fertility in the face of increased animal production demands.

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

Key Theme: 1.06 Animal Production Efficiency
Title: Cow-Calf Quality Assurance Program

Description: This program has evolved into a series of educational programs that that are offered to producers in traditional meeting format. The first in the series is known as QAP I, is an overview and a certification program where producers receive basic information and are tested for certification. The QAP I emphasizes production and health practices to ensure a quality product and minimizes the potential for product condemnation from misuse of animal health products. Additional training can be received from modules, animal health (QAP II), genetics (QAP III) and (QAP IV) the new Advanced Beef Cattle Residue and Contamination Avoidance module. Through cooperative efforts of University of California Cooperative Extension and organizations representing industry organizations, efforts were initiated in 1992 to develop and deliver educational programs that would effectively and efficiently provide information to producers addressing the need for them to understand and adopt practices that would assure consumers that beef is safe, wholesome and produced using practices and acceptable techniques with concern for the animal when used during the handling and transportation. In addition the program will provide educational programs for producers to learn of the issues associated with food safety and learn skills in proper use of health products. As a major statewide effort by both Cooperative Extension and industry, the programs are delivered throughout the state. In an effort to accommodate all potential participants, we now have Spanish versions of the written test materials necessary for certification. Because of the demand for this program, livestock advisors and specialists have to work together to see that all producers requesting this information can be certified. Working with a veterinarian and with help of Ventura County Cattlemen's Association, a California advisor conducted two QAP I programs resulting in the certification of 50 producers. He also have worked with a veterinarian from Ventura County in the planning and delivery of two of the Beef Cattle Health modules, QAP II, for Ventura County producers. In addition, he worked with a team of Cooperative Extension animal scientists to certify 20 producers in San Diego County.

Impact: In total, QAP I programs were held in Santa Barbara, Ventura and San Diego Counties, which resulted in 235 producers receiving their certification. California advisors also assisted with the planning and delivery of both the QAP III and QAP IV at Cal Poly, San Luis Obispo during the Animal Science Department's Annual Beef Cattle Field Day programs. These programs were a collaborative effort between the faculty of the Animal Science Department at Cal Poly, Cooperative Extension advisors and specialists, and industry. Results were presented at the National Cattlemen's Beef Association market cow and bull quality audit and lead the session on body condition scoring.

Funding Source: Smith-Lever and State

Scope of Impact: State Specific

Key Theme: 1.07 Apiculture
Title: Interaction of Honey Bees and Varroa Mites: Behavioral and Reproductive Aspects

Description: Experiments under laboratory conditions were conducted to evaluate the feasibility of using a neem-based (Azadriachta indica) insecticide to control Varroa destructor (new species, formally known as V. jacobsoni). The results showed that the active ingredient, azadirachtin, inhibited feeding in the worker bees, and exhibited an oral LC50 of 10.87 ug/ml to worker bees, and 41.87 ug/ml to associated mites. The topical LC50 was 12.53 ug/ml and 35.43 ug/ml to worker bees and associated mites correspondingly. Worker larvae were more sensitive to azadirachtin, exhibiting an LC50 of 180.92 ng/ml to purified azadirachtin, and 100.13 ng/ml to formulated azadirachtin. The results also clearly showed that mite feeding on azadirachtin treated host larvae significantly reduced their fecundity. The egg hatching rates produced by female mites fed on treated host larvae were also reduced significantly. These reproductive effects potentially could increase the feasibility of using azadirachtin to control varroa mite. However, more research is needed to evaluate the effects of azadirachtin queen bee reproduction and drone spermatogenesis, as azadirachtin has been documented to have spermicidal effects on mammalian sperm. Current research focuses on testing the potential of Entomopathogenic fungus, Hirsutella thompsonii, as a biolcontrol agent for the Varroa mite. A total of 9 isolates of the fungus have been obtained and tested. Three isolates showed high promise and their infection site has been established. More research is to be carried out to study the effect of formulation on fungal germination.

Impact: Our present finding is the first botanical compound identified to have significant effects on varroa mite reproduction. Azadirachtin may have the potential to be used to reduce mite reproduction as well as decrease the mite egg hatching rates. Although the present results showed some potential promise of using azadirachtin in field control of varroa mites, more research is needed to understand whether the compound would also affect queen bee and drone reproduction negatively.

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

Key Theme: 1.08 Aquaculture
Title: Epidemiology of White Sturgeon Iridovirus and White Sturgeon Herpesvirus 2 in Three Commercial Facilities

Description: White sturgeon aquaculture is an important contributor to total U.S. fish production. About 10-15 Classical fish health approaches should be complemented by epidemiologic investigations addressing disease as a function of a complex web of factors that interact both at the individual and the population level. Progeny from 6 different spawns of white sturgeon broodstock were monitored for 20 months in a commercial white sturgeon hatchery for occurrence of outbreaks of white sturgeon iridovirus (WSIV) and white sturgeon herpesvirus-2 (WSHV-2). Five WSIV but no WSHV-2 outbreaks occurred during the study period. Signs of WSIV were restricted to tanks from a single spawn each time. Temporal-spatial statistical analysis of outbreaks did not indicate that WSIV tanks were clustered in time and space. Furthermore, WSIV was isolated from progeny of all 6 spawns

in the study, even though occurrence of outbreaks and clinical presentation varied greatly among fish from different spawns. These findings support a hypothesis of vertical transmission of WSIV, with tank-to-tank transmission having lesser or no role in spread of the virus. Differences in the onset and severity of WSIV outbreaks in fish from the 6 affected spawns indicate a possible genetic resistance to the virus and/or a role of stressors. All outbreaks followed at least one major stressful event that occurred 9-32 days before disease onset. We conclude that the minimization of stressors (avoidance of pump failures, handling and transportation) of fish should be a priority for hatchery managers. In addition, because difference in resistance to WSIV probably exist among spawns, exclusion from breeding of parents that yielded progeny susceptible to WSIV might also improve survival of young white sturgeon in hatcheries.

Impact: Minimization of stressors (avoidance of pump failures, handling and transportation) of fish should be a priority for hatchery managers to control WSIV outbreaks. In addition, because difference in resistance to WSIV probably exist among spawns, exclusion from breeding of parents that yielded progeny susceptible to WSIV might also improve survival of young white sturgeon in hatcheries.

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

Key Theme: 1.08 Aquaculture
Title: Engineering Systems For Aquaculture

Description: Future growth of the California aquaculture industry will require that new species be cultured and that production techniques be more predictable and efficient. This project examines biengineering requirements of aquacultured fish, as well as engineering solutions to water quality problems in aquaculture. The emphasis is on development of culture techniques that promote resource use efficiency. A new hydrodynamic model of aquaculture raceways is being developed. The model uses a modeling package (SSIIM) available as a free download from the following web site: . Work to date has focused on the simulation of flow patterns and water velocities. The model is being tested against data collected from a number of raceways used for the culture of rainbow trout. Those raceways are typically around 20 to 30 m long, 3 to 5 m wide, and 0.6 to 1 m deep. The flow equations are solved for over 5,000 points in the raceways, resulting in detailed views of flow conditions in them. After validation of the flow velocity model, particle transport will be added to the model to allow for the simulation of the movement of uneaten feed and fish feces particles. A new project was initiated aimed at the development of diets and recirculation technology for the culture of California halibut (Paralichthys californicus). Newly hatched larvae were transported successfully by air and by car from Southern California. The larvae were reared in a recirculation seawater system. Water treatment unit operations used in the recirculation system included screen filtration, biofiltration using fluidized submerged media, chilling for temperature control, aeration, and ultraviolet disinfection. The fish were fed with rotifers and artemia during the early stages. Weaning to prepared feeds has been successfully achieved, although mortalities have been high. We have documented the early development stages of the fish, its early growth rate, and have developed successful feeding and weaning procedures.

Impact: The hydrodynamic models will be useful in developing and selecting more efficient processes for controlling solids concentrations in raceway effluents. Improved solids removal will result in

reduced environmental impact from aquaculture effluents. The recirculation technology and diets being developed for California halibut production will help with the establishment of an industry for the culture if this fish.

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

Key Theme: 1.08 Aquaculture
Title: Optimum Lipid and Essential Fatty Acid Levels in Sturgeon Feed

Description: Two 24-day growth experiments were conducted on 12-day post-hatch larvae of white sturgeon, Acipenser transmontanus, to determine effects of dietary lipids on their growth, survival rate and whole body composition and fatty acid composition. In the first experiment, larvae were fed two commercial feeds (C14 & C17) containing 14% and 17% lipid and two experimental diets (E26 & E41) containing 26% and 41% lipid, respectively. In the second experiment, larvae were fed either C17 or three isonitrogenous experimental diets (E25, E35 & E45) containing 25%, 35%, and 45% lipid, respectively. In both of the experiments, each diet was fed to triplicate groups of 1,000 larvae at 25-30% body weight per day, and the larvae were kept at 15-16,aC. At the end of the first experiment, larvae fed C14 had significantly($P<0.05$) higher body weights and those fed C17 had significantly higher survival rate than those fed the two experimental diets. Larvae fed C14 and C17 had significantly higher whole body moisture and protein but lower triacylglycerol than those fed the two experimental diets. At the end of the second experiment, whole body weights, moisture and ash content of larvae fed C17 were significantly higher than those of larvae fed the three experimental diets. In both of the experiments, fatty acid composition of larvae was affected especially by dietary 18:2(n-6) (linoleic), 20:5(n-3) (eicosapentaenoic) and 22:6(n-3) (docosahexaenoic) fatty acids. In conclusion, the results of both experiments indicate that feeding with the experimental diets with low protein to energy ratio, high content of linoleic acid, and low content of eicosapentaenoic and docosahexaenoic acids might have an adverse effect on the growth performance of white sturgeon larvae.

Impact: Information on the Glycemic and glycosuric, as well as plasma beta-hydroxyl butyric and lactic acid responses, after oral administration of different levels of glucose will provide a better understanding on the carbohydrate utilization by white sturgeon. This will allow feed mills to manufacture environmental friendly yet cost-effective sturgeon feed with optimum amount of carbohydrates, the cheapest dietary energy source.

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

Key Theme: 1.08 Aquaculture
Title: Genetic Assessment, Development, and Improvement of Shellfish Stocks For West Coast Aquaculture

Description: Crossbreeding to improve farmed Pacific oysters was explored, using experimental crosses among inbred lines from the Molluscan Broodstock Program (MBP), Hatfield Marine Science

Center, Oregon State University. Factorial crosses among seven inbred lines were done at two different times at the Taylor Resource, Inc., (TRI) hatchery in Quilcene, WA, to test F1 hybrids. For each cross, parental pedigree was confirmed, before spawning, by sending biopsies from brood stock to BML for analyses of microsatellite DNA markers. Mixing among families occurs, but is readily identified by genetic markers, and poses no threat to the integrity of experiments. Each lot of hybrid seed rears through four phases: larval culture, indoor seed culture, field seed culture, and final grow-out cages. Tools and standard operating procedures were developed to control density at each phase, to promote uniform growing conditions for testing hybrid seed. The new system for rearing test-seed in the field produced seed of uniform size within each bag. With the infrastructure for four-phase experimental culture in place, we can now evaluate early indicators of hybrid yield-potential; an accurate early indicator would eliminate the need to carry each 7x7 experiment to harvest. A large-scale test of commercial hybrid seed was initiated by a controlled cross among two of the most promising inbred lines from the previous year's tests. The hybrid seed were reared in a commercial hatchery, shipped to Hawaii for rapid growth, and shipped back to a floating upwelling system in Oakland Bay, WA. These seed will be planted in 2002. Finally, construction of a moderately dense genetic linkage map was initiated, using 24 previously published and 80 new microsatellite DNA markers developed for this purpose.

Impact: This research sets the stage for commercial crossbreeding programs and for continuing applied and basic research in oyster breeding and genomics. Hybrid vigor for growth is commonly observed when inbred lines are crossed experimentally. A larger program for selecting and crossbreeding elite inbred lines would rapidly improve commercial oyster seed, especially if biotechnology can increase the efficiency of selection.

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

Key Theme: 1.08 Aquaculture
Title: Genetics of Fish For Aquaculture and Conservation

Description: A three-generation selection experiment, with replicate selection lines and a control line, was undertaken to assess the effectiveness of using BLUP estimated breeding values as the selection criterion for improved body weight at 98 days of age. Fixed effects of tank and its interaction with generation and line were significant factors determining performance. Estimated heritability was 0.20 +/- 0.04 while maternal direct-genetic and full-sib common environmental effects, as a proportion of phenotypic variance, were 0.02 +/- 0.02 and 0.09 +/= 0.02, respectively. Genetic gains of 2.61 +/- 0.05 g and 2.42 +/- 0.37 g per generation were achieved in the two replicate lines, equivalent to about a 40% improvement in just three generations. Additionally, although the randomly selected control line showed a steady increase in performance, the genetic change was only 0.28 +/- 0.01 g per generation indicating that most of the change in performance of the control line was due to improved management and/or adaptation to the culture environment. The post-selection analysis of these data clearly demonstrated the superiority of the mixed-model approach to selection, with the potential of increasing selection response by 20% to 30% above that expected from simple mass selection.

Impact: Breed improvement through application of modern quantitative genetic and animal breeding techniques has the potential of greatly increasing the efficiency of fish farming, as it has for all

livestock species. However, it is essential that advanced methods be tested with fish species to ensure appropriate application procedures and to demonstrate the potential benefits.

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

Key Theme: 1.08 Aquaculture
Title: Enhancing Reproduction of Sturgeon

Description: Reproduction plays central role in aquaculture and conservation of sturgeon. We are investigating reproduction in two species endemic to Pacific coast: domesticated white sturgeon (in collaboration with aquaculture industry) and wild green sturgeon (in collaboration with the Yurok Tribe, Klamath river). We examined effects of prespawning holding temperature on the oocyte development, plasma sex steroid profile, and final ovarian maturation in white sturgeon. The exposure of gravid females to elevated (higher than 15 Deg C) winter temperature led to a decrease in plasma sex steroids and a high incidence of the ovarian regression observed during a transition of oocyte from vitellogenic growth to maturational competence. Holding females in cool water (12 Deg) sustained normal development and extended the capacity of fish to maintain maturational competence and normal reproduction over a period from spring through summer. "Vernalization" of gravid females for the efficient spawning and caviar production is now a common practice in sturgeon farms. In field studies with green sturgeon, we initiated development of artificial spawning and larval/juvenile culture methods. Wild broodfish (captured during the spawning run) are stimulated to release their gametes by treatment with gonadotropin-releasing hormone and dopamine antagonist. The effective culture techniques are established for larvae and juveniles, which are currently used for laboratory experiments aimed to determine environmental impact on the reproduction of green sturgeon.

Impact: Studies with white sturgeon led to improved reproductive efficiency, prevention of ovarian atresia, and stress management in sturgeon farms of California producing sturgeon meat and caviar for the food markets. Studies on green sturgeon provided first insight into reproductive biology of this species and cultured fish for ongoing research aimed to restoration of green sturgeon.

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

Key Theme: 1.08 Aquaculture

Title: Determining Lysine and Methionine Requirements of Juvenile White Sturgeon

Description: A technique combining esophageal intubation, dorsal aorta cannulation, and urinary catheterization established in our laboratory was used to evaluate the glucose utilization by white sturgeon. Seven groups of five fish each were intubated with 0, 250, 500, 750, 1,000, 1,250, or 1,500 mg glucose per kg body weight and blood, plasma, and urine were sampled at 0, 1, 2, 3, 4, 8, 12, and 24 hours thereafter. Blood glucose peaked at 3 hours post intubation instead of the 6 hours observed in the previous study, and the earlier peak may have resulted from the more frequent sampling in the present study. Plasma and urinary glucose as well as plasma beta-hydroxyl butyric and lactic acid will

be determined in the next three months. Glycemic and glycosuric, as well as plasma beta-hydroxyl butyric and lactic acid responses of white sturgeon after oral administration of different levels of glucose will be used to determine whether white sturgeon, like many other species of fish, will show a diabetic response to high dietary glucose. The animal trial of the study was completed but the sample analyses and computer modeling will be completed within the next three to six months.

Impact: Information on the Glycemic and glycosuric, as well as plasma beta-hydroxyl butyric and lactic acid responses, after oral administration of different levels of glucose will provide a better understanding on the carbohydrate utilization by white sturgeon. This will allow feed mills to manufacture environmental friendly yet cost-effective sturgeon feed with optimum amount of carbohydrates, the cheapest dietary energy source.

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

Key Theme: 1.10 Biofuels
Title: Structure, Function, and Regulation of Clostridium Celluvorans Cellulase

Description: The conversion of agricultural biomass into more utilizable energy forms by biological methods is desirable, since it will result in value-added products, in reduction of pollution of the environment, and in disposal of unwanted agricultural waste products. We are studying Clostridium cellulovorans, a bacterium, that is capable of degrading many agricultural biopolymers. The cellulosome (an enzyme complex for degradation of plant cell walls) from CLOSTRIDIUM CELLULOVORANS is being analyzed for its structure, function, assembly, and regulation, since microbial degradative enzymes play a major role in degrading plant cell wall materials. A knowledge of the enzymes involved is essential if the enzymes are to be improved so that the process can take place more efficiently in transforming biomass to more utilizable forms of energy such as ethanol. During the past year, we have cloned the pectate lyase A gene whose product PelA is also a subunit of the cellulosome, have demonstrated that the cohesins of the scaffolding protein (CbpA) of the cellulosome have different binding affinities for the cellulosomal enzymes, have characterized the xylanolytic enzymes that are induced by growth on xylan, have shown that the surface layer homology (SLH) domains of EngE can bind the enzyme to the cell surface, and have demonstrated the heterologous expression of EngB in BACILLUS SUBTILIS and prepared a mini-cellulosome containing a mini-CbpA and EngB. The latter experiments are the first step in our plans to make "designer cellulosomes" with specific functions and to obtain efficient production of cellulosomes in a heterologous organism which may be easier to handle that C. CELLULOVORANS. Thus significant progress has been made in understanding the properties of the cellulosome as well as the regulation of expression of its subunits.

Impact: The cellulosomal enzymes are capable of degrading plant cell wall materials. Thus agricultural biomass can be converted to more utilizable forms of energy such as ethanol and methane if this process can be improved. This research can lead to the development of more efficient enzymes to carry out this biomass conversion.

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

Key Theme: 1.10 Biofuels
Title: Biomass, Bioenergy and Environmental Impacts

Description: Close-coupled gasification of biomass for power generation was investigated using a laboratory scale fluidized bed reactor. Alkali partitioning and the emissions of nitrogenous species including NOx, NH3, and HCN were determined for rice straw, sewage sludge, whole tree wood chips, walnut tree prunings, almond shell, and non-recyclable waste paper. Ammonia concentrations in product gas were two to three orders of magnitude higher than HCN for rice straw and almond shell, two high nitrogen fuels. Pilot studies were conducted on ash deposition from co-firing energy cane and coal using unprocessed cane and cane that had been treated to remove alkali and chlorine. KCl was evident in the deposits from unprocessed cane, but not in those from leached cane. A rice straw smoke generation system was used to test human subjects to evaluate respiratory response. A single exposure to smoke at high concentration, and serial day exposure at low concentration increased the concentration of alveolar macrophages. Agricultural burning data were accumulated for the western U.S. as part of a fire emissions inventory. Improved roles for DC power systems based on renewable technologies were assessed and recommendations made for common mobile and stationary 42 V equipment standard. Rice straw and cotton wastes were investigated for mushroom production. Anaerobic digestion of fish and dairy processing wastes yielded 89.7% VS digestion, resulting in a high biogas yield. Steam exploded wood residues had about 30% VS digestibility. Site assessments were conducted for village level biomass fueled power systems in the Philippines, and an interagency working group established to facilitate system implementation.

Impact: Use of biomass for energy, chemicals, and other products has important local and global environmental benefits including reductions in atmospheric emissions of criteria pollutants and greenhouse gases. Biomass utilization also improves fuel diversity and global security and enhances farm production and forest management.

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

Key Theme: 1.11 Biotechnology
Title: Light-Regulated Phya Gene Expression in Dicotyledonous Plants

Description: The PHYA gene of Arabidopsis has three TATA boxes and three transcription start sites. The corresponding sub-promoter elements have different strengths, with the shortest transcript being the most abundant. In order to simplify subsequent studies aimed at isolation of signaling mutants, we have generated transgenic Arabidopsis lines expressing a recombinant gene-fusion where the PHYA promoter lacking the two upstream TATA boxes is fused to the selectable marker, hygromycin phosphotransferase. It is hoped that these lines will show stronger overall light-induced repression of the PHYA promoter activity as the two upstream initiation sites appear to be constitutive.

Impact: Understanding of the molecular basis of the light-regulated expression of the PHYA gene derived from this study has the potential for biotechnological applications by providing a defined, negatively-regulated promoter for use in dicotyledonous crop plants.

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

Key Theme: 1.11 Biotechnology
T**itle:** Defense-Response Genes: Roles in Insect Infestation and Pathogen Invasion

Description: Each year agricultural crops suffer severe damage or total crop loss due to pests and pathogens. While herbivore and pathogen-induced damage can be limited by the use of chemical applications or in some cases by plant resistance genes, the need to develop novel methods to protect plants is strong. This project will further our understanding of known defense-response genes in plants and identify novel genes that are induced or suppressed after feeding by the silverleaf whitefly. These genes can be used in novel strategies for plant protection. Polyclonal antibodies to the wound-induced leucine aminopeptidase (LAP) detected the wound-induced 55-kD acidic LAP-A proteins and the constitutive 55-kD LAP-N and 66 and 77-kD LAP-like proteins. We over-expressed His6-LAP-A fusion protein in Escherichia coli. The substrate specificity of the E. coli PepA and porcine LAP on dipeptide and tripeptide substrates was determined and compared to the tomato LAP-A1. These studies provide the first insights into the nature of LAP-A substrates. LAP-A1 hydrolysis of peptide substrates is profoundly influenced by the N-terminal and penultimate residues, whereas the P2' residue did not strongly influence substrate hydrolysis. To understand the expression of LAP in the plant kingdom, the accumulation of LAP and LAP-like proteins was monitored in dicots and monocots. LAP-A is restricted to a subset of the Solanaceae and LAP-N is ubiquitous in the plant kingdom. LapA genes are primarily regulated at the transcriptional level and LapA1 and LapA2 promoters were analyzed for conserved motifs important in defense regulation. LapA antisense plants (35S:asLapA) were evaluated for LapA RNA, protein and activity levels. To understand changes in gene expression in response to phloem feeding insects, squash responses to the silverleaf and sweetpotato whiteflies were determined. SLW1 and SLW3 are genes that are preferentially induced systemically by the silverleaf whitefly. SLW1 encodes a M20b peptidase and SLW3 encodes a b-glucosidase. SLW1 is regulated by jasmonic acid, while SLW3 is modulated by an unknown defense signal. In a collaborative project, we identified the gene encoding an adhesion protein active in the lily pollen tube adhesion assay.

Impact: Identification of genes activated by tissue damaging herbivores and by phloem-feeding insects is the first step in strategies to enhance herbivore tolerance using biotechnology. Future studies to identify the mechanisms that regulate these genes will aid us to develop cogent transgenic strategies for broad-based resistance to herbivores.

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

Key Theme: 1.11 Biotechnology
Title: Molecular Genetics of Insects

Description: A permit was obtained from USDA-APHIS for field cage studies of the reproductive ability of transgenic pink bollworm compared to non-transgenics. Preliminary results show the transgenics to be slightly less competitive than the non-transgenics. This difference in reproductive

behavior matches a slightly lower viability character of the transgenic strain in culture. The USDA-APHIS issued a Finding of No Significant Impact (FONSI) for this field test. We continue to develop conditional lethal strains of pink bollworm. A collaborator at USDA-ARS reported genetic transformation of codling moth using a Notch-piggyBac transformation plasmid designed for pink bollworm. A new project was initiated to find methods of delivering gene products via endosymbiotic bacteria of the glassy-winged sharpshooter (GWSS) to prevent the vectoring of Pierce's disease to grapes in California. A transformation protocol was worked out for the first candidate bacterium, Alcaligenes spp., isolated from GWSS.

Impact: The major accomplishment of this project in 2001 was to obtain a permit for conducting field cage studies comparing the reproductive ability of transgenic pink bollworm with non-transgenic strains in Phoenix, AZ. This is the first time a transgenic insect has been the subject of a field test. The transformation protocols and conditional lethal genes developed for pink bollworm have reportedly been exported into codling moth. The cotton industry is just now gearing up for pink bollworm eradication following on the boll weevil eradication attempts. The goal for this project is to supply an Autocidal Biological Control (ABC) pink bollworm during the pink bollworm eradication project planned for the next several years. ABC ushers in a conceptually new method of controlling insects that is the first biotechnology-based improvement to the Sterile Insect Technique was first perfected by USDA.

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

Key Theme: 1.11 Biotechnology
Title: Engineering Crops Resistant To Abiotic and Biotic Stress With Improved Growth and Enhanced Quality

Description: Throughout their life cycle, plants have to react to changeable environmental conditions, including drought, salinity, pathogens, etc. The purpose of this study is to identify the key proteins that allow plants to survive these stress conditions. 1) Development of salt tolerant transgenic crops. We have successfully demonstrated the important role of sodium homeostasis and vacuolar sodium accumulation in salt tolerance. We have developed transgenic plants that are able to grow, set fruit and seed at a concentration of 200 mM NaCl (a concentration that inhibits the growth of most of crop plants). Our results clearly show that transgenic plants accumulate sodium in their leaves but not in the fruits and that the agronomical attributes of the transgenic fruits and seeds are comparable to those of the wild type plants. 2) Characterization of the role of protein modules in signal-stimuli response. We have characterized and identified a group of plant AtSH3Ps (Arabidopsis thaliana SH3-containing Proteins) likely involved in trafficking of clathrin-coated vesicles. These proteins contained predicted coiled-coil domains and Src-Homology 3 (SH3) domains that were similar to animal and yeast proteins involved in the formation of clathrin-coated vesicles. Our results demonstrated the association of AtSH3Ps with the endomembrane system. In particular, AtSH3P1 was localized on or adjacent to the plasma membrane, to vesicles of the trans-Golgi network, and on the partially-coated reticulum. At all locations, AtSH3P1 was also associated with actin filaments and co-localized with both clathrin and the auxilin-like protein. 3) To characterize the gene network that determines fruit quality traits. Our objective is to characterize the 'proteome' in apple and citrus fruits to define the network of genes that

determine these different quality traits and to develop cDNA markers (derived from EST) to assist the selection of quality traits. Work has been already initiated, protein maps are being generated by two-dimensional PAGE and individual proteins are being identified by mass spectrometry.

Impact: Our results demonstrate the potential use of these transgenic plants for agricultural use in saline soils. Our findings, showing that the modification of a single trait significantly improved the salinity tolerance of this crop plant, suggest that with a combination of breeding and transgenic plants it could be possible to produce salt tolerant crops with far fewer target traits than had been anticipated. Our data also suggest that plants possess a molecular network for clathrin-coated vesicle trafficking similar to animals and yeast, and that AtSH3Ps may provide critical scaffold for different components in this network. This network could play a paramount role during flower development and possibly in the endocytosis of receptors in the pollen tubes, suggesting a role of these proteins in the regulation of compatibility/self-incompatibility.

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

Key Theme: 1.19 Invasive Species
Title: Invasions of Exotic Weedy Species and Their Interactions With Native Vegetation and Cultivated Plants

Description: (1) High relative growth rate in invasive pine species depends on their high relative leaf production rate. (2) Research on relationship between genome size, cell cycle times, and relative leaf production rate is in progress. (3) Infestations of FOENICULUM VULGARE (Umbelliferae), an invasive perennial weed, were treated with Triclopyr on Santa Cruz Island, California. After five years of monitoring, it is clear that many non-target species, including exotic grasses and several natives, profited from this treatment. (4) Controlling for area, most of the islands harbor more naturalized species than continents. However, Taiwan, Hainan, and neighboring islands in the western Pacific seem to be more resistant to plant invasions. Proximity of the largest continent that itself seems to be resistant to plant invasions is one of the possible explanations.

Impact: Evaluations of biological characters of successful invaders give rise to both general and habitat-specific procedures for screening of introduced plants and prioritization in control of invasive taxa.

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

Key Theme: 1.19 Invasive Species
Title: Bioinvasions of Exotic Insects: Molecular Genetics, Database, and Modeling Approaches

Description: This project contains 3 elements, molecular genetics, databasing, and modeling. 1.) Molecular Genetics. We are continuing to develop genetic methods for the studies of origins and biology non-indigenous, invasive (exotic) insects. In addition to collecting data for nuclear intron sequences that we have used previously, we are exploring the use of other co-dominant nuclear markers, such as microsatellites (VNTR's) and single nucleotide polymorphisms (SNP's). Insects that

we have worked with this year include Medflies, Mexican fruit fly, walnut husk fly, pumpkin fruit fly, other fruit flies in the Bactrocera dorsalis complex, and rice brown planthopper. 2.) Database. We have completed a database of all tephritid fruit fly captures in California. We are using GIS software (ArcView/ArcInfo) to analyze these captures. We also have now developed a prototype of a database (Sun Sparc/Oracle) of exotic organisms which will include exotic insect pests of California and the Pacific Rim, original and current distributions, as well as links to ecological and genetic data. This work is in collaboration with San Diego State University and UC Gump Lab, Moorea as well as genetic database scientists at the Lawrence Berkeley Lab. 3.) Modeling. We have updated and distributed a computer program to analyze recent histories of populations (ESP, now available in version 1.13 on the web at http://www.bio.sdsu.edu/pub/andy/ESP.html). This program compares actual genetic diversity found in invading organisms to that from the simulations to assess critical features of biological invasions.

Impact: Methods are 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

Key Theme: 1.19 Invasive Species
Title: Marine Biodiversity: Importance For Ecosystem Function and Resistance To Exotic Species Invasion

Description: This project is still in the development stages. The project is focused on two main 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. With regard to the first objective we have marked plots along the rocky shore near Bodega Marine lab and adjacent areas and will begin manipulating the algal species diversity of those plots this winter. Our work on invasive species has been opportunistic and has focused thus far on a recently discovered invader, the kelp UNDARIA PINNAFITIDA, native to Japan. The annual and solely sexual life history of UNDARIA differs strikingly from that of another recent seaweed introduction in California (CAULERPA TAXIFOLIA), and introduces uncertainty as to how the kelp will establish and maintain populations in California, as well as to the success of future eradication efforts. It is important that we understand exactly when these populations are dormant and when they are expanding. The objective of this work is to study various aspects of UNDARIA's reproductive biology in populations in Santa Barbara and Monterey in order to document when the species becomes reproductive, quantify reproductive output of the population, and study the effects of temperature on growth, reproduction, and recruitment, as temperature will likely be an important factor in determining the spread of UNDARIA to other regions of California. Thus far, we have focused our efforts on monitoring extant populations including measuring growth rates, survival, and reproductive parameters of UNDARIA in the field. This winter we will begin experiments with the reproductive cycle of UNDARIA in the lab and should have more to report next year.

Impact: Knowing whether diversity in producer species enhances animal diversity and productivity will be critical for managers to consider in the designing of marine protected areas. Specific

information on the influence of temperature on the fertilization, germination, survival, and reproduction of the invasive seaweed UNDARIA will be the key to predicting its northward spread along the California coast.

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

Key Theme: 1.22 Niche Market
Title: Nutritional requirements of cherimoya

Description: There is little information on the nutritional requirements of cherimoya; most of it comes from outside of California. The varieties grown here are different from most of the rest of the world and cultural practices are different here, as well. Fruit bearing patterns vary from San Diego to Santa Barbara with the same varieties, so it is important to develop fertilizer recommendations for locally grown cherimoya, in order to minimize fertilizer pollution. A field trial and a greenhouse trial have been established to evaluate the nitrogen requirements and the nutritional sufficiency levels of the trees. In a cherimoya orchard in Ventura, trees have been treated with 4 levels of nitrogen fertilizer. Growth and yield parameters are being measured. In a greenhouse, two varieties of cherimoya are being treated with deficiency levels of 9 nutrients to determine leaf deficiency levels of the two different varieties. Results. The field treatments of differential nitrogen levels were initiated in summer 1999 and have continued to this day. Initial leaf tissue levels of all treatments have been similar in the first two years, suggesting previously high levels of nitrogen application. There have been no differences in yields or plant growth. The coming years should show some differences. The first phase of the greenhouse trial was terminated and an initial report was made at the California Cherimoya Association Annual Meeting and a set of color images of nutrient deficiency symptoms was made available for growers. The greenhouse study has been refined and the number of replications increased in order to obtain better numerical data.

Impact: We have been working with the California Cherimoya Association for15 years and much of our work has been on cultural matters, in order to increase the profitability of this new crop. There are now currently 800 acres in the State. We have now shown how to properly fertilize the trees to avoid nitrogen contamination. More than half of the growers are using our guidelines for the proper use of nitrogen.

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

Key Theme: 1.22 Niche Market
Title: Litchi and Longan trials

Description: Litchi and longan have the potential to be a profitable new commercial crop in California. They have been tried on a limited scale in southern California, however with no commercial plantings. We are studying all the commercially available varieties of litchi and longan and developing a nursery industry at the same time that will be able to supply the trees. One of the limitations to the industry has been the cost of the trees, since they are produced by a laborious air-layering technique. We are working with a USDA researcher who has developed a new technique of grafting which should significantly reduce the cost and improve the quality of trees. Research

methods. Nurseries have been contacted in Australia, Florida and Hawaii, as well as the USDA germplasm repository in Hawaii to supply all the known varieties of litchi and longan. Trees have been propagated at a nursery in Vista, CA. Six trees of each variety have been planted on growers' properties at 20 sites from Morro Bay to Vista. At this point there are 9 varieties of litchi and 4 varieties of longan in the ground. Another 8 varieties of litchi and longan imported from Australia are in quarantine in Vista and will be planted at the 20 tests sites in 2002 and 2003. The varieties are being evaluated for growth and production. The plantings are still young, but some preliminary data has been collected and some important observations have been made. The 'Emperor' and 'Bengal' varieties of litchi produce larger fruit than the more commonly available 'Mauritius' and 'Brewster' varieties. The trees need small, regular amounts of micronutrients to compensate for their small root systems. They also need windbreaks in their first year. Importation from Australia and Hawaii has resulted in 8 new varieties never before available in California. The nursery in Vista has increased sales of both litchi and longan reflecting a significant grower interest in this new crop. The results of the trials so far have been presented at two grower meetings and are available on the website: ceventura.ucdavis.edu. A popular article for Tree Fruit Magazine was published. The trials will continue for another eight years.

Impact: It was previously assumed that litchi and longan could not be commercially grown in California. The trials are still young and the data is still being collected, but the trees do quite well in southern California. In spite of this relative lack of knowledge, there have been several large plantings in Riverside, Ventura and San Diego Counties (at least 8 are greater than one-acre per site). Growers have relied on our initial results in order to make decisions on what varieties to plant and the cultural care of the trees. The total commercial plantings of these tree fruits have expanded to about 40 acres since the initial results of are studies have been made known. Finding new and promising subtropical crops is essential for maintaining the sustainability of California agriculture.

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

Key Theme: 1.24 Ornamental/Green Agriculture
Title: Pest and Disease Persistence in Commercial Mulch Piles

Description: We have shown that avocado and citrus derive significant benefits from the use of mulch derived from urban yard waste – mulch reduces water use by as much as 25% in young orchards, reduces weeds and herbicide use, reduces nutrient inputs and improves root health. Every new planting of avocado in this county and in much of the rest of the state now receives a mulch application. With the widespread use of urban-derived yard waste in Ventura orchards, the question of the fate of introduced pests and diseases has been unresolved. Although, the lag time from collection to spreading would appear to be sufficient for destruction of disease-causing organisms, the potential has never been addressed. The Ventura County Agricultural Commissioner has been concerned about the threat of introducing pests from Los Angeles County where much of the yard waste for Ventura is generated. The Commissioner is in the process of developing an ordinance on the use of yard waste in orchards. The purpose of this study was to assess the survival of several noxious weeds, pests and diseases in a typical mulching operation. Research methods: A commercial yard waste operation was used to chip freshly collected material. Five piles of ten cubic yards each were constructed. Bags with two weed species, two insect species, two disease-causing organisms and a nematode specie were

buried at four levels in the static piles to be harvested regularly over a period of two months. The bags were excavated and the various organisms were evaluated for viability. This procedure has been followed 4 different times, including two times when piles were also built of an 18 month old mulch that had slowed in decomposition. Results indicate that there is little survival beyond three days in the piles constructed of freshly chipped material. In piles that have been constructed of old mulch material survival is longer and less consistent that in new piles. Organisms on the surface of the piles dry out and those within the pile are destroyed by a combination of heat that is generated by the decomposing pile and various gases that are also generated.

Impact: This has been an important study, not just from the standpoint of science, but because it has been instrumental in providing growers with information on the consequences of using urban-derived mulches. These mulch materials have shown their benefits in reduced fertilizer, water, herbicide and fungicide use and now we have guidelines for ensuring that these mulches do not spread disease and pests. Currently in Southern California, nearly all new avocado orchards are planted using a mulch and perhaps as much as 10% of the mature citrus orchards are using mulch. Mulching is now listed in the USDA's NRCS EQIP as a cost-share program because it not only reduces materials sent to landfills; it also leads to reductions in fertilizer, water, herbicide and fungicide use.

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

Key Theme: 1.25 Plant Genomics
Title: Analysis of Virulence Genes in Plant Pathogenic Bacteria

Description: The identification of genetic elements involved in disease production (pathogenesis) will provide valuable isights on how pathogens work.The mechanism of horizontal transfer of the T-DNA from A. tumefaciens to plants is encoded by vir genes on the resident Ti plasmid. The proteins encoded by the eleven virB genes are involved in the synthesis and assembly of the T-pilus. This extracellular, flexuous filament is required for tumorigenicity and is thought to be the conduit through which the T-DNA is transmitted. The T-pilus is composed of T-pilin subunits which are composed cyclic peptides resulting from the processing of VirB2 propilin. The biogenesis of T-pili is linked to the down regulation of flagellation and chemotaxis. The biphasic reaction requires the histidine kinase is VirA, suggesting that this reaction is mediated through a two-component signal transduction system. The presence of a 2 nm diameter channel running the length of the T-pilus was revealed by electron microscopy. This diameter is of sufficient size to accommodate the T-DNA complex composed of VirD2 protein linked to the 5 prime terminus of the single-stranded T-DNA. Thin section electron microscope studies of A. tumefaciens mating with Streptomyce lividans hyphae reveal a filamentous bridge linking the mating pairs only under conditions identical to that in T-pili biogenesis. These results indicate intricate use of the T-pilus in T-DNA transmission. Studies on the Ros respressor encoded by the A. tumefaciens chromosome revealed that the C2H2-zinc finger in Ros originated from a marine animal rather than from a plant. The C2H2-zinc finger is unique among prokaryotes and is found in soil bacteria related to A. tumefaciens.

Impact: Knowledge on the mechanism of T-DNA transfer between A. tumefaciens and plants provides a more complete understanding on how genes are transferred by this organism when used in

the genetic engineering of crops. The formation of a large cyclic peptide is unique in microbiology and promotes further investigations on the biochemical mechanism of peptidyl cyclization. The presence of a C2H2-zinc finger in a small regulatory protein encoded by A. tumefaciens abolishes the dogma that the C2H2-zinc finger is restricted to animal regulatory proteins.

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

Key Theme: 1.25 Plant Genomics
Title: Genetics and Varietal Improvement of Strawberries

Description: California strawberry growers face the combined challenge of competitive markets, increasing labor cost, and growing regulatory obstacles to use of their most effective cultural tools. The purpose of this project is to provide genetic solutions to the problems faced by commercial growers, by development and release of strawberry cultivars with improved production and harvest efficiency, better fruit quality, and broad tolerance to environmental stresses. Two short-day strawberry cultivars were released to the industry for commercial propagation and fruit production. The Ventana cultivar provides the best alternative for southern California and similar production systems; it produces large quantities of early-season fruit with weather tolerance and fruit quality superior to the target cultivar Camarosa. The cultivar Camino Real provides an alternative for central California growers and other similar environments that initiates fruiting late enough to escape winter weather, has superior disease resistance, fruit quality, and weather tolerance to the Camarosa cultivar in these regions. Nursery trials demonstrated that most strawberry runner plants infected with Verticillium are initially infected via infected mother plants through stolon transmission, and that post-nursery chilling can reduce expression of this disease for infected plants in some cultivars. Also, genetic evaluations demonstrated distinct differences in breeding value for Verticillium resistance dependent on selection methodology. Nursery treatments designed to clean stock heavily infected with Phytophthora cactorum were effective in reducing nursery symptoms but not in reducing infection levels in the runner plants produced by this stock. Nursery infestation trials for Phytophthora cactorum showed that the this disease causes relatively little problem for moderately resistant cultivars, serious compromise of productivity is only realized when the disease/resistance interaction causes severe plant mortality.

Impact: Together the two cultivars released in 2001 are expected to replace the Camarosa cultivar worldwide. The benefits conferred by these two cultivars will thus affect approximately 50% of the fruit production around the world. The cumulative results for Verticillium resistance and treatment research have demonstrated multiple mechanisms of resistance. Results for research addressing Phytophthora cactorum in strawberry verify the importance of nursery clean stock measures in addition to cultural and genetic control measures.

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

Key Theme: 1.25 Plant Genomics
Title: Introduction and Expression of Transgenes To Improve Quality and Productivity of Tree Crops

Description: Quality and productivity traits are key to the production and marketing of tree fruit and nut crops and enhance their value for both growers and consumers. However, the molecular/biochemical basis of many of these traits are largely unknown. To identify key quality and productivity traits using molecular and genomics based approaches to provide genetic alternatives to current practices in growing and storage of tree fruit and nut crops. Research in our laboratory comprises analyzing the function of individual genes in tree fruit and nut crops that impact quality and productivity using functional genomic approaches that involve plant transformation and post transcriptional gene silencing (PTGS) with a focus on 1) plant protection and 2) fruit/nut quality and productivity. 1) Transformation technology is being utilized to incorporate genes that confer resistance to pest and disease. Transgenic walnuts are being field tested in two locations in California to evaluate resistance to codling moth. Developing resistance to insects is important to reducing the usage of chemical pesticides as well as the level of aflatoxin contamination in tree nuts. Resistance to crown gall in being investigated via PTGS of Agrobacterium oncogenes. We have successfully demonstrated that this approach blocks gall formation in tomato and Arabidopsis. Research is underway to engineer gall resistance in walnuts. 2) Fruit quality is being investigated in transgenic plants through the PTGS of ethylene or sorbitol biosynthesis. Fruit are being analyzed from plants that display a marked inhibition in ethylene or sorbitol biosynthesis. Almond productivity is being studied through the identification of S-alleles that are responsible for self-incompatibility. Focus here is on the identification of new S-alleles and to define the almond genomic region that contains these genes.

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

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

Key Theme: 1.25 Plant Genomics
Title: Stone Fruit Diseases: Etiology, Pathogenicity Mechanisms and Host Resistance

Description: Brown rot disease is a major limiting factor in stone fruit production worldwide, and is one of the most important diseases of peach in California. Information about host chemistry and fruit architecture, fungal quiescence and pathogenicity, and disease resistance will foster rational approaches for new disease management strategies. This research will provide new cultivars with greater disease resistance, resulting in the reduced use of fungicides. Over 200 peach genotypes were evaluated in laboratory assays for resistance to brown rot disease caused by Monilinia fructicola. Mean lesion diameters and incidence (proportion of infected fruit) were determined in inoculated fruit for each genotype, and from these values disease severity values were calculated. Fruit color, an indicator of quality and ripeness, was estimated by color image analysis of photographs. Consistent with results from previous years, fruit from the various peach genotypes displayed significant differences in

disease resistance to the brown rot fungus, with a significant number of the genotypes showing high levels of resistance with a disease severity value of 0.2 or less. During 2000, we expanded our studies on brown rot resistance to include evaluation of selections from the French prune breeding program in collaboration with members of the UCD Pomology Department. Basic studies on Monilinia pathogenicity mechanisms have continued with the purification, cloning, and characterization of the predominant 18 kD cutinase. From a series of full-length cDNA clones, we deduced a cutinase protein of 201 amino acids, which includes a 20-amino acid secretory signal peptide, cutinase/lipase consensus sequences containing active site serines, and a novel histidine substitution in the D-H active site motif. Naturally occurring antioxidants such as caffeic acid and glutathione suppressed cutinase mRNA accumulation and enzyme activity in M. fructicola cultures. The contributions of redox climate and other fruit factors are being examined in vitro with Monilinia and other post-harvest fungal pathogens.

Impact: These findings are advancing our ongoing efforts to select a range of promising genotypes for further development within the stone fruit breeding programs, with the goal of developing cultivars with improved fruit chemistry and resistance to brown rot disease. The results of this research also could lead to novel strategies to develop disease resistant crops.

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

Key Theme: 1.25 Plant Genomics
Title: Molecular Genetic Improvement of Fruit Quality

Description: The goals of the research project are to enhance tomato fruit quality by integrating biochemical and molecular genetic approaches to modify fruit textural properties, disease resistance and nutrient content. During the last year we have continued to focus on the sequential disassembly of hemicelluloses and pectins as likely determinants of early softening and overripe tissue deterioration, respectively. Based on data developed over the last several years in this project a comprehensive model of cell wall disassembly was developed and published (Bennett, 2001). This model proposes that the earliest cell wall disassembly occurs in the xyloglucan fraction and is controlled by expression of ripening-regulated expansin genes in tomato (LeExp1).
Subsequent loss of firmness in the overripe stage is proposed to be regulated by pectin disassembly and this event is regulated by expression of polygalacturonase gene(s). This general model of cell wall disassembly can be tested using a variety of biochemical and molecular genetic methods in a number of different fruit. While the model is likely to be fairly robust and explain major elements of fruit softening, it is likely that testing of the model will also lead to identification of other factors that regulate fruit softening. During the last year we have begun to test this model by constructing transgenic rin tomato genotypes expressing a ripening-specific expansin gene, a ripening-specific polygalacturonase gene and plants expressing the combination of both genes. To date, the results suggest that these two genes play major roles in early and late fruit softening, respectively. This year we have evaluated transgenic plants grown in Davis field conditions for softening, long term storage, and paste viscosity characteristics. We have compared fruit from plants suppressed for the expression of LeExp1 or PG to plants in which both LeExp1 and PG are suppressed. We have also demonstrated that transgenic rin tomato fruit expressing both LeExp1 and PG soften extensively but do not undergo other changes associated with ripening, such as color changes.

During the last year, we have also initiated a genetic approach to define loci and biochemical processes that contribute to elevated vitamin and antioxidant levels in tomato fruit. The experiments we have conducted to date, have been to screen populations of tomato near isogenic lines (NILs) introgressed with defined regions of a tomato wild relative genome (L. pennelli of L. peruvianum). We have initiated mapping projects to identify genome segments containing the sequences encoding three enzymes that are involved in ascorbic acid metabolism. These experiments promise to provide material suitable for breeding tomatoes with enhanced nutritional value and provide the basis for elucidating the regulation of pathways that contribute to elevated vitamin and antioxidant levels.

Impact: The impact of the research has been to identify the molecular events that underlie fruit softening and to initiate the elucidation of strategies to enhance fruit nutritional content. This information provides the basis to improve the quality of fruit for consumers.

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

Key Theme: 1.26 Plant Germplasm
Title: Plant Genetic Resource Conservation and Utilization

A. Somatic Embryos from Pistachio Cultivar: The Committee had joint meetings with key USDA-NPGS administrators and toured the National Seed Storage Facility. Current research focuses on the development of a protocol for producing somatic embryos from the 'Kerman' pistachio cultivar. Preliminary results suggest that cells can be isolated and be induced to multiply.

Impact: The W-6 project supports the activities of the National Plant Germplasm System and provides a system for reporting the use and value of germplasm distributed through the NPGS to California users. Reporting this information is important as it becomes part of the documentation to demonstrate the value of plant germplasm maintained in the National Plant Germplasm System. The information is used as part of the justification for continuing to fund the National Plant Germplasm System, which maintains these plant materials. The embryogenesis project is a necessary prerequisite for any future genetic engineering efforts in this crop.

B. Celery Mosaic Virus Resistance: Celery (Apium graveolens var. dulce) plants from an advanced second backcross population segregating for celery mosaic virus (CeMV) resistance were grown for selection of resistant plants. Also a similar population but segregating for resistance to fusarium yellows derived from the smallage 'Afina' was produced for selection of resistant individuals. A male sterile line (nuclear) was improved by backcrossing it to commercial celery and to a fusarium resistant line. Two new experimental fusarium resistant F1 hybrids were produced and field evaluated using the improved male sterile line. Seed increase for fourteen depleted accessions of the Apium germplasm collection at UC Davis was carried out under isolation. For Brassica oleracea we increased the seed of 150 F2 plants of a large mapping population obtained by crossing two doubled-haploid lines of broccoli and cauliflower. This population was created for following the inheritance of the major genes involved in aliphatic glucosinolate synthesis. We produced F2 seed from two interspecific crosses involving broccoli the wild species B. villosa, and B. macrocarpa. These plants segregating for high glucosinolate content will be used to maximize beneficial glucosinolate content in experimental lines.

Impact: Maintenance of a working germplasm Apium collection will assure the availability of sources for desirable traits to celery breeders. Development of Brassica germplam segregating for glucosinolate content will allow extraction of lines containing specific glucosinolates for different research purposes such as biological control of pests and diseases and as sources of cancer-protecting agents.

C. Prunus Genotypes Resistance to Bacterial Canker: We have screened a large number of *Prunus* accessions for crown gall. A manuscript was published as a result of the work (Bliss, et al. 1999). The general conclusion from the work, so far, is that we can arrange Prunus groups with increasing resistance as follows: plum>cherry>peach>almond>apricot. Work on the level of reaction of other Prunus genotypes to this pathogen is still underway. Screening of Prunus genotypes for resistance to bacterial canker has shown seedlings from the peach accession Flordaguard and P. hortulana with increased resistance. A field trial evaluating several Prunus rootstocks for bacteria canker is in its second year after planting.

Impact: Use of biological resistance found in these studies will reduce the need for chemical pesticides currently used in nurseries to control crown gall disease and in growers fields to reduce the incidence of bacterial canker. Reduced use of chemicals will favor the environment and reduce production costs.

Funding Source: Hatch Multistate Research and State
Scope of Impact: AZ, CA, CO, ID, MT, NM, OR, UT, WA, WY, USDA/FS, USDA/ARS

Key Theme: 1.26 Plant Germplasm
Title: Molecular Genetics of Developing Cotton Fibers

Description: Research goals are aimed at elucidating what genes are responsible for controlling cotton fiber development and hence, agronomically important fiber traits. Current efforts focus on cotton functional genomics to study regulation of fiber gene expression and to transfer this information into applied goals and objectives. Analysis of our cotton fiber dbEST indicates that ~12,000 genes are expressed in developing fibers - or almost 50% of the genes encoded in the A-genome of G. arboreum. Of the 9,000+ unique fiber genes identified thus far, over 50% do not show any significant homology to sequences in GenBank. Overexpression of a fiber gene encoding a transcription factor has een shown to function as a novel repressor for phenylpropanoid biosynthesis. The expression of this gene in cotton is being altered using sense and antisense technology to determine the role this gene plays in fiber development and hence, agronomically important fiber traits (yield and quality).

Impact: The work lays the foundation for developing a functionally-anchored genetic/physical map of the cotton genome suitable for marker-assisted breeding, including potential for developing PCR-based DNA markers. Functional analysis of the cotton genome, in terms of fiber traits, is and will continue to pave the way for improving cotton germplasm using molecular approaches, and offset rising production costs that threatens the health of the U.S. cotton industry.

Funding Source: Hatch and State

Scope of Impact: State Specific

Key Theme: 1.26 Plant Germplasm
Title: Development of Germplasm Resources and Breeding Methods For Alfalfa (*Medicago* Sp)

Description: During the current year we continued to investigate a biochemical approach to developing resistance to Lygus bugs. Our primary target is resistance to the salivary enzyme polygalacturonase, but the scope is being expanded to include protease, amylase, and possible cellulase. The enzymes have been targeted based on reports in the literature and our recent feeding studies showing increases in these enzymes in alfalfa, bean, and cotton tissue that has been feed on by lygus bugs. We have also successfully developed a microinjection technique that permits us to inject plant tissue with lygus saliva and salivary components and assess damage. Polygalacturonase inhibitor proteins have been identified in alfalfa, blackeye beans, and cotton. In both alfalfa and cotton there is significant genetic variation for PGIP. As might be expected, in cotton the primary variation is among germplasm sources. In alfalfa while there is variation among germplasm sources the greatest variation is within sources. At present we have identified genetic stocks in both cotton and alfalfa exhibiting 35 to 50% inhibition of Lygus salivary polygalacturonase. Inheritance studies have been initiated in both species. Selection/breeding programs are in progress. Silverleaf whitefly - UC-Impalo-WF continued to preforme well on the low desert in grower trials. Yield and quality were high, and damage due whitefly feeding was substantially reduced relative to commercially available cultivars. Cycle-7 populations (three generations past UC-Impalo-WF) evaluated during the past two years have been outstanding relative to commercial (public and proprietary) check materials. We are continuing to improve this material to increase levels of resistance to Phytophthora root rot and the blue alfalfa aphid and incorporate resistance to a new pest the alfalfa black aphid (ABA) and the Lygus bug. Crop Physiology: Fall Dormancy -Trials were established and evaluated and data collect at 4 locations. For the next two years we will be concentrating on evaluation of materials commercially grown in California in order to develop dormancy ratings that are accurate for California growers.

Impact: There has been considerable interest in private breeding industry in using UC-Impalo-WF germplasm in breeding programs. Inhibition of lygus PG by a plant PGIP is the first example of this type of plant-insect interaction. Fall Dormancy (FD): Techniques we developed were used to settle a genetic shift dispute.

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

Key Theme: 1.26 Plant Germplasm
Title: The Characterization and Exploitation of Molecular Diversity in Plants

Description: The goals of this project are to investigate the process responsible for the generation of genetic variation in plants and to utilize genetic variation for crop improvement. To achieve these goals we will characterize the role to transposable elements in the generation of genetic diversity; we will screen DNA sequence variation at a sample of loci in barley to search for traces of past selection

and we will develop microsatellite markers for avocado improvement. Research in our laboratory has three main foci: (1) analyses of molecular genetic diversity within wild and cultivated barley; (2) investigations of the joint evolution of flavonoid genes and floral color phenotype in morning glory genus (Ipomoea); and (3) the development of molecular markers for avocado improvement. With respect to topic 1 we have characterized DNA sequence diversity at the alcohol dehydrogenase 2 (adh2) locus in wild barley and compared diversity patterns with previous work on adh1 and adh3. The data reveal strong heterogeneity among loci in diversity patterns and low levels of linkage disequilibrium relative to expectations for a self-fertilizing crop species (Lin and Clegg 2002). Our work on topic 2 has focused on an analysis of gene expression patterns among various Ipomoea species for flavonoid biosynthesis genes. The ultimate goal is to identify the genes that are responsible for shifts in floral color among different species of Ipomoea. We have established that I. alba has white flowers owing to an absence of chalcone synthase D message in floral limbs and that I quamolit has yellow flowers owing to an absence of chalcone isomerase expression. With respect to topic 3, we have developed more than 50 good microsatellite markers for use in avocado improvement. These markers are being applied to the analysis of paternity and to the reconstruction of genetic relationships among avocado accessions.

Impact: The analysis of nucleotide sequence diversity within barley is important in understanding crop plant origins and in the design of germplasm conservation programs. Our work on floral phenotypic evolution is aimed at connecting phenotypic and molecular levels of evolution. Our work on avocado genetic markers should lead to accelerated rates of improvement of this fruit crop species.

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

Key Theme: 1.26 Plant Germplasm
Title: The Citrus Clonal Protection Program

Description: This past year a total of ten new varieties completed all therapy and pre-testing procedures and were entered into the CCPP VI index. This is a test for all the known bud transmitted diseases affecting citrus. If all tests are negative, these new varieties will be released from quarantine and placed in the CCPP Foundation Plantings for evaluation. The varieties included one blood orange, one lime, one lemon, one grapefruit, one sweet orange, one tangelo, one kumquat and three mandarins. All of these varieties may be of commercial value and will require additional field evaluation. We were able to reduce the number of varieties that the CCPP has been holding in quarantine this year. This was possible because the curator of the USDA/ARS National Clonal Germplasm Repository for Citrus and Dates was granted a permit to import and maintain citrus in quarantine. As a result of this the CCPP transferred 52 varieties from our quarantine facility to the USDA facility. The varieties transferred were primarily imports that will give greater depth to the citrus germplasm collection of USDA and the University of California Citrus Variety Collection and were of no commercial value.

This leaves the CCPP with about 75 varieties still in quarantine. Once again all of the citrus on the Lindcove Research and Extension Center (LREC) was tested for tristeza. Several trees were determined to be positive for citrus tristeza and were immediately removed. Fortunately none of these trees were in the Foundation-Evaluation Block. The 30,000+ square foot addition to the CCPP LREC

Screenhouse that houses the CCPP Protected Foundation Block was completed this past winter and is ready for use. Approximately 100 of the most popular CCPP varieties were propagated in February and will be planted in the new screenhouse facility as soon as they are ready. These varieties will be planted directly in the ground where they will be spaced so that budwood production will be similar to that on field grown trees. Once these trees are growing well, the same varieties that we have been holding in containers will be eliminated thus freeing up some space to house new varieties in the protected environment. The small screenhouse that the CCPP had been using for a number of years was moved to the new site adjacent to our large screenhouse. This screenhouse will be used to house the source plants for the growth modifying Tsn-RNA's. Distribution of this material began this June, 2001. This past fall we again evaluated fruit from our registered trees. The results of these evaluations were posted on the CCPP Website (www.ccpp.ucr.edu). We were also able to add a number of new images to the website. We are hoping to complete all the needed images within the next year.

Impact: Continued availability of disease tested propagation material from the CCPP is essential for the variety of research projects conducted by the University and it is extremely important for the protection of California's citrus industry. Maintaining California in the forefront of high quality fruit production demands the newest varieties and the highest quality propagation material.

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

Key Theme: 1.26 Plant Germplasm
Title: An Integrated Approach To Management of Rice Residue and the Control of Rice Diseases

Description: Open-field burning has been effective in managing rice diseases in the past. New legislation has passed to phase out burning of rice straw. This study seeks to identify alternatives to burning while maintaining disease control. Until this year the blast disease was only known to occur in Colusa, Glenn, Sutter and Butte Counties. In (2000) it was found in a few fields in Yuba County. The continuing spread of blast in California indicates the continuing need for caution in using pathogen free seed sources and to avoid spread through transport of and use of contaminated equipment. DNA analyses of the pathogen isolates collected in 1999 revealed that there is still only one known race (IG -1) of Pyricularia oryzae in California. Analyses of samples from 2000 is underway. This information is essential for plant breeders attempting to develop blast resistant cultivars for California.

Results of fungicide trials to determine optimum time and rate of application of Quadris for control of Aggregate Sheath Spot were consistent with previous results. A decrease in AGGS severity and increases in paddy yield and percent head rice were observed on M-202 with 0.2 lbsaiacre applied at 70 days from planting. Decreases in AGSS severity and an increase in paddy yield and percent Total and percent Head rice were observed on M-204 with a single application at 70 days from planting. Reductions in stem rot severity were not observed at the treatment times and rates tested. Bakanae disease was observed in fields in Colusa, Glenn, Butte, Sutter and Yuba Counties. The disease is primarily seed born and the pathogen is not particularly well suited to overwintering and survival in soil. The pathogen is abundant in residue of killed plants at harvest time. Preliminary studies have shown that the pathogen is primarily a surface contaminant of the seed and that it may be easily removed by treatments with Sodium Hypoclorite. Additional study is needed to determine

concentrations that are effective in removing the pathogen and not detrimental to rice seed and seedlings.

Impact: Knowledge of P. grisea races that occur in California allow breeders to proceed with confidence in attempts to produce blast resistant cultivars for California. Control of Aggregate Sheath Spot disease with a single application of fungicide is economical and results in an increase both yield and quality. Development of potential seed treatments for control of Bakanae disease appears promising.

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

Key Theme: 1.26 Plant Germplasm
Title: Horticulture, Biology and Environmental Physiology of California Strawberries

Description: California is the world's largest strawberry producer, growing 83% of the U.S. strawberry crop, and 23% of world production, but urbanization, loss of important agricultural chemicals, increased costs for labor and water, and increased competition from foreign producers threaten California's competitive advantage. The purpose of this research is to develop novel production technologies, including new varieties, that will maintain California's lead in strawberry production, while increasing fruit quality and market share. Field trials were conducted statewide to evaluate the performance of two new strawberry cultivars, 'Camino Real' and 'Ventana', developed in the UC strawberry improvement program and released to the California strawberry industry in Spring, 2001. These cultivars are short-day flowering types that are well-adapted to coastal California. Both are highly productive, producing large fruit (average fruit size is greater than 30 grams) with good color, flavor, shelf-life and shipping qualities. Compared to the present standard variety 'Camarosa', both cultivars have improved fruit harvest efficiency due to high yields, excellent pollination, low cull rates, and smaller or more open plant canopies. Results of trials indicate that Ventana is best adapted to coastal areas from Santa Maria south, while 'Camino Real' is better adapted to coastal areas from Santa Maria north. Field trials conducted in Watsonville, California sought to determine the cause of a strawberry fruit bronzing injury that is not due to arthropod feeding or the use of chemical sprays, but for which the causal agent has not been identified. Due to production of nonmarketable fruit, bronzing results in economic losses in some years. Application of clear, full-bed polyethylene mulch resulted in increased strawberry plant vegetative growth compared to plants grown with full-bed green polyethylene or center-strip mulch. In spring and summer, plants grown with full-bed clear polyethylene mulch had greater yield and less bronzing compared to plants grown with other mulch treatments. Overhead sprinkling twice weekly for fifteen minutes resulted in reduced bronzing incidence but increased fruit rot. Microscopic examination of bronzed fruit indicated that bronzing injury resembles sunscald damage, and may result from excessive heat or solar radiation. Field trials were conducted to develop protocols for propagating and conditioning containerized strawberry transplants ('plug plants') for maximum fruit yield and fruit quality after transplanting. With loss of methyl bromide and restrictions on other soil fumigants, propagation of plug plants may be a useful method for producing disease-free planting stock, but information on plug plant production and performance is lacking for strawberries in California. Plugs were propagated in early and mid-August using two container sizes (6 or 11 cm deep) and high-elevation (4,000 feet) or low-elevation (600 feet) plant conditioning environments. Large plugs had greater early season (December-March 31) and total season (December-May 31) fruit yield and greater early season fruit size than small plugs. Similarly,

plugs conditioned at high elevation had greater early and total season yields and larger fruit size than plugs conditioned at low elevation.

Propagation date had no effect on plug plant fruit yield, but plugs propagated on August 2 had larger fruit size throughout the harvest season than plugs propagated on August 16. The influence of container size and nursery conditioning environment is being studied during a third season to determine optimal strawberry plug propagation protocols for the California strawberry industry.

Impact: The development of new commercial strawberry cultivars provides important options to California strawberry growers, and will enable the production of high quality fruit with greater production efficiencies. Early application of clear, full-bed polyethylene mulch is a simple and highly cost effective means of increasing fruit yields and, at the same time, reducing fruit bronzing. Similarly, the information developed in regard to strawberry plug propagation will enable commercial nursery growers to make effective and informed production management decisions about this type of nursery propagation system.

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

Key Theme: 1.26 Plant Germplasm
Title: Genetic Improvement of Peach and Almond

Description: The objectives of the cling-peach and almond breeding programs are the development of new varieties which reduce grower and processor costs while improving quality and yields. Immediate needs for processing peach were the replacement of the 'Dixon', 'Andross', 'Halford' and 'Starn' varieties because of their tendency for red-staining of the pit cavity with associated pit fragmentation. 'Hesse' has been previously released as a replacement for 'Starn' and presently has substantial plantings. 'Rizzi', a 'Dr. Davis' period selection was released at the same time, primarily for the southern San Joaquin Valley regions where its capacity for prolonged cold storage prior to processing is crucial to that industry. In 2001, 'Goodwin' and 'Lilleland' have been released as replacements for the now abandoned 'Dixon' variety, and the 'Halford' variety, respectively. New varieties have good processing quality and freedom from pit deterioration. The breeding priority for almond has been the development of pollinizers for 'Nonpareil'. The release of the 'Winters' almond in 2001 provides a high quality and productive pollinizer for the early 'Nonpareil' bloom, while the continued selection of low-Bud-Failure clones of 'Carmel' have allowed the continued plantings of this important mid-bloom pollinator which was being abandoned in the early 1990s because of high Bud-Failure losses. The almond x peach hybrid 'Nickels' was previously released as a root-rot and nematode resistant rootstock for almond replant situations, though current research has demonstrated good tree structure and productivity under a range of production systems.

Impact: Genetic solutions to problems resulting from the rapid losses in traditional agro-chemicals, productive land, and skilled labor for California processing peach and almond is essential for continued viability of these industries. New 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

Key Theme: 1.26 Plant Germplasm
Title: Physiological and Genetic Mechanisms of High Salt Stress Tolerance in Lophopyrum Elongatum: Genomic Approach

Description: We assume that most of the differences in salt stress tolerance between wheat and the highly salt tolerant L. elongatum, a close relative of wheat, are due to quantitative differences in gene expression rather than differences in gene function. Identification and isolation of such genes will facilitate manipulation of salt stress tolerance in wheat. To identify genes showing differenetial expression in the two species under salt stress, gene expression in L. elongatum during a time-course of the acclimation to stress with 100 mM NaCl will be compared with that in wheat by cDNA microarray hybridization. Genes showing differences in expression will be identified. To develop a population of cDNA clones for arraying on glass slides (microarrays), cDNA libraries of salt-stressed Chinese Spring wheat were produced and two thousand random clones were selected from each cDNA library and sequenced, thereby producing their expressed sequence tags (ESTs). ESTs of these clones were compared with the existing pool of 60,000 wheat ESTs and putative unigenes were selected. They are being mapped utilizing a set of 101 Chinese Spring wheat stocks with overlapping deletions. Currently, a total of 260 clones have been deletion mapped in the wheat genomes.

Impact: The goal of this project is to identify regulatory elements responsible for the high expression of genes controlling salt stress response in L. elongatum, the highly salt-tolerant relative of wheat. This knowledge will make it possible to engineer cereals with enhanced salt stress tolerance, which is an important breeding goal for irrigated agriculture in California.

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

Key Theme: 1.26 Plant Germplasm
Title: Genetic Improvement of Walnut

Description: Our goal is to provide the California walnut industry with superior varieties through breeding and genetic engineering. It is proceeding swiftly due to the enthusiasm of participants at our annual crack-out meeting and the first Walnut Breeding Day. In the field we evaluated almost 2000 trees and cracked out nut samples from over 1300. We have 10 grower field trials underway and several more planned including a 6-acre block at Delta College. 29 new selections were identified at the crack-out meeting in March, bringing the total to 51. Many of these are targeted for general areas of the state, for example early harvest regardless of leafing date for the South and low blight for the North. In the coming year we expect to have commercial quality selections for resistance to blackline for the central area. Cross-pollinations this year were severely damaged by the spring frost, bagged flowers being more damaged than the surrounding shoots, resulting in only a few hundred seed.

Laboratory work including improvements in micropropagation was highly successful. The media and conditions for the induction phase of rooting were optimized and the problem of rosetting after acclimatization in the greenhouse was solved. Transgenic lines expressing or silencing the polyphenol oxidase gene for insect resistance and rootability were developed and plantlet tests are underway in the Entomology Department. We also cooperated in the crown gall research of Dandekar and Escobar, aflatoxin research with USDA and generated embryos for testing oil content for the Labavitch lab.

Impact: New walnut cultivars have had a major impact on walnut production in the U.S.. The majority of trees now planted are derived from UC breeding programs. The patent approval process is still in progress for 'Robert Livermore' a red kerneled walnut that can serve a niche market or may prove to have a wider impact.

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

Key Theme: 1.26 Plant Germplasm
Title: Genetic Improvement of Pistachio and Genetic Study of the *Genus pistacia*

Description: Propagation materials from *Pistacia vera* selections identified as potentially superior items, either because of nut characters, yield compared to the population averages, or superior disease resistance were collected at 2 locations and budded to rootstocks. They will be maintained in a collection for use in future breeding or for testing in advanced selection trials. Heritability estimates for precocity (years to first fruiting) and flowering dates were calculated and summarized in manuscripts. A relationship between flowering date and first leafing date was established which could be useful for selecting later flowering cultivars.

Impact: Collection and propagation of selected pistachio accessions will ensure that materials with superior economic value are retained for future testing. Identification of extent to which genetics contribute to economically important traits will be useful for development of future crop improvement efforts.

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

Key Theme: 1.26 Plant Germplasm
Title: Use of Wild *Lycopersicon* Species in Breeding For Improvementof Cultivated Tomato

Description: The project seeks to use wild tomato species to genetically improve cultivated tomato for agriculturally important traits and to use a combination of classical genetics, breeding and molecular marker techniques to study trait inheritance, map genes controlling important traits, and to help transfer wild species genes to cultivated tomato. The objective is to create, select and release improved tomato germplasm. Tomato germplasm enhancement research is focused on introgression of genes for various agriculturally important traits, including resistance to blackmold (RBM), late blight (RLB), and chilling tolerance (CT), from wild to cultivated tomato (*Lycopersicon esculentum*). Quantitative trait loci (QTL) for RBM, RLB, and CT were mapped previously in interspecific populations. Selected

RLB QTL on chromosomes 3, 4, 5 and 11, and RBM QTL on chromosomes 2, 3, 9 and 12, were introgressed into cultivated tomato using backcrossing and marker-assisted selection (MAS) with DNA markers linked to the QTL to select progeny lines containing different combinations of the desired QTL. BC3S1 lines containing different combinations of 1 to 4 RLB QTL from *L. hirsutum* were identified using MAS, then field-tested and assayed in disease screens in 2001. Lines containing RLB QTLs on chromosomes 5 and 11 tended to be most resistant, and further testing is in progress. BC1S2 progeny with 1-3 RBM QTL from *L. cheesmanii* were identified with MAS and field tested in 1999; *L. cheesmanii* alleles at RBM QTL on chromosomes 2, 3 and 9 conferred resistance in an *L. esculentum* background. Near-isogenic lines (NILs) for RBM QTL on chromosome 2 and RLB QTL on chromosomes 3, 4, 5 and 11 have been developed. These NILs were used to derive sub-NILs that will be field-tested in 2002 to fine map the resistance loci to smaller chromosomal segments and determine the location of loci involved in linkage drag. Three QTLs for CT (as measured by turgor maintenance) from *L. hirsutum* are being individually introgressed into *L. esculentum* using MAS during backcrossing to develop NILs. Sub-NILs will be derived from the NILs and used for fine mapping of the 3 CT QTLs, as well as for further phyiological studies to characterize turgor maintenance under chilling. A subset of breeding lines derived from *L. pennellii* and *L. hirsutum* that were field tested in 2000-2001 exhibited significant resistance to aphids during both years; these lines are suitable as donor parents for further breeding efforts.

Impact: Genes controlling agriculturally important traits that are present in wild species can be used to improve cultivated tomato for agricultural sustainability. For example, wild species' genes for resistance to diseases, pests, and chilling can permit the development of cultivars that require fewer chemical inputs, reducing environmental impacts and enhancing economic returns to the grower.

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

Key Theme: 1.26 Plant Germplasm
Title: Genetic Improvement of Beans (*Phaseolusvvulgaris* L.) For Yield, Disease Resistance and Food Value

Description: Common bean is characterized by a narrow genetic basis and relatively low yields. This research aims at increasing the genetic diversity of the gene pool available to breeders and to identify factors promoting outcrossing, the latter also as a prerequisite for the future development of a hybrid seed production system. The following activities related to broadening the genetic basis of common bean were pursued. First, field evaluation in Mexico of two recombinant populations resulting from crosses between a wild and a weedy bean and a black-seeded domesticated bean was completed. Field evaluations for two inbred backcross populations resulting from the same crosses were conducted for a second year. The results of the latter evaluation are quite hopeful in that they seem to suggest that it will be possible to derive progeny lines with yields significantly higher than that of the domesticated recurrent parent, while maintaining some of the essential domesticated traits. Concurrently, a molecular linkage map based on AFLP markers was constructed in each of the two populations. In the coming months, a QTL analysis will be conducted to locate the major genetic effects on the common bean linkage map. These maps will be the first maps of the domestication syndrome of common bean resulting from within-gene pool crosses. Second, a collaborative project was conducted to map seed

color genes or markers tagging those genes onto the common bean linkage map. The following loci were mapped in the core mapping population developed in the BAT93 x Jalo EEP558 recombinant inbred (BJ RI) population: seed color genes G (linkage group B3), V (B6), C (B8), and Gy (also on B8) and seed color pattern genes Z (B3), T (B9), and Bip, Ana, and L (all on B10). These markers join previously mapped color genes (B and Rk on B2, P on B7). Thus, most of the seed color and color pattern genes are located on different linkage groups, thereby segregating independently.
This type of segregation may explain the high levels of diversity for seed color types observed in segregating populations and in the bean germplasm. None of the genes mapped appear to co-segregate with known loci involved in the anthocyanin pathway, phenylalanine ammonialyase, chalcone isomerase, and chalcone synthase. Either these color genes involve other enzymes of the pathway or they are regulatory rather than structural loci. Third, we have been converting RFLP probes into sequence tagged sites (STS). These probes are important because they anchor the current core linkage map in the BJ RI population. The purpose of this activity is to facilitate the use of these markers by a broad range of researchers by converting these markers into PCR-based markers. Fourth, we have been analyzing the marker diversity data from wild and domesticated bean populations from Mexico. These data provide evidence of changes in the degree of linkage disequilibrium (LD) during domestication. Specifically, there appears to be an increase in LD during domestication, which can be attributed to either one or more genetic bottlenecks or to selection. Separate data showing extensive gene flow between wild and domesticated beans suggest that this increase in LD is due to selection. However, additional data are needed to obtain a more definitive answer.

Impact: The use of wild beans to broaden the genetic basis of common bean will have substantial effects in bean breeding by opening up a whole new segment of the germplasm. This will allow breeders to introduce additional genes not only for disease and pest resistance, but also - most importantly - for yield. The markers developed here will assist in transferring those traits and simultaneously eliminate undesirable traits from the wild parent.

Funding Source: Hatch Multistate Research and State
Scope of Impact: CA, CO, FL, GA, ID, MI, NE, NYC, ND, OR, PR, WA, WI, SDA/ARS, WI, MT

Key Theme: 1.26 Plant Germplasm
Title: Classical and Molecular Genetics of Lettuce

Description: This project involves the classical and molecular genetics on lettuce with an emphasis on disease resistance. It spans classical plant breeding to basic molecular biology and includes the latest genomic approaches. It will increase the efficiency of lettuce improvement. It will also increase the use of genetic approaches to disease control and decrease the reliance on chemical applications. This project encompasses both classical genetics and biotechnology approaches to lettuce improvement. We are introgressing multiple genes for resistance to several diseases, particularly downy mildew, from wild species into leafy lettuce types as well as crisphead types. These are being combined with other genes for resistance to corky root and lettuce mosaic. 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. Resistance genes are being also mapped and introgression will be aided by linked molecular markers.

Molecular marker analysis of resistant wild germplasm demonstrated a large number of distinct haplotypes with little overlap indicating that there are many resistance genes available for introgression. We are also mapping genes of agricultural importance, particularly root 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 1,500 molecular markers as well as disease resistance and loci of horticultural importance. This is accessible over the www in a database focused on Compositae species (http://compositdb.ucdavis.edu/).

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

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

Key Theme: 1.26 Plant Germplasm
Title: Agricultural Change, Crop Diversity and Crop Genetic Resources

Description: Analysis continued on data on diversity in California orchards as well as on data gathered in Turkey on wheat and Mexico on maize. Evidence of increasing diversity in peaches in California was compared to traditional agricultural practices in Mexico. The purpose was to investigate the differences between a highly developed farm sector and a relatively under-developed one that maintains important components of crop evolution. Attention was increased to identify the role on non-environmental factors in determining crop diversification. A case study of linkage between kinship and diversity in upland rice in Vietnam was completed. New theoretical work on the issue of local adaptation of crops was undertaken. Analysis of the management of genetic resources as part of the public domain continued.

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

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

Key Theme: 1.26 Plant Germplasm
Title: Systematics Studies of Horticultural Crop Plants and Their Wild Relatives

Description: The evolutionary relationships among many horticultural crop plants and their wild relatives remain poorly understood. The purpose of this study is to add to a growing body of molecular genetic data that can help elucidate relationships in several plant groups that include important

horticultural crop species, and to use the information to revise classifications of those groups as necessary. Results from our phylogenetic analyses of DNA sequence variation in chloroplast matK and trnL-trnF genes across Rosaceae have been accepted for publication. We have continued to investigate the phylogenetic utility of several protein-encoding nuclear genes in the family. A collaborative project with a University of Connecticut researcher to examine patterns of co-speciation between actinorhizal species of Rosaceae (members of the genera *Cercocarpus, Chamaebatia, Cowania, Dryas*, and *Purshia*) and the nitrogen-fixing actinomycete bacteria (Frankia spp.) with which they form symbiotic relationships, has been funded by the National Science Foundation. Preliminary work on this project has included collecting root nodules from several species in California and New Mexico and proceeding with gathering molecular data to generate a phylogeny for the plant species in this group. A graduate student has proceeded with phylogenetic and biogeographic studies of the tribe Neillieae, while another graduate student continued his work on Prunus. A visiting scientist from Spain working has completed collaborative work in our lab on variation among cultivars of almond (*Prunus dulcis*) and peach (*Prunus persica*) and related species using simple sequence repeat (SSR) markers.

Impact: As a result of studies in our lab and several others, we are developing a detailed understanding of evolutionary relationships among taxa of Rosaceae, which include the majority of temperate fruit crops. Studies of variability among and within species of Prunus have relevance to plant breeding and germplasm conservation for these crops. Our examination of co-speciation between actinorhizal Rosaceae and nitrogen-fixing Frankia will have important implications for our understanding of the evolution of symbiotic nitrogen fixation and of symbioses in general.

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

Key Theme: 1.26 Plant Germplasm
Title: Wheat Breeding and Molecular Genetics

Description: The overall goal of this research is to develop new varieties of wheat with good agronomic performance and end-use properties. Variety releases: Certified seed of the released variety Kern was produced and distributed. The PVP application process was completed. Best lines: Two red lines and one white line were advanced to the 2001 Regional Wheat. Yield trials: 687 common wheat and 571 durum-wheat yield trial plots from preliminary, advanced, and elite experiments were evaluated and harvested.

Based on yield, disease resistance and quality the best lines were advanced to Elite trials in three locations (Davis, Sutter and Kings). Observation Plots: 341 entries from bulk breeding head-rows and from CIMMYT materials were grown for observation in Davis. Seventy-two lines were tested for protein at the quality laboratory at the California Wheat Commission. Additional 35 common wheat lines were tested for Polyphenoloxidase activity (PPO), and 105 durum lines were tested for semolina color in the UCD laboratory. Based on these tests, 56 lines were selected. Evaluation of headrows: 157 families including 18,696 head-rows were evaluated this year representing a 50 percent increase from previous year. From this trial, 556 rows were determined to have satisfactory agronomic appearance and disease resistance and were advanced to Observation yield trials. Addition of new lines and early

generation materials: One hundred and fifty new five hybrid combinations were made in January, 2000. Backcrossing for the high grain-protein gene was completed in six varieties of common wheats and one variety of durum wheat, and advanced 2 generations in other 15 lines. Backcrossing of high molecular weight glutenins was completed in 4 lines and advanced one generation in another line. The incorporation of a low molecular weight glutenin with positive effect on gluten strength was advanced one generation in 4 lines. Two more generations of backcrossing were advanced for five rust resistance genes in Kern, Yecora Rojo, Anza, Express, RSI5, UC1037, UC1128, UC1107 and UC1041. Backcrossing of Lr47 in six recurrent parents was completed and seed was increased in the greenhouse and planted in the field. Backcrossing of linked resistance genes Lr37 and Yr17 was completed in six different genetic backgrounds. Two additional generations of backcrossing were completed for stripe rust resistance gene Yr15.

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

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

Key Theme: 1.26 Plant Germplasm
Title: Potato Cultivar Selection, Evaluation and Development

Description: In 2001, official releases for Mazama and Winema were published in cooperation with Oregon State University. Management guidelines were published for CalWhite and CalRed. Research emphasis was on cultural management (nitrogen rate, spacing) of new varieties and clonal selections of Russet Norkotah. Results of these multi-year experiments are preliminary. A "new" potato project was initiated, with emphasis on production and marketing of specialty varieties and products. UC conducted selection and evaluation trials on long whites, russets, chippers, reds, yellow flesh, and specialty potato types.

Collaborative projects included the Western Regional Trials for russets, reds, chippers; Southwest Regional Trials (Colorado, Texas, California), national Snack Food Association chip trial, national late blight resistance screening trial, European private company yellow trials, and the California Potato Research Advisory Board (potato industry) trials. Extensive trials were conducted in Kern County and Tulelake/Klamath Basin; numerous smaller trials were conducted in cooperation with local Cooperative Extension and growers. Best performing clones and new cultivars included AC87079-3Ru, A8893-1Ru, CO93016-3Ru, TXNS223, A9014-2RU, AC89536-5RU, AC92009-4RU, NDTX4304-1R, Winema, NDTX4271-5R, CO89097-2R, NDO4323-2R, Platina, Carlita, Vivaldi, Ilona, Satina, CAPC15, B0766-3 and A04326-5W. No late blight was recorded in the resistance screening trial in 2000.

Impact: The number of new varieties that were grown by California potato growers continued to increase. More growers began specialty production and alternative marketing systems. These changes allow the California potato industry to maintain their market share with higher quality, higher value varieties.

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

Key Theme: 1.26 Plant Germplasm
Title: Grape Rootstock Breeding For California

Description: A portion of the UC Davis grape breeding program addresses the soil-borne pests and diseases confronting California viticulture. The primary foci are nematode resistant rootstocks for sites with few rootstock alternatives, and resistance to fanleaf degeneration. Three fanleaf degeneration field trials with advanced Vitis rupestris x Muscadinia rotundifolia selections have up to three years of fruiting data. These selections are now becoming infected and several look very promising. Infection was expected and these field trials are designed to test the ability of selections to induce tolerance to fanleaf infection in the scion (previously observed in a related rootstock, O39-16). Seven years ago we created about 5,000 seedlings with the objective of combining multiple sources of root-knot and dagger nematode resistance to produce broadly and durably resistant rootstocks. Over 100 rooted well and were advanced to nematode screening against *Meloidogyne incognita* Race 3, two Harmony aggressive strains (one *M. incognita* and the other *M. arenaria*), and *Xiphinema* index about two years ago. Thirteen of these selecitons resist all of four nematodes and will go to field testing in San Joaquin Valley vineyards declining to nematode complexes. They are also being evaluated against combinations of these nematodes to determine whether resistance will breakdown. We are finalizing a genetic map for *Vitis rupestris* x *Muscadinia rotundifolia* from an F2 progeny of 116 individuals and have about 500 AFLP, RAPD and SSR markers on 19 linkage groups. Preliminary X. index resistance screens of the population placed this trait on linkage group 1. This F2 population has been replicated and is being retested for X. index resistance prior to efforts directed at identifying resistance genes.

Impact: We are producing new nematode and phylloxera resistant rootstocks that will allow grapes to be grown where these pests limit viticulture. These new rootstocks will decrease the need for soil-applied pesticides and allow grape culture when these pesticides are restricted. Our efforts to identify pest resistance genes will optimize breeding progress and lead to effective genetic engineering.

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

Key Theme: 1.26 Plant Germplasm
Title: Adaptation and Quality of National and International Garlic Varieties.

Description: There is no doubt about the geographic and climatological conditions of the state being conducive to developing good garlic yield and quality. Nevertheless, there are only two major garlic "varieties" produced throughout California, the same ones that visitors can see during the annual "Garlic Festival" in Gilroy. In comparison, in Bern, Switzerland, they celebrate annually in November a public festivity call the "Traditional Onion and Garlic Market", where an average visitor can see a display of at least 500 different varieties of onion and garlic. A California CE specialist has evaluated a world collection for several years at UC Davis. Some of these introductions appear to have cultural adaptation to California; however, quality has not been fully evaluated. The objectives for this

research project were: A) Evaluation of the adaptation and quality of several international garlic clones or varieties; B) Provide crop diversification for the growers, the existing market, gourmet stores, and other consumers; C) Study the consumer awareness and evaluation of the several clones/varieties introduced. We successfully planted the parcel six consecutive years, spread on a lot size of approximately 0.5 acres. The collection consists of 240 varieties: 213 accessions from USDA, 5 varieties developed for California, and 22 UCD experimental varieties. The vegetative material comes from 34 different countries of origin. We planted some materials in replicated units, others in single observational parcels. The trials have three harvest dates: early, intermediate and late varieties. Data collected and (to be) evaluated: variety/clone yield and quality, botanical classification, anatomical characteristics, yield and quality, bulb shape, number of cloves per bulb and distribution, flavor, and pungency. Extension Methods: 1998, 1999, 2000 and 2001 Garlic Field Days at BAREC with a full 5 hr agenda including speakers, field displays and garlic tasting targeting growers and garlic industry. During 1998, 1999, 2000, and 2001, an informational booth and display of sample varieties in the 3-day "Garlic Festival" at Gilroy, targeted more than 300,000 people attending the festival. Upon request, we sold and mailed 14 informational packages on "How to Grow Garlic". Results: An average of 40 growers and garlic industry related personnel attending the annual field days. An average of 500 people stopped and obtained information at the booth in the "Garlic Festival" each year. We have identified at least 27 clones with potential in the area. After the rust screening conducted on 1999, some growers switched to "new" varieties.

Impact: More growers in Santa Clara County are growing "Specialty Garlic", and the area of garlic production increased from 350 acres (1999) to 1,200 (2001). Consumer awareness of garlic from nutrition and health stand points is growing, testified by multiple magazine and newspaper articles on the subject. The choice of specialty garlic makes agriculture more profitable for garlic growers.

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

Key Theme: 1.28 Plant Production Efficiency
Title: Freeze Damage and Protection of Horticultural Species

A. Flower Differentiation in Olive and Almond: We are investigating aspects of flower differentiation in olive and almond. Our work has focused on variation in the timing of floral transition and floral differentiation events among locations, cultivars and years, and within individual trees during a given year. Within-tree variation was shown to be much greater than the literature on the subject would predict. Variation among locations over a four degree latitudinal range was not predicted by position along the north-south gradient. Variation among years was highly significant as expected. Efforts to model floral differentiation as a function of time from bloom either as calendar days or degree-days were unsuccessful due to the high within-tree variation. We are currently attempting to dissect the factors leading to within-tree variation. Our investigations focus on spur autonomy, spur position on the tree, bud position on the spur and photosynthate flux within individual spurs. Efforts to identify molecular markers for floral initiation and development events in almond continue. One goal is to find homologs to Arabidopsis genes APETELA (ap1) and/or LEAFY (lfy) which are associated with early events in floral initiation. Our intention is to use the homologs to the Arabidopsis genes to localize temporally the early initiation events.

Impact: Results will provide the ability to predict timing of floral initiation in buds. This information is important in orchard management decision-making. In olive, especially, previous workers disagree wildly on the timing of floral initiation with estimates ranging over six months. In almond, the timing of floral development events may predict bloom phenology and provide useful insights into avoiding frost damage during bloom. Our results will better inform orchard managers on the precise phenology, and enhance production efficiency.

B. Fruit and Nut Crops: The process by which ice nucleation active bacteria become established on emerging flowers of pear was studied by making frequent measures of bacterial population size on cohorts of flowers that opened at different times, as well as by inoculating flowers with different bacterial strains at different times after they had opened. The initial immigrants to flowers, whether they were naturally dispersed to the flower or were spray inoculated into flowers, grew rapidly and because the dominant bacterial strain within 3 to 4 days. The proportion of such immigrants in flowers decreased steadily as the time between flower opening and inoculation increased.

To ensure that Pseudomonas fluorescens strain A506, an antagonist of ice nucleation and phytopathogenic bacteria, was among the first immigrants to a flower it was inoculated into flower buds before they opened using 0.5% Breakthru, an organosilicon surfactant with very low surface tension. Nearly all flowers that emerged form treated buds rapidly developed population sizes of this antagonist of over 1 million cells. The populations on such treated flowers often exceeded that of flowers that were spray-inoculated weekly with a similar bacterial suspension but without penetrating surfactant. Since pear flowers are not synchronized and open over a period of 4 weeks or more, the single application of antagonist to buds reduced greatly the number of bacterial applications that were needed. The incidence of freezing injury to pear fruit at harvest from radiative frosts of minimum air temperatures of about -4C shortly after bloom, was reduced on average 78% on trees treated with strain A506, irrespective of method of application. Phytotoxicity of flowers on surfactant-treated trees was observed only when flowers were open at the time of treatment.

Impact: Grower adoption of biological control of frost injury and fire blight disease of pear and apple is hampered by the need for repeated applications of antagonistic bacteria. Such treatments must often be applied when other crop protectants need to be applied, and are often not compatible as spray mixtures with such materials. The demonstration that an early-season application of antagonistic bacteria is effective, less cumbersome, and less expensive than current methods of application should greatly increase adoption of this strategy of frost control.

Funding Source: Hatch Multistate Research and State
Scope of Impact: CA, CO, FL, GA, IN, MD, MI, MN, OR, SD, UT, WA, WV, WI, USDA/ARS

Key Theme: 1.28 Plant Production Efficiency
Title: Reproductive Biology of Tree Fruit and Nut Species

Description: Elements of reproductive biology of tree-crop species are fundamental to crop productivity and quality. These include pollination biology and flower development. Basic parameters of pollination and flower initiation are being studied in almond, olive, walnut, and pistachio. We are investigating of pollen flow in walnut orchards. Pollen has a complex role in walnuts going beyond

fruit set. It carries the viral agent that causes blackline disease and high pollen loads lead to reduced set due to pollen-induced pistillate flower abortion. We are using SSR markers for paternity analysis to follow the movement of pollen in orchard situations. We are working on the action of streptomycin on pollen tube growth and fruit set. Streptomycin has potential use as a control agent for walnut blight (Xanthomonas campestris pv. juglandis) but causes fruit drop. Our investigations suggest that this is a consequence of streptomycin-induced inhibition of pollen germination and pollen tube growth which occurs in vivo but not in vitro. Streptomycin may be acting on pistillate tissues at the stigma or style. Strawberries produced in California coastal growing regions are subject to bronzing, a disorder at the surface of the fruit that results in discoloration, tannin accumulation and unmarketable fruit. Anatomical investigations of strawberry fruits indicate that bronzing damage is consistent with sunscald injury. The cuticle is disrupted, the epidermal cell layer is destroyed and subsurface cells accumulate phenolic materials.

Impact: Results will provide a clearer understanding of the dynamics of pollen flow in walnut orchards. This information is needed to develop management strategies to manage blackline disease and pistillate flower abortion which are both related to walnut pollination. The work on streptomycin and fruit drop provides an understanding of the biological basis for the phenomenon and will be useful in developing control strategies for walnut blight. Strawberry bronzing results in high economic losses; our work suggests causes and possible control measures.

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

Key Theme: 1.28 Plant Production Efficiency
Title: Improving the Productivity of Crops Growing Under Abiotic Stress

Description: An estimated nitrogen (N) replacement value for 'Hass' avocado (*Persea americana* Mill.) was calculated for California. Annually approximately18 g N per tree was lost in leaf drop. A 10% increase in vegetative shoot and root growth and N stored in branches required 68 g N per tree. A yield of 45 kg fruit per tree removed 200 g N. An estimated 30% loss in N fertilization by leaching, volatilization, and fixation required 23 kg N/ha. Using these values and a planting density of 110 trees/ha, the calculated annual N fertilization replacement rate was 40 kg N to produce 12 tons of avocados. To protect groundwater from potential nitrate pollution, 'Hass' avocado growers in California divide the total annual soil-applied N fertilizer (56-168 kg/ha) into small applications made from January to November. No research had been conducted to test the efficacy of this strategy. There was concern that the amount of N in the individual applications may be too low to meet tree demand at some phenological stages. Two stages were identified for which N application at 56 kg/ha in a single application (double dose of N) significantly increased 4-year cumulative yield (kg fruit/tree) 30% and 39%, respectively, compared to control trees. In each case, more than 70% of the net increase in yield was commercially valuable large size fruit (178-325 g/fruit). The two phenological stages were: when shoot apical buds have four or more secondary axis inflorescence meristems present (mid-November); anthesis-early fruit set and initiation of vegetative shoot flush at the apex of indeterminate floral shoots (approx. mid-April). When the double dose of N was applied at either of these two stages, both kilograms and number of large size fruit averaged across the 4 years of the study were significantly greater than the control trees and alternate bearing was reduced. Time and rate of N application are

factors that can be optimized to increase yield, fruit size, and annual cropping of 'Hass' avocado. When N application rates were equal (196 kg/ha), time of application was the more important factor. Yield of 'Washington' navel orange (*Citrus sinensis* L. Osbeck) was increased by winter pre-bloom foliar applications of low-biuret urea or potassium phosphite. Summer applications of either fertilizer increased fruit size. Proper timing was important to achieve the desired outcome. The winter pre-bloom spray increased flower number and yield without reducing fruit size. The most effective application time was around irreversible commitment to flowering, approximately December 15 to February 15 in California. Summer applications of either urea or potassium phosphite were designed to extend the cell division stage of fruit development to achieve an increase in fruit size without increasing yield. The end of the cell division stage of fruit development is characterized by maximum peel thickness, which was experimentally determined to occur between approximately June 15 and July 27 in California. Urea was most effective in increasing fruit size when applied July 1 to 15; potassium phosphite required two applications, one in early May and one in early July.

Impact: Foliar-applied low-biuret urea and potassium phosphite are cost-effective management tools for increasing sweet orange (*Citrus sinensis*) fruit number or fruit size at harvest. A grower can achieve either production goal by selecting the proper application time. By properly timing the application of soil-applied nitrogen, 'Hass' avocado (*Persea americana*) growers can increase yield and fruit size and reduce alternate bearing. The treatments result in a net increase in income to the grower.

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

Key Theme: 1.28 Plant Production Efficiency
Title: Agronomic Practices Affecting Yield, Forage Quality, and Sustainability of Irrigated Alfalfa

Description: This project is an integrated research and extension program concerning alfalfa and other harvested forages grown in California. These collectively occupy more than 20 percent of the irrigated acreage, with alfalfa alone over 1 million acres, currently economically the most important field crop in the State. An MS thesis project was completed, modeling the growth of alfalfa in relationship to yield and quality of alfalfa in different environments, characterizing growth curves. Additionally, a decision model for the yield quality tradeoff in alfalfa was devised. Behavior of California markets was characterized, and the maximum potential allowable yield reduction or quality gain with cutting schedule was described. This data should enable prediction of optimum economic cutting schedules for different California environments. Yield and stand persistence of alfalfa and berseem clover cultivars were quantified at 7 sites in California and results published in the Agronomy Progress Report and electronically (http://alfalfa.ucdavis.edu).

These studies span a wide range of environments, including desert environments (8-10 harvests), Mediterranean environments (6-8 harvests), and intermountain environments (3-4 harvests). A 3-year study on overseeding older alfalfa stands with different forages including oats (Avena sativa), berseem clover, red clover (Trifolum pretense), and orchardgrass indicated that this practice increased or maintained forage yield, eliminating need for insecticides to prevent yield loss from the Egyptian alfalfa weevil (Hypera postica). However, overseeding did not prevent damage by the insect, and in the case of the grasses, lowered forage quality. Studies on the efficacy of the ANKOM fiber analysis

systems repeatability and accuracy were completed. Studies on the efficacy of using resistance blocks for soil moisture monitoring in relationship to alfalfa and pasture production were summarized, and an MS Excel spreadsheet developed for management of irrigation water (see http://alfalfa.ucdavis.edu). This should enable growers to be more careful with water applications. A detailed publication of a study of the environmental interactions of alfalfa with wildlife and the environment was completed, and mitigation measures for preventing off-site movement of pesticides used in alfalfa reported. Alfalfa is host to about 27 percent of the naturally-occurring wildlife species in California, from a review of the California Habitat Relationship model. Studies were initiated on alternative forages in 2001, including field studies of tef (Erogrostis tef), soybean (Glycine max), cowpea (Vigna unguiculata), ryegrass (Lolium spp.), sudangrass (Sorghum bicolor (L.) moench) and foxtail millet (Setaria italica), and various perennial grasses (e.g. tall fescue, Festuca arundinacea, orchardgrass, Dactylis glomerata). A new field study on the interactions between cutting schedules and varieties of alfalfa was initiated in 2001 and will likely continue for three years.

Impact: The differences due to improved alfalfa varieties are worth $50-$100 million/year due to increased yields or pest resistance. Our economic analysis of cutting schedules has enabled growers to save or gain between 12 percent and 30 percent due to improved decisions on cutting schedules. Mitigation measures we developed may prevent pesticide runoff, helping to improve the quality of polluted surface waters.

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

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

Description: An increasingly competitive marketplace is pushing growers to maximize early returns by increasing planting density, but these high-density plantings may have negative effects on long-term productivity. This project examines the role of irrigation, nutrition and pruning practices on maintaining sustainable productivity in high-density plantings. Objective 1- There were no significant effects of the high limb pruning treatment on midday canopy light interception at any time during the season. The largest factor affecting the canopy light interception was the date of hedging. Trees spaced at 15.3 feet tended to have higher water potentials than trees spaced at 11.5 feet and this might explain a tendency toward higher canopy light interception and higher yields with the wider spaced trees.

There were no significant treatment effects on yield. First year results were encouraging in that yields were not negatively impacted by the high limb pruning treatment. The plan is to continue the pruning treatments for the 3 years it is anticipated will be required to lower canopy height without impacting yield. Objective 2- The objectives of this aspect of the project are to quantify the dynamics of spur renewal, fruitfulness and longevity and to determine how these are influenced by nitrogen and irrigation. Tags were placed on 2400 spurs which will be monitored throughout the anticipated 6 years of the study to quantify the impacts of treatments on spur longevity. After late July, the two moderate irrigation treatments led to a significant decrease in canopy light interception. This is most likely because the midday stem water potentials in these treatments were consistently below -1.2 MPa which is the level at which vegetative growth is impacted. There did not appear to be any treatment impacts

on yield in the Nonpareil with the treatments all yielding within 75 pounds per acre of the control. Nut size was significantly smaller on both the moderate nitrogen and moderate irrigation treatments. In order to get smaller nut size and equivalent yields, there must have been more nuts maintained on these trees in the year of treatment imposition. This suggests that differences in canopy light penetration may have influenced nut retention. Objective 3- Codling moth is the key pest in walnut orchards and requires successive intervention through the season to suppress damage levels at harvest. This work was initiated to look at the relationship between leaf water potential and nut susceptibility to provide growers with an opportunity to maximize the natural resistance of nuts to codling moth damage through irrigation management. The experiments were conducted in two unsprayed commercial orchards. Irrigation treatments were imposed by changing/and blocking sprinkler heads. Nuts were sampled at five times during the season and used for in laboratory codling moth susceptibility assays. In general, after treatment differences in water potential were seen, the susceptibility of the nuts to codling moth attack varied as well with lower water status correlating with decreased codling moth susceptibility. Since both of the orchards were moderately to severely stressed, we did not have fully watered controls. Natural codling moth damage in both orchards was very light, particularly for unsprayed orchards.

Impact: Developing pruning methods that maintain productivity in high density plantings will help lead to improved productivity with decreased inputs. The first year results of this project are promising. If deficit water management can be used as a tool for managing these dense plantings while decreasing the susceptibility of these orchards to pests, the reliance on fossil fuels for orchard practices such as irrigating, pruning tower operation and spraying operations can be reduced. In addition, the use of chemical pesticides can be minimized leading to reduced potential for environmental impacts. These practices would provide benefits to growers (decreased costs of production and reduced pesticide exposure) and to consumers (products with the lower pesticide residues they desire).

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

Key Theme: 1.28 Plant Production Efficiency
Title: Alternative Trellising Systems for Chardonnay and Merlot Vineyards in the Central Coast

Description: Narrow row spacing, coupled with vertically shoot positioned (VSP) trellis systems are used extensively in coastal wine grape production regions. When the vigor of the vines are low to moderate the VSP trellis results in shoot and cluster exposure that optimizes fruit and wine quality. At higher vigor levels VSP systems can increase canopy shade and can reduce bud fruitfulness and wine quality. Canopy separation is an effective method to deal with canopy shading. Horizontal divided system are effective in reducing canopy shade but cannot be used with narrow row spacing and are not as adaptable to machine harvesting. Vertically divided system such as the Scott-Henry and the Smart-Dyson have been proposed to improve the canopy microclimate for higher vigor sites planted to narrow row spacing. The objective of this study was to compare the performance of bilateral cordon

trained, spur pruned Chardonnay and Merlot grapevines trellised to the vertically shoot positioned trellis system (VSP), the Smart-Henry trellis system (SH) and the Smart-Dyson trellis system (SD) and to characterize the differences in light interception of the canopies and the vegetative and fruit growth differences between the trellis systems. At the time of the experiments establishment it was the first attempt to compare these trellis system in a replicated field trial in California. There has been a concern by wineries that use of these divided canopies would result in uneven ripening of the fruit and reduce potential wine quality. Results: Primary leaf size, as well as primary, lateral and total leaf area per vine, did not differ significantly among the treatments. VSP vines had greater leaf layer numbers in the fruiting zone compared to SD and SH vines, and these treatments had greater amounts of sunlight in the fruit zone compared to the VSP treatment. Vine yield components were similar among the treatments in both cultivars. Compared to upward-oriented canopies, trends toward reduced yields for downward-oriented canopies were observed in Chardonnay, while the opposite was true for Merlot. Pruning weights and pruning weight ratios were similar among the treatments in both cultivars. Fruit on downward-oriented shoots on the SH and SD systems generally ripened more slowly compared to shoots oriented upward. At harvest, however, no significant differences in combined fruit (upper and lower canopies) soluble solids, titratable acidity and pH were observed among the treatments in either cultivar. Wine lots made from each treatment demonstrated that there were significant sensory differences in wine produced from the trellis systems. For Merlot there was a significant reduction in the vegetative character of the wines in the SD and SH when compared to the VSP trellis.

Impact: The results of the this experiment have shown growers and wineries that large maturity differences between upward and downward canopies of the SD and SH systems are not creating a loss in fruit ripening uniformity. There is an improved light environment with the use of SD or SH which has resulted in higher yields and a reduction in vegetative flavors in the Merlot wines when compared to the VSP. There has been a significant increase in the use of the SD trellis in the central coast winegrape growing region.

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

Key Theme: 1.29 Precision Agriculture
Title: Develop and Assess Precision Farming Technology and Its Economic and Environmental Impacts

Description: Research during this period continued to focus on the application of systems analysis methods to the development and implementation of site-specific management technology for California production systems. In the application of remote sensing methods to cotton production, we carried out the first year's full experiments in site-specific soil amendment application. These experiments compare variable rate application methods with the traditional method in which a fixed rate of amendment is applied. The experiments involve variable and fixed rate gypsum and sulfuric acid. Preliminary results indicate no significant yield differences, but in these experiments the amendments often take a few years to have an effect. In rice management we carried out our first tests of the relationship between spatial distribution of nighttime water temperature and rice yield. Water temperatures and yield were measured in two fields. In addition, we have begun experiments on the

variable rate application of nitrogen in rice. We are comparing fixed and variable rate methods to determine if there is an economic savings associate with variable rate N application.

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 Multistate Research and State
Scope of Impact: AL, ALX, CA, GA, IN, KY, LA, MS, MO, NC, OK, SC, TN, TX, USDA/ARS, DOE, AR

Key Theme: 1.31 Risk Management
Title: Pesticide Applicator Safety Training Seminars in Spanish and English

Description: The objective of this program is to ensure safety of pesticide applicators and the public by designing and implementing continuing education on the safe and effective use of pesticides. The program has evolved from meetings originally held in 1989 and 1990 when we cooperated with the UCIPM project to develop hands-on demonstrations for pesticide applicator safety training. In 1990, we offered large group training sessions that originally featured videos as well as lecturers covering topics such as cholinesterase testing, worker health and safety, respirator and eye protection, decontamination, and record keeping. Topics also included respirator fitting and use and an in-depth review of the labels of commonly used pesticides. For these applicator training seminars, two California advisors incorporated and adapted parts of the 1989-90 programs and provided educational materials and hands-on training to clientele in both English and Spanish. In San Diego County, there are many applicators who do not speak English and who need this type of training. The program format was modified and improved and topics now include labels, first aid, laws and regulations, nozzles, calibration, mixing and loading, leaks and spills, and cleanup and disposal. In addition, "Jeopardy" and "La Lotteria" were utilized as game sessions for review of the safety information. Demonstrations, props, and handout materials were designed and prepared. The targeted audience was applicators in the floriculture, nursery, and landscape industries. We advertised the program by designing and mailing flyers and through association newsletters. An on-going one-day training program has been developed and delivered successfully two to four times per year from 1994 to 2001. Audience size ranges from 25 to 125 for each event. The seminars provided information on safe handling and use of pesticides to both English and Spanish speaking pesticide applicators. Spanish speaking clientele ranged from one-third to two-thirds of the attendance.

Impact: The pesticide safety information is disseminated in a hands-on, small group format, which has been well received. This extension method has had much greater impact and information transfer than the traditional seminar/lecture format. The workshops have received very high evaluations by both the participants and growers who send their applicators. The participants comment that they have a greater understanding of how to do their job and how to do it safely. They repeatedly comment that they like the interactive nature of the 'hands on' format, in part because they are able to learn from

other participants, as well as the course instructors. The program also provides a good model for employer-based training programs for applicators. Growers report an increased awareness in pesticide safety by the applicators and improved compliance with pesticide regulations by the applicators. They have also reported significant improvements in applicator technique and care of equipment as a result of these workshops. One grower indicated that he believed that the money spent for the training workshops was recovered very rapidly due to reduced pesticide waste and improved coverage. After an instructor has assisted in a training workshop, he/she receives a complete set of curriculum in both English and Spanish. This allows the trained instructors to conduct their own training sessions, further extending this information. We now have a pool of trained instructors we use for these intensive hands-on workshops. In fact, in 1998 these instructors conducted the full set of curricula and trained more than 60 people without our direct oversight. This demonstrates the value of using these trainers to extend this information.

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

NATIONAL GOAL 2

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

UC-ANR's Human Resources Programs Covering:

- **Human Health and Nutrition - Food Borne Diseases**

According to estimates from the Centers for Disease Control, approximately 75 million Americans last year suffered from some type of food-borne illness. 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 programs and research projects have resulted in agricultural producers who have a greater understanding of their own products and are better able to share this information with consumers; food processing being used to achieve specific and desired physical and chemical states in food products; an understanding of how the color of young red wines relate to their phenolic composition providing a basis for improved grape growing and winemaking; identification of sources of emulsifiers from natural sources to provide enhanced emulsifiers that will be economical for use in the food industry; the availability of alternatives to methyl bromide fumigation to help reduce worker safety issues and maintain the competitiveness of U.S. agriculture; edible coatings to improve food quality and food safety and minimize packaging cost; and an educational opportunity for parents to learn about nutrition and food safety needs of their children and how take-along lunches can contribute to children's health.

Fifteen local extension programs were delivered in this area. In addition, four statewide collaborative workgroups composed of both AES and CE academics planned and conducted research and extension projects. California academics published 4 peer-reviewed articles to address Goal 2 last year.

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 2001-2002Allocated Resources

Extension Federal Funds (Smith Lever 3 b&c)	Extension State Match	Research Federal Funds (Hatch)	Research State Match
$19,360	$1,374,706 [7.91 FTE]	$226,003	$4,841,721 [19.59 FTE]

Key Theme: 2.01 Food Accessability and Affordability
Title: Food Systems, "Reasons for the Seasons"

Description: According to the agricultural census, less than 2 % of the population is involved in agricultural production. Many of the remaining 98% possess little knowledge about where their food comes from. Without this basic understanding, consumers often make poor decisions that impact the environmental quality of their area, the sustainability of local food systems and their general health and well-being. There exists a need to educate local consumers on their local food supply and the impact their decisions can have on the social, economic, and environmental health of their community.

To better help consumers and producers link in their participation in the local food system, the "Reasons for the Seasons" project was conceived and consumer education and agricultural marketing support materials were developed. The program was further refined. Over fifty one-sheet answers on local produce and products were posted on the Placer and Nevada County UCCE website. The WIC program also uses the sheets at Farmers' Markets and other locations where consumers need nutrition and food point-of-purchase information. Educational sessions on the materials and the campaign have been presented at the PlacerGROWN Farm Conference (two years) and the State Small Farms Conference and written about in several popular and extension publications. A monthly newspaper column, *'Tis the Season*, ran in 1999-2000 in the Roseville Press Tribune, focusing on tips for purchasing, safe storing, preparing, and serving locally grown foods.

Hundreds of the "Reasons for the Seasons" one-sheet-answers are distributed through direct marketing outlets, through the UCCE office, and off the web. The sheets are also linked to the PlacerGROWN website. The "Reasons for the Seasons...A Consumer Education Ag Marketing Program" received first place honors at the State and Western Region, and placed third nationally in NAEFSA awards program.

Impact: The "Reasons for the Seasons" campaign has educated local consumers on the economic, social, and environmental benefits of buying local agricultural products. Agricultural producers have a greater understanding of their own products and are better able to share this information with consumers. This innovative approach to consumer education and support for local food systems is being used as a model for other communities (Oregon, Washington, and New England States) interested in addressing these same issues in their communities.

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

Key Theme: 2.02 Food Handling
Title: Improvement of Thermal and Alternative Processing For Foods

A. Air Impingement Systems: Most of the impingement systems used in the food industry utilize jets with a circular opening. However, jet systems with a two-dimensional opening, and arranged parallel to each other, promise to have a more uniform convective heat transfer coefficient distribution. This may result in uniform cooking, freezing, or thawing characteristics while applying impingement systems. In the present work, a comparative study of flow distribution patterns from an array of four circular-opening nozzles and a two- dimensional jet was conducted using flow visualization techniques. The jet was impinged on a flat metal surface. A Helium-bubble generation device in conjunction with a CCD camera system was used for the purpose of visualization. The relative spatial distribution of convective heat transfer from the two types of jets was studied at jet exit with airflow velocities of 15, 20 and 25 m/s. A previously described setup for measurement of spatial heat transfer coefficient was used for the temperature ranges of 25 C to 80 C. For the same exit air velocities, the laminar jets show a slightly lower convective heat transfer coefficient (averaged over the entire area) but a more uniform heat transfer coefficient distribution pattern as compared to the array of circular jets. The flow patterns indicate that the lower convective heat transfer may be attributed to the reduced turbulence in the boundary layer while using the two-dimensional jet as compared to the circular jets where the jets interact with each other to increase the turbulence effect. The results show that with a suitable optimization procedure, two-dimensional jets may give a much better product quality than conventional round jets due to uniform heat transfer coefficient distribution.

Impact: Air impingement systems have been used in various industrial applications such as textile and paper drying and electronic cooling. More recently, air impingement systems are developing as a promising thermal processing technique for industrial food processing operations. In our studies, we are developing new design information that will allow uniform heating/cooling of foods.

B. Measurement and Prediction of Engineering Properties: Objective A: The difference between the chemical shift of two peaks in the NMR spectrum of ethylene glycol is used as a temperature measurement. Chemical shift imaging data is acquired and yields maps of temperature variations during cooling and heating of the fluid in a standard NMR tube. Temperature can be accurately measured to 0.1 K and the data show thermal gradients as large as 1 K are observed even during steady state operation. Objective C: The time-dependent internal moisture distributions in lasagna pasta were experimentally evaluated as a function of cooking time and holding time. During the holding time, changes in the moisture distribution were followed using a magnetic resonance imaging (MRI) spin-echo based pulse sequence. Immediately after cooking the moisture distribution was highly nonuniform for all samples. The moisture content was high on the surface of the pasta and low in the central plane. This gradient equilibrated over time as the moisture redistributed. Objective D: This work included a transport-based model for the redistribution of moisture in the absence of surface hydration or dehydration. The driving force for moisture redistribution is the initial concentration gradient at the onset of equilibration. The moisture redistribution was modeled using a one-dimensional Fickian diffusion equation; values of the diffusion coefficient ranged from 0.8 - 1.6 x 10-7 cm2/s.

Impact: Food processing is used to achieve specific and desired physical and chemical states in a product. The measurement and prediction of engineering properties, coupled with mathematical

models based on transport mechanisms, facilitates the development of improved processing techniques and higher quality products.

Funding Source: Hatch Multistate Research and State
Scope of Impact:CA, FL, IL, IN, IA, MI, MN, MO, NE, NJ, NYG, NYC, NC, ND, OH, OR, PA, SD,TX, WA, WI, Nat'l Ctr. for Food Safety and Tech., FDA, VA, ID, DE

Key Theme: 2.02 Food Handling
Title: Evaluation of Fruit Texture

Description: A laser Doppler vibrometer procedure has been applied to the analysis of fresh fruits and vegetables. The technique offers the potential for nondestructive, rapid and remote analysis of produce after harvest and during distribution to markets. It is recognized that commodity texture is a major component in consumer acceptance and is critical in imparting protection of fresh produce in transport and storage. But the measurements are difficult and time consuming hence there is very limited sampling actually conducted. Fundamentally the project has focused on the use of visco-elastic parameters as a means to understand what consumers perceive as quality and what structural components of commodities contribute of these parameters during ripening. We have shown that the total quantity of cell wall polysaccharides and starch decreased during ripening but more specifically the decrease in tissue elasticity was related to a decline in the average molecular weight of xyloglucan while the changes in viscosity were associated with depolymerization of pectin. To further resolve the rheological properties of fruit texture a stiffness coefficient was defined as the frequency of the second resonance peak and the fruit mass. When fruit firmness was analyzed using conventional techniques we found the values were highly correlated with the stiffness coefficient. We also found that a loss coefficient, based on two frequencies 3dB below the peak of the second resonance peak was correlated to the fruit soluble solids content. The early stages of fruit softening were related to the stiffness coefficient and the late stages of ripening related to the loss coefficient. The two values distinguished the internal properties of unripe and ripe fruit based on external measurements during which there was no tissue damage. The values determined by laser Doppler vibrometer were highly correlated with evaluation by human taste panels. The evaluation of fruit and vegetable texture is clearly important to the industry especially with the current emphasis on delivering fresh products to distant markets.

Impact: There is a need to determine tissue texture of fresh produce quickly and without damage. Such values representing the characteristics of texture would provide an important component for quality control and the assessment of tissues will allow the delivery of high quality nutritious products to market with less loss and damage. We have shown that tissue vibration characteristics (acoustics) offers such a means for assessment.

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

Key Theme: 2.02 Food Handling
Title: The Effects of Different Winemaking Procedures on the Phenolic Content of Wine

Description: During this year we have completed our major wine maceration trial in cooperation with three wineries, Wente Bros., Sebastiani Vineyards, and J. Lohr. The last vintage of wine was bottled and that lot is now undergoing analysis along with followup analysis on prior vintages. The analyses include chromatographic procedures along with colorimetric procedures. Results to date clearly show that the extended maceration and heat at the end treatments affect the extraction of tannins, while the rotary, enzyme and oak additions have modest and variable effects on phenolic content.

Impact: We show that a rarely used maceration procedure, heat at the end, has a significant effect which may be of great value in wine production.

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

Key Theme: 2.02 Food Handling
Title: The Role of Copigmentation in the Color of Red Wine

Description: The studies thus far, have addressed the development of the cofactors in maturing grapes and the behavior of copigmented color during various wine treatments by identifying the major copigmentation cofactors involved in the color of red wine, in addition to determining their abundance in the major wine grape culitvars. The general importance of copigmentation to the color is the economically significant cultivars, Sangiovese from Italy, and Tempranillor and Grenache from Spain. These cultivars are experiencing a renewed interest in California, and have been characterized as having poor color and color stability. The project continues to develop prediction methodologies for the level of copigmentation in wines, based on grape composition, by development the relationships between grape composition and wine composition, and between wine composition and copigmentation.

Impact: The findings have provided an understanding to how the color of young red wines relates to their phenolic composition. This major finding is important to both wine researchers and it provides a basis for improved grapegrowing and winemaking decisions.

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

Key Theme: 2.02 Food Handling
Title: Structural Bases of Biological Functions and Industrial Applications of Arabinogalactan-proteins

Description: This project is focused on the structure, function, and industrial applications of arabinogalactan-proteins (AGPs), carbohydrate-rich macromolecules found on the surface of probably every cell in every plant. As regards the function of AGPs, work in the current reporting period investigated the hypothesis that AGPs function in cell wall assembly. In particular, the hypothesis was that AGPs act as shuttles or chaperones that interact with pectins or hemicelluloses as these other wall polymers are synthesized in the Golgi apparatus, transported in vesicles to secretion at the plasma membrane, and then incorporated into the cell wall. In this work, we tested the action of AGPs by perturbing them with beta-glucosyl Yariv phenylglycoside, a synthetic agent that binds and aggregates

AGPs. The most important finding was that beta-glucosyl Yariv phenylglycoside causes massive deposition of matrix material at the plasma membrane-cell wall interface. These deposits are being investigated to determine if they represent improperly assembled wall polymers, and if AGPs in these deposits are bound to other polymers that might be cargo being shuttled by AGPs. Because an abundant polymer in these deposits is callose, a characteristic wound polymer, tests are also being performed to determine if beta-glucosyl Yariv phenylglycoside induces wound- or pathogen-like responses. As regards the industrial applications of AGPs, we are investigating the hypothesis that the valuable emulsifying activity of gum arabic is due to a subset of the molecules in the mixture that comprises this natural product. Many of the molecules in the gum arabic mixture are AGPs, and the hypothesis holds that a subset of these AGPs have covalently attached glycosylphosphatidylinositol lipid, and it is these lipid-modified AGPs, in particular, that are responsible for the emulsifying activity. One specific aim was to fractionate gum arabic and assay the resulting fractions for emulsifying activity and for the structural components of glycosylphosphatidylinositol lipid anchors. We developed a very effective fractionation based on preparing a concentrated emulsion of gum arabic with pure hexadecane and then floating this emulsion in a concentrated solution of potassium bromide. The creamy layer is collected from the surface, leaving the non-emulsifier components of gum arabic dissolved in the potassium bromide solution below. The mass of gum components recovered in the creamy layer amounted to 0.65-0.75% of the mass of total gum emulsified with the hexadecane, but this subset of gum molecules was enriched with eight to twelve times more covalently-attached fatty acid lipids than the total gum. These results are consistent with the central hypothesis. Another area of emphasis was to determine if highly effective emulsifiers can be synthesized by chemical attachment of exogenous lipids to the large proportion of gum arabic molecules that do not contain endogenous lipid groups. The best reaction condition that we have found so far resulted in attachment of an average of six stearic acid molecules to each gum arabic molecule and increased emulsifier activity by 40%.

Impact: Portions of this project are helping us to understand the biological function of arabinogalactan-proteins, molecules that are widespread in the plant kingdom but remain mysterious as to their function. Other portions of this project are helping us understand how gum arabic acts as an emulsifier in dilute oil-in-water emulsions. This knowledge is being applied to develop methods for chemical modification of gum arabic to further improve its emulsifier activity and will also be useful in identifying promising sources of emulsifiers from other natural sources. These enhanced emulsifiers should be economical for use in the food industry.

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

Key Theme: 2.02 Food Handling
Title: Private Strategies, Public Policies and Food System Performance

Description: Research has examined the extent of market power in various dimensions of the food chain. Work on the U.S. beef packing industry has found that earlier results indicating such market power was negligible are robust to estimation using more traditional industrial organization models. Little input buying power is evident, along with significant utilization economies, suggesting that economic pressure is toward higher demand for cattle. Work on retailer market power for fresh produce commodities found strong evidence of buyer power for California iceberg lettuce, but evidence on buyer power was mixed for fresh tomatoes from either Florida or California. Retailers

exercised some market power as sellers of produce commodities to consumers, but pricing was restrained relative to what was possible, based on estimated elasticities of demand. Although retailers may be exercising some degree of unilateral market power, no evidence of collusive behavior among retailers was found. Research has also targeted the impacts of technical change, international trade, and outsourcing on shifts in compensation and labor composition in favor of highly educated workers for a variety of manufacturing industries, including food processing. Technological change has had the greatest effect on changes in labor composition, but the indirect impact of foreign trade on employment patterns augments its direct impact, since trade stimulates computerization, leading to a reduction in demand for lower-skilled workers.

Impact: Other projects have examined the impacts of brand advertising by food manufacturers on farmer welfare and the efficiency of the U.S. Department of Agriculture's mechanism for auctioning bonuses under the Export Enhancement Program. Brand advertising is likely to benefit farmers in concentrated markets and when the advertising is more effective at increasing total market demand than in creating brand market power. Farmer welfare is also more likely to increase when the brand advertising is conducted by a producer-owned cooperative. An alternative, second-price auction format was shown to be more efficient than the existing mechanism in auctioning bonuses for wheat exports.

Funding Source: Hatch Multistate Research and State
Scope of Impact: AR, CA, CTS, FL, GA, IL, IN, IA, KS, KY, LA, MD, MA, MI, MN, MT, NE, NH, NJ, NYC, NC, ND, OH, RI, TN, TX, VA, WI, USDA/ARS USDA/ERS, USDA/RBS, USDA/AMS, USDA/PSA, CDCP, FDA, GAO

Key Theme: 2.03 Food Quality
Title: Taste, Flavor and Perception: Sensory Methodology

Description: There were six research thrusts: 1) Investigation into mechanisms of sensory discrimination was continued, refining and improving test protocols. Further modifications of power, sequencing and memory were investigated. 2) R-index measures were applied to consumer measurement for market concepts of personal products as well as to preferences for coffee temperature. 3) Cognitive aspects of estimation of magnitudes continued, examining cognitive spacing, memory, context and cross-cultural variables. Methods of reducing scaling drift were studied using cancer patients. 4) The investigation of the relationship between panelist and consumer d' values was continued with reference to dairy quality control. 5) The mechanism of hot taste and oral irritation was investigated, noting mechanisms for capsaicin, piperine and nicotine, while the mechanisms associated with the 'tingle' in carbonated drinks was elucidated. 6) Research into bias in preference tests was initiated.

Impact: These studies complement physiological and molecular biology studies of brain function. Human senses are used as instruments to measure food flavor, texture and acceptance. This research develops sensory methodology to be used more effectively for food measurement, quality control, product development and consumer acceptance.

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

Key Theme: 2.03 Food Quality
Title: Physiological and Biochemical Responses of Fruits To Controlled Atmospheres

Description: Postharvest-life of fresh fruits based on flavor is shorter than that determined by appearance and textural quality. The purpose of this project is to identify the optimum atmospheric composition to maintain flavor and nutritional quality of fresh fruits. 'Thompson Seedless' grapes were kept at 0C in air (control); 45% CO2; 0.25% O2; or 0.25% O2 + 45% CO2 to investigate the effects of insecticidal controlled atmospheres (ICA) on quality and induction of fermentative metabolism. Quality attributes including firmness, soluble solids content, titratable acidity, pH, color and visual quality, and production of fermentative volatiles (mainly acetaldehyde and ethanol) and activities of corresponding enzymes that catalyze their production, pyruvate decarboxylase (PDC) and alcohol dehydrogenase (ADH), were measured initially and after 4, 8, and 12 days of exposure and after 1 and 3 days following transfer to air at 0C. Although quality attributes were not significantly affected by ICA treatments compared to air control, production of both acetaldehyde and ethanol increased by 5 to 10 fold and 40 to 50 fold, respectively, over a 12-day exposure to ICA with greatest increase found in grapes kept in 45% CO2, while the levels of these volatiles remained low and relatively constant in air control fruit. Concentration of acetaldehyde in grapes kept in 45% CO2 decreased by 70% after transfer to air for 3 days 0C, while ethanol concentration decreased slightly. Activities of PDC and ADH increased significantly during exposure to ICA, particularly under 45% CO2, with slight reduction on day 12 of storage. ADH activity in grapes kept in 45% CO2 sharply increased after transfer to air for 1 day. Low O2 seemed to reduce the effect of high CO2 on both production of the volatiles and enzymatic activity as indicated by lower accumulation of acetaldehyde and ethanol and lower activities of PDC and ADH in grapes kept in 0.25% O2 + 45% CO2 compared to those kept in 45% CO2 alone.

Impact: We have demonstrated that fruits tolerate stress caused by very low oxygen concentrations and/or elevated carbon dioxide concentrations (that can be used for insect and/or decay control) for 10 to 15 days at their optimal storage temperatures. Thus, such atmospheres can be used during transportation and/or short-term storage. Decay control can be achieved by keeping table grapes in 15% CO2 enriched atmospheres (instead of using SO2) at 0C for up to one month.

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

Key Theme: 2.03 Food Quality
Title: Postharvest Physiology of Fruits

A. Pest and Disease Control: Strategies for the use of 1-methylcyclopropene (1-MCP) on Bartlett pears are under development. Pears have been treated with low concentrations of 1-MCP to improve post-storage quality while allowing fruit to fully ripen after harvest. Treatment with 1-MCP controlled storage scald and internal breakdown in pears stored more than 4 months in air. The benefits of 1-MCP are being confirmed on the major California apple varieties. Biological control of Botrytis rot on harvested strawberries was demonstrated to be effective, but not more so than holding berries in fifteen percent carbon dioxide atmospheres during cold storage. Acetaldehyde (4 percent) was

demonstrated effective for control of western flower thrips and two spotted spider mites on harvested strawberries, but the effective levels caused browning of the strawberry calyx. Ethyl formate was shown to be effective for insect control at levels that caused only minor damage to the strawberry calyx. Ethyl formate has also been demonstrated to control grape mealybugs on table grapes when used in conjunction with 45 percent carbon dioxide atmosphere treatments. Table grape tolerance is under investigation. We have also initiated a project to further explore the mode of action of controlled atmospheres in causing insect mortality. We are exploring the effects of carbon dioxide on membrane permeability and ATP production. In addition, we are comparing closely related species of mealybugs that vary greatly in their susceptibility to carbon dioxide treatments. Radio frequency energy is being explored as an alternative to methyl bromide for postharvest insect control in various nut crops, sweet cherry, and Bartlett pear. This rapid heating method appears particularly promising for walnuts, almonds and pistachio nuts as these dry commodities heat more slowly than insect pests. Product is heated to 55 degrees Celsius within 5 minutes and held at this temperature for 5 minutes to control codling moth, navel orangeworm and Indianmeal moth.

Impact: 1-MCP will soon be marketed under the name SmartFresh. It is important to develop recommendations for use of this powerful tool before the material is commercially available. Our research is developing the information necessary to make such recommendations. Our work on insect control is developing alternatives to methyl bromide fumigation. The availability of alternatives is important to reduce worker safety issues and maintain the competitiveness of U.S. agriculture. Non-chemical alternatives for postharvest insect control are desired by the fruit industry and consumers.

B. Ethylene Exposure: Climacteric and non-climacteric stone fruit were exposed to ethylene gas during long term cold storage [0C (32F) and 5C (41F)], and the effect on eating quality, brown rot decay development (Monilinia fructicola) and internal breakdown was investigated. Quality attributes such as fruit flesh firmness, soluble solids concentration, titratable acidity, pedicel browning (cherries), and flesh and ground color were not affected by constant exposure to ethylene (10 ppb, 100 ppb or 1,000 ppb) during long-term cold storage. Constant exposure to ethylene did not affect decay development, expressed as lesion size or incidence, on peaches, plums, nectarines and cherries wound-inoculated with Monilinia fructicola. In peaches, ethylene treatments did not negatively affect development of visual symptoms of internal breakdown (flesh mealiness or browning). In one case, flesh mealiness symptoms were reduced by the presence of ethylene present during storage. This work indicates that there is no commercial benefit to ethylene removal during commercial cold storage of peaches, nectarines, plums and cherries.

Impact: Recent research has indicated that removal of ethylene to very low levels (<5 ppb) prolongs the storage life of some non-climacteric fruits and vegetables. Our research, however, indicates that ethylene exposure during postharvest cold storage has no deleterious effect on stone fruit eating quality, decay or internal breakdown incidence. Removal of ethylene during commercial cold storage of peaches, nectarines, plums and cherries is unnecessary.

Funding Source: Hatch Multistate Research and State
Scope of Impact: CA, DC, GA, MA, MD, MI, NC, NYC, NYG, OR, PA, WA (Pullman & Wenatchee), CANADA, USDA/ARS

Key Theme: 2.03 Food Quality
Title: Characterization of the Sensory Properties of Fats and Oils and of Their Role in Food Intake

Description: 1. Difference threshold, descriptive analysis, time-intensity profiling (TIP), instrumental measurements, and consumer testing methods were developed and optimized for measuring human sensitivities to fat, the sensory properties of fats and oils, and preferences for fat, respectively. 2. In a study of the effects of fat and flavor (aroma) on the sensory impression of fat, we showed that the flavor component of fat-based foods can influence fat perception, and we demonstrated that the sensory impression of fat can be enhanced by manipulating the flavor (olfactory) component of fat-containing foods. 2 & 4. Fat content affects not only the texture and mouthfeel of foods and beverages, but also their flavor release properties. 3. No relationship was found for normal-weight individuals between energy from fat in the diet and sensitivity to, or preferences for fat in foods. Sensitivities to fats and oils were significantly lower than sensitivities to chemical (taste, smell, trigeminal) stimuli (in human subjects). Sensitivity to the bitter taste of 6-n-propylthiouracil (PROP) was not related to the perception of fat in a set of foods varying in fat and flavor concentration, and its effect on dietary intake patterns of a population of college students appeared limited, yet PROP-sensitive individuals may be including too many high-fat foods which have been associated with chronic disease in their diets. 5. Texture-specific satiety was demonstrated, but not olfactory-specific satiety. No significant evidence was found for sensory-specific satiety to fat.

Impact: Human ability to sense fat in foods is limited, and that may compromise fat intake regulation. Genetic taste markers only have a limited effect on human sensory perception and intake of fat. Flavor manipulation may enhance the impression of fat in a food. These findings have implications for the adoption of low-fat diets and the development of fat-modified foods with acceptable sensory properties.

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

Key Theme: 2.03 Food Quality
Title: Postharvest Quality and Safety in Fresh-cut Vegetables and Fruits

A. Fruit Tissue Softening: Existing approaches to enhance consumption of fruits and vegetables are not meeting dietary guidelines. Novel techniques for assuring the quality, safety and convenience aspects of fresh-cut produce depend on additional research efforts. Based on preliminary studies, we selected at 6-hour exposure at 10C to 1000 ppb 1-methylcyclopropene (1-MCP) as the standard treatment for testing on several fresh-cut fruits that were kept at 5C following 1-MCP treatment until the end of their marketable-life. In each case, the MCP treatment was applied to either the intact, partially-ripe fruits before cutting or to the fresh-cut products (slices or wedges) immediately after cutting. Quality evaluations included color and firmness (penetration force) of the fruit slices or wedges at intervals during storage at 5C. Also, the rates of respiration and ethylene production were measured. A brief summary of our results so far follows: Exposure of color 4 bananas to 1-MCP before cutting stimulated more ethylene production and did not influence softening or browning rates of bananas slices. In contrast, exposure of bananas slices to 1-MCP had no effect on their ethylene production and browning rates, but delayed their softening rate by 1 to 2 days at 10C, especially when

exposed to 2 ppm ethylene in air. Softening of kiwifruit slices was delayed by 1 to 2 days at 5C in responses to 1-MCP treatment of either whole fruits before cutting or the slices after cutting. Concurrently, ethylene production rate was decreased by the 1-MCP treatment. Exposure of partially-ripe 'Keitt' mangoes to 1-MCP was not effective in slowing down softening of fresh-cut mango cubes beyond 3 days at 5C. Treating the fresh-cut mango cubes with 1-MCP was effective in delaying their softening by 1 to 2 days during storage at 5C. Treating intact 'Fuyu' persimmons with 1-MCP was more effective than treating the fresh-cut wedges in delaying their softening, but it increased ethylene production rate during storage at 5C. A 3 to 4 days extension of post-cutting life at 5C was observed.

Impact: We have shown that fruit tissue softening is triggered by ethylene. Thus, ethylene scrubbing and/or exclusion from packages of fresh-cut fruits can be a useful supplemental procedure to add another day or two to the post-cutting life of fresh-cut fruit products.

B. Reducing Surface Bacterial Populations: Fresh-cut fruits and vegetables present unique challenges because they support greater growth and survival of spoilage and pathogenic microorganisms than do their intact counterparts. This research will assess novel approaches to ensure the highest quality and safety of these products. We have developed and validated standard methods for inoculation and recovery of pathogens from a variety of produce items including tomatoes, apples, strawberries, melons, oranges, and broccoli. This has enabled us to evaluate growth and survival of SALMONELLA, LISTERIA MONOCYTOGENES, SHIGELLA FLEXNERI, and E. COLI O157:H7 at refrigerated, frozen and ambient temperatures on intact and cut surface of these fruits and vegetables. Survival of pathogens is significantly better on cut surfaces than on intact surfaces, although survival on intact surfaces is very good for most tested fruits and vegetables. When the pH of the cut surface is not acidic (e.g., melons), these surfaces can support the growth of pathogens at ambient temperatures. Survival on acidic cut surfaces (e.g., strawberries) is exceptional even though growth does not occur. The ability to remove pathogens from the surface of fruits and vegetables decreases with increasing surface complexity. Hard and smooth surface fruits such as oranges, tomatoes and apples can be rubbed which significantly improves removal of organisms. Rinsing with running water and removing residual water by towel drying also lowered microbial populations. Brushing cantaloupe significantly improved removal of inoculated organisms. Delicate and complex surfaces such as strawberries , cut surfaces, and broccoli were resistant to bacterial removal. Use of 200 ppm chlorine or 5% acetic acid significantly improved reductions for most produce types.

Impact: Survival of human bacterial pathogens on cut and intact surfaces of fresh fruits and vegetables indicate the need to focus on sanitation when handling these products. Washing with plain or chlorinated water or with acetic acid and when possible physical treatments such as rubbing or brushing will reduce surface bacterial populations.

C. Optimization of Processing: Fresh-cut produce can help increase the consumption of fresh produce due to its convenience and attractive appearance and flavor. Development of novel approaches for assuring the quality and safety of fresh-cut produce depends on a better understanding of fresh-cut vegetable and fruit physiology, including nutrients and other functional components as affected by storage and handling. Research conducted over the past year focused on both fruit and vegetables raw material characteristics and processing optimization. Lycopene concentration in new tomato varieties was compared over a 3 year period in eight different California counties. The effects of cultural practices on tomato peelability indicate that irrigation treatments may cause significant

differences. Defects such as sunburn, small size and mold make it difficult to utilize fruit and vegetables for processing. Kinetic data on thermal inactivation of quality-related enzymes was determined in carrots and peaches. Phenolic components of fresh and canned peaches were identified for their health benefits. Finally, textural integrity in vegetables was enhanced by short heat treatments which activated pectin methylesterase; this information can be applied to fresh-cut or frozen products.

Impact: Knowledge of the chemical components of raw fruits and vegetables, and their initial raw material properties, is valuable information for food processors. Optimization of processing will result in superior texture, color, flavor and nutritional quality in fruit and vegetable products.

Funding Source: Hatch Multistate Research and State
Scope of Impact: AL, AR, CA, FL, GA, IL, IA, LA, MD, MI, NYC, OK, PA, TN, USDA/ARS

Key Theme: 2.06 Food Safety
Title: Edible Coatings To Improve Food Quality and Food Safety and Minimize Packaging Cost

Description: Whey protein film solubility and oxygen permeability decreased, and film strength and stretchability increased, as film-forming solution heating temperature and time increased. These property changes are likely due to increased protein chain crosslinking due to protein heat-denaturation. Compared to more-commonly-used plasticizers added to decrease film brittleness, sorbitol and sucrose had a relatively larger effect on increasing film flexibility and a smaller effect on increasing oxygen permeability, a desirable outcome that can allow optimization of film properties. The effect of adding hydrophobic beeswax on reducing the water vapor permeability of whey protein films increased as the beeswax particle size decreased, likely because of increased protein-wax interaction due to increased protein-wax interfacial area. Whey protein film-coatings on paper were shown to have excellent barrier to grease and oxygen and excellent gloss and low color, comparable to existing commercial synthetic coatings. Whey protein coatings for chocolate had gloss comparable to existing commercial chocolate coatings.

Impact: Whey protein film-coatings formed on foods can improve food quality, as well as reduce packaging and allow for easier package recyclability. Water-based whey protein coatings have potential for replacing commercial synthetic paper coatings and alcohol-based food coatings, thus improving food quality and safety and reducing environmental problems.

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

Key Theme: 2.06 Food Safety
Title: Teaching Youth FSNEP About Food Safety

Description: Research studies continually indicate good nutritional and food safety practices as major contributors to human health. Yet, consumers indicate confusion regarding correct information and often do not practice good health behaviors regarding nutrition and food safety.

Health professionals are considered to be a credible source of food safety and nutrition information for consumers. Health professionals need to remain current in their knowledge in order to best assist consumers in achieving healthier lifestyles.

The overall goals of this effort are:
- To provide current, accurate, and useable nutrition and food safety information to San Luis Obispo consumers, health professionals and other professionals who influence consumers' knowledge of nutrition and food safety.
- To provide professional in-service training to health professionals through conferences, newsletters, curricula, and publications.
- To improve the health status of low-income students by providing bi-lingual nutrition and food safety information through teacher in-service trainings.
- To improve the health of San Luis Obispo County consumers due to improved nutrition and food safety practices.

Youth FSNEP: Training for teachers working in schools with high student participation in the free and reduced lunch meal program were trained in Youth FSNEP. Professional seminars were held for health and family service professionals. The Update newsletter was developed and mail to health and family service professionals. Educational materials were finalized and distributed to assist parents in packing healthy brown bag lunches for their preschool children.

During FY 01-02, 88 trained teachers extended Youth FSNEP information to more than 2,500 students; 6 professional seminars were offered and attended by 189 health and family service professionals; 3 Update newsletters were distributed to over 275 health professional; 5 educational brochures in English and Spanish were finalized and distributed to 980 parents through 16 preschools to assist parents in packing healthy brown bag lunches for their preschool children.

Impact: More than 85% of teachers trained in Youth FSNEP have incorporated nutrition training in their teaching curriculum; l00% of participants attending professional nutrition and food safety seminars indicated they gained useful and meaningful knowledge. Eighty-nine percent of participants responding to a 6-month follow-up survey regarding their attendance at a Cooperative Extension nutrition or food safety conference indicated they made at least one positive behavior change based on the information presented during the conference. On the economic front, improved nutrition and food safety practices will reduce medical costs and decrease lost work time due to health problems.

Funding Source: State, Youth FSNEP and Smith-Lever
Scope of Impact: County Specific

Key Theme: 2.06 Food Safety
Title: The Lunch Box Program - Packing Healthy Take-Along Lunches for Preschool Children

Description: The target population was parents who pack lunches for their children to take to preschool. Participating preschools were selected from throughout the county and with different fee requirements in an effort to reach most socio-economical groups, with the exception of very low-income families who would participate in government child care.

Most parents enroll their children in preschools to provide care for their children while parents are employed. Parents report the many demands on their lives leave little time to plan healthy lunches for their children. Yet parents want to provide for the health and well-being of their children today and as they grow. Therefore, educational information that parents can read as their schedules allow, that provide information on the nutritional and food safety needs of young children, and has easy ways for parents to meet these needs would be welcomed by parents.

The Lunch Box program consists of five education brochures designed to assist parents in packing healthier lunches for their preschool children. The brochures provide specific information regarding the nutrition and food safety needs of young children and simple ways for parents to meet these needs. The commitment the preschools made in helping to develop this project reflects their interest in the program-of the nine schools that cooperated in the development and assessment of this program, seven schools cooperated for 12 months each, while the other schools cooperated for 15 months. Preschool staff has consistently expressed support for the program and appreciation through verbal and written comments. An evaluation of program effectiveness indicated significant and positive behavior change by parents.

Impact: A Cooperative Extension observational study of 528 lunches parents sent to school with their children found that:

- 60% of the lunches contained three or less food groups
- Food groups were represented in lunches as follows:
    - 16% of the lunches included a vegetable
    - 69% of the lunches included a fruit or 100% fruit juice
    - 75% included a dairy product (includes milk served at lunch by the preschools)
    - 77% included a protein food
    - 91% included a grain
- 81% of the lunches contained low-nutrient foods
- The average lunch contained 1.4 low-nutrient foods
- The most common low-nutrient foods were:
    - Fruit Drinks - in 44% of lunches
    - Jelly - in 36% of lunches
    - Chips - in 20% of lunches
    - Fruit Snacks/Fruit Rolls - in 17% of lunches
    - Cookies/Granola Bars - in 15% of lunches
- 23% of the lunches could become unsafe by lunchtime from food borne bacteria

A written survey completed by 92 parents who send lunches with their preschool children found that 88% of parents believe they pack nutritious and safe lunches for their children. Parents indicated challenges in their packing children's lunches including: 36%--honoring child's food preferences, 35%--including variety; 21%--nutrition; and 20%--time. These results suggest an educational opportunity for parents to learn about nutrition and food safety needs of their children and how take-along lunches can contribute to children's health.

Funding Source: State, Children and Family Commission, and Smith-Lever
Scope of Impact: County Specific

Key Theme: 2.08 Foodborne Illness
Title: Fecal Indicators and Pathogenic Bacteria in Food and Water

Description: Much of our effort was expended in the defense of the Colitag patent of the Regents of the University of California. In a long series of experiments and written materials, we demonstrated that, contrary to the charges of the plaintiff, Colitag is a rich, nutritive medium that supports the luxuriant, non-specific growth of a great variety of coliform and non-coliform bacteria. After considering the data, the U.S. Superior Court of Connecticut issued a summary judgement dismissing the plaintiffs' suite. In addition, we pushed Colitag to its limits for detecting E.coli in decomposing alfalfa sprouts. These sprouts have massive populations of coliform bacteria that can swamp out a few cells of the target E.coli. We found that when the coliforms outnumber the E.coli by roughly six logs, the target E.coli are no longer detectable unless the medium is subcultured. This is the same detection limit obtained with the more tedious Standard Methods LTB+EC/MUG medium. Curiously, we could not reproduce this swamping-out effect in model experiments with pure cultures of Klebsiella pneumoniae isolated from the sprouts. Decreasing interference in Colitag from non-target Aeromonas and other oxidase-positive bacteria. As mentioned in previous reports, we are interested in preventing the ubiquitous aeromonads from generating false positive coliform tests at 35 degrees C. (This interference was probably the major reason that the Standard Methods includes a tedious two-media procedure for presumptive and confirmed coliforms.) As we extended our studies to foods of plant origin, we find that Pseudomonas and other oxidase-positive bacteria were also sources of interference. In our ongoing search for suitable inhibitors of all these interfering bacteria, we found that in addition to dinitrophenol, the herbicide 2.4-D is a promising compound. Service activities. Over the years we have become a resource for those who have questions about water testing. In 2001 we helped the university Department of Environment and Health Services conduct sanitary monitoring of Strawberry Creek which runs through the campus. As a result of our collaboration, they decided to use Colitag as a convenient in-house monitoring tool, rather than sending their samples out for coliform analyses.

Impact: Waterborne and foodborne illnesses are major causes of morbidity and mortality. By defending the Colitag patent, we helped assure that it will be available to protect the public from these diseases

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.

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. Twenty-five percent of California's children live below poverty level, 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. Breast feeding practices of Southeast Asians, childhood obesity and anemia prevention are a few of the areas being worked on that will impact the health and nutritional status of Californians. Specifically, our work has provided an understanding of the effects of environmental toxicants on health; increased our understanding of the biological basis of obesity; contributed knowledge of the genomic and metabolic effects of caloric restriction in order to develop pharmaceuticals and treatments that mimic the effects of caloric restriction; provided information on why heptachlor causes cancer and formulated preventative and/or therapeutic strategies to reduce the incidence of this type of cancer; identified genes that might cause obesity and provide evidence that Lipin-3 influences human obesity; discovered novel therapies that can unblock the blood vessels, thus reversing coma in patients who suffer and die from cerebral malaria; developed nutrition education interventions to improve the nutrition of young Latino children; educated physicians to counsel parents and to examine a small child's mouth to determine if they need a referral to a dentist; used molecular markers to increase the yield of cheese in the range of five to eight percent resulting in a significant economic impact for the dairy industry; developed means to stabilize lipids, to improve their nutritional impact and demonstrate their nutritional value in diets; found that the lunasin peptide can be used as a novel chemopreventive agent against skin cancer and possibly other cancers; developed a novel anti-infective formula that can protect formula-fed infants against infections; improved our ability to detect vitamin B-12 malabsorption in population groups who suffer from this condition; found that intermittent administration of iron supplements is safer and as effective as daily supplement administration; established that appreciation of the health significance and causes of iron deficiency and iron deficiency anemia by members of the medical community is necessary for a successful iron deficiency anemia intervention program; and provided knowledge that children who are taught about plants and nutrition as well as gardening, learned or retained more of the information than students who were only given nutrition lessons.

Forty local extension programs were delivered in this area. In addition, five statewide collaborative workgroups composed of both AES and CE academics planned and conducted research and extension projects. Last year, California academics published 63 peer-reviewed articles and 5 extension publications to address Goal 3.

FY 2001-2002Allocated Resources

Extension Federal Funds (Smith Lever 3 b&c)	Extension State Match	Research Federal Funds (Hatch)	Research State Match
$467,612	$3,535,839 [27.77 FTE]	$328,800	$4,783,404 [17.74 FTE]

UC-ANR'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.

Key Theme: 3.02 Human Health
Title: Physiology of the Yeast Vacuole

Description: This project has focused on an analysis of vacuolar proteins and on biogenesis of the organelle. We have been analyzing the proteins that are required for import of the vacuolar protein aminopeptidase I (API). We found that a novel conjugation system is involved as part of the machinery that sequesters precursor API into a cytosolic double membrane vesicle. We showed that Apg7p is required to covalently join Apg12p to Apg5p. We extended our analysis to determine the role of the Apg5 protein. Precursor API in the apg5 mutant is protease sensitive and membrane associated. Electron microscopy studies confirm that API is partially surrounded by membrane structures in this strain. These data indicate that the conjugation system is needed to complete the sequestration of precursor API. A second protein that we have analyzed in the last year is Aut7p. This protein is induced by starvation, a condition that leads to autophagy. The Aut7 protein associates with the vesicles that deliver API to the vacuole and is itself degraded within the vacuole lumen. These data suggest that Aut7p may be a structural component of the sequestering vesicle. Recently, we have shown that the Apg5p-Apg12p conjugation system is required for membrane binding of Aut7p. An additional set of proteins including Aut1p and Aut2p is also needed for recruitment of Aut7p, perhaps in a parallel pathway. Finally, we have analyzed a protein complex including Cvt9p, Apg1p and Apg13p. This complex appears to be involved in regulating the pathway depending on nutrient conditions.

Impact: The process we are studying overlaps with autophagy, a physiological response to starvation. Autophagy has been shown to have connections to various human diseases including cancer. The information we are learning may help in developing therapies for these diseases.

Funding Source: Hatch and State
Scope of Impact: State Specific
Key Theme: 3.02 Human Health
Title: Altering the Stability of Beta-lactoglobulin

Description: Beta-lactoglobulin (BLG) is the most abundant protein in cheese whey and determines the properties of whey, and is responsible for milk allergies. We will alter the structure of BLG so that it unfolds more readily to increase its ability to foam and stabilize emulsions as well as reduce its immunogenicity. Whey proteins will be more widely used, fetch a higher price, and cause fewer allergies. This project investigates a protein from cows' milk, beta-lactoglobulin, that is responsible for allergies to milk proteins and an off-flavor that develops in milk upon heating. It is the major protein component of cheese whey, a by-product of the California cheese industry. We would like to alter its functional properties to make it a more useful food ingredient and to make it less immunogenic. Functional properties are related to denaturation of the protein; we have used NMR spectroscopy to determine the extent of denaturation and renaturation of beta-lactoglobulin that is caused by various treatments. In this period, we have examined the effect of high pressure processing on beta-lactoglobulin. The structure remains intact at 100Mpa, and denaturation occurs between 200 and 400Mpa. The denaturation appears to be strongly cooperative. Refolding of pressure-denatured beta-lactoglobulin is rapid, but the precise native fold is not achieved.

Impact: Our overall goal is to improve the quality of dairy products, to enhance the usefulness of dairy proteins in other food products and to decrease the incidence of allergic response to dairy products. Consumers will benefit from the first and last of our goals; dairy producers and processors will benefit from the remaining goal because whey proteins will fetch a higher price for use as food ingredients.

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

Key Theme: 3.02 Human Health
Title: Physiological Effects of Acute and Chronic Exposure To Environmental Toxicants

Description: Use of insecticides to kill disease vectors, protect food crops, etc. continues, and so does public concern over the health effects of the insecticides used both now and, because of their persistence, in the past. This project examines some new possibilities for how these chemicals may produce effects on the brain. Heptachlor, an organochlorine insecticide, has acute neurotoxic (including convulsant) effects that can be explained by antagonism of the GABA-A receptor - the most important receptor mediating inhibition in the nervous system. We have been investigating a new idea, namely, that heptachlor activates binding sites associated with the peripheral benzodiazepine receptor (PBR) on the outer mitochondrial membrane in glial cells in the brain. PBRs are not found in neurons - only in glia. PBRs may be involved in synthesis of neurosteroids which in turn may either antagonize or enhance the action of GABA on neurons. This could theoretically either enhance or ameliorate the convulsant effects of heptachlor. Rats were treated with heptachlor and mitochondria were isolated at various times after dosing, but always at one hour. The binding sites were measured in intact mitochondria isolated from whole brain as a pure fraction using differential cenrifugation and a ficoll gradient in the last step. Binding occurred during incubation of the mitochondria with the ligand 3H-PK11195 (a phenyl isoquinoline carboxamide derivative) in the cold (4 degrees C). Separation of the bound and free ligand was carried out in the cold under vacuum with a Brandel M30R rapid filtration cell harvester using Brandel GF/B filter paper soaked in PEI. Nonspecific binding was less than 10%, indicating a high degree of purity of the mitochondrial fraction. There was a gender difference in the

ability of heptachlor to increase PBR binding sites during development. At 10, 12, 14, 18, and 20 days of age, heptachlor (60 mg/kg, per os in oil) increased PBR binding sites in brain by about 2-fold in female rats at one hour after administration but did not produce an increase in the male. However, at 30 and 45 days of age, numbers of brain PBR binding sites in males were also significantly increased and were not different from those in females one hour after administration of heptachlor. During the 10-20 day developmental period, the failure of PBR binding sites to increase in males was not caused by a lack of toxicity of the heptachlor in males. Rather, toxic effects appeared to be greater in the males. We next determined if there was a similar gender difference in response to a non-chemical stressor such as maximal electroshock seizures (MES). To do this we measured seizure intensity in response to a standard electroshock stimulus in male and female rat pups during development, as well as the time course of expression of PBR binding sites in whole brain and other tissues (adrenals, kidneys). On the day of birth there was a gender difference in PBR expression in whole brain with females having a greater number of binding sites than males at one hour after the MES. At the same time there was no behavioral response to the MES stimulus in either males or females. At 12 and 20 days of age, PBR binding sites were increased almost 2-fold one hour after MES in both sexes. Therefore males do show increased brain PBR binding sites in response to the MES stressor but not to heptachlor.

Impact: Our studies help in understanding the effects of environmental toxicants, such as organochlorine insecticides, on the health of nontarget organisms such as man, his pets and domestic animals, and wildlife. Some of our findings help explain the mechanisms involved in producing toxic effects on the brain that result in seizures, anorexia, or other adverse behavioral effects.

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

Key Theme: 3.02 Human Health
Title: Neural, Hormonal, and Genetic Mechanisms Regulating Heat Production and Energy Balance in Animals

Description: As part of our research on altered regulation of energy balance, we have studied effects of aging on energy intake. Near the end of their natural life, many mammals, including humans, exhibit spontaneous weight loss unassociated with any specific disease. This year, we found that such senescent rats have blunted responsiveness to neuropeptide Y, a robust stimulator of feeding in nonsenescent rats. Our preliminary data suggest that this attenuation doesn't reflect fewer hypothalamic Y1 receptors. In addition to altered feeding behavior, senescent rats appear to have severe deficits in hippocampal function, which may relate to altered memory. We have also studied effects of altered gravity on leptin regulation of energy balance, finding that at hypergravity (2G), there is a significant drop in feeding and adiposity that cannot be explained by abnormally high leptin. We are currently evaluating expression of neuropeptides that modulate feeding behavior and fat accretion at 1G. Finally, we have continued studying obesity and brain serotonin. We previously found lower steady state turnover of serotonin in the ventromedial hypothalamus of obese rats and suggested that this decrease could contribute to their hyperphagia. We explored two potential mechanisms for this decrease, negating both - i.e., decreased sensitivity of sertonergic dorsal raphe neurons (which in fact appear to be hyperexcitable) and decreased responsiveness of the rat to a meal. We are now exploring alternative explanations for the blunted hypothalamic serotonergic activity seen in obese animals.

Impact: Our research has a direct relationship to human welfare. Senescence in rats mirrors the syndrome "failure to thrive" in humans. Thus, senescent rats are a model system allowing studies of potential mechanisms that underlie the alterations seen in this syndrome. Identification of such mechanisms should lead to treatments that slow down or compensate for this state in the elderly. Similarly, increasing our understanding of the biological basis of obesity should result in more rational treatments for this condition.

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

Key Theme: 3.02 Human Health
Title: A Theoretical Investigation Into the Origins and Maintenance of Genetic Variation

Description: During the past year a California researcher investigated the possibility that the main random force in evolution is not genetic drift, as is generally believed, but rather is the stochastic forces induced by linked selection. An important aspect of this work has been a general investigation of the role of population size in evolution. The rate of evolution at loci that are under relatively strong natural selection has generally been thought to be proportional to the population size. Some rather naive mathematical calculations are generally used to support this view. He has shown that under more realistic models, the rate of substitution is virtually independent of population size. The reasons for this depend on the particulars of each model, but always involve the inhibiting effect of one substitution on successive substitutions. An important corollary of this result is that the stochastic force induced by these substitutions--a force that called genetic draft--is also virtually independent of population size. What little dependence remains is curious: the rate of substitution of weakly selected advantageous mutations decreases with increasing population size while that for weakly selected deleterious mutations increases with increasing population size. These relationships are exactly the opposite of what they are under genetic drift. Thus, it may well be that population geneticist's emphasis on the role of population size in evolution has been misguided and backwards.

Impact: Progress in crop improvement and in our understanding of the genetic basis of human diseases both depend critically on knowing the biological effects of the genes that vary between individuals. Genetic variation of very small effect can best be studied with the sorts of mathematical models that have been developed by this research.

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

Key Theme: 3.02 Human Health
Title: Serologic Detection of Salmonella Dublin Carrier Cows Using Elisa

Description: The biology of Salmonella on three large western dairies was studied using culture techniques and an ELISA which detects antibodies directed against LPS from groups B, C, D, and E Salmonella (the four most common serogroups in cattle) . A high proportion of cows on Salmonella

culture positive dairies become seropositive. Salmonella was found to widely contaminate animals and the environment, and could be found in bulk tank milk. Feed was a source of Salmonella, and the feed contamination on the three dairies was traced to irrigation water which had been contaminated by human sewage effluent of three separate origins.

Impact: The study indicates that dairies are a part of the entire regional ecosystem. They contribute to environmental contamination, and they are the unwilling recipients of environmental contamination. Salmonella can go full circle, from human sewage effluents to human food . The importance of considering the entire ecosystem in designing programs to reduce Salmonella contamination was demonstrated.

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

Key Theme: 3.02 Human Health
Title: Diet, Health and Longevity

Description: Caloric restriction (CR) is the only non-genetic means of extending average and maximum life span in mammals. CR preserves immune responsiveness, reduces the incidence and severity of age-related diseases, and delays the onset of cancer, diabetes, and heart disease. Understanding its molecular basis of action holds the keys to improved health as we age, and to longer life. To explore its global effects on gene expression, we undertook genome-wide, microarray expression analysis of 11,000 genes in a mitotic-competent tissue, the liver, during aging. Aging was accompanied by changes in gene expression associated with increased inflammation, cellular stress and fibrosis, and reduced capacity for apoptosis, xenobiotic metabolism, normal cell-cycling, and DNA replication. Long-term CR (LT-CR) and just 4 weeks of short-term CR (ST-CR) reversed the majority of these changes. LT-CR produced in young mice a pattern of gene expression that is a subset of the changes found in old LT-CR mice. It is possible that the early changes in gene expression, which extend into old age, are key to the life- and health-span extending effects of CR. Further, ST-CR substantially shifted the "normo-aging" genomic profile of old control mice toward the "slow-aging" profile associated with LT-CR. Therefore, many of the genomic effects of CR are established rapidly. Thus, our data indicate that expression profiling should prove useful in quickly identifying CR mimetic drugs and treatments. Differential "fuel usage" has been proposed as a mechanism for life-span extension by CR. The first aim of the project was to "Test the hypotheses that reduced chaperone abundance leads to enhanced serum protein secretion, increased serum protein clearance, reduced levels of glucose-modified serum proteins, and reduced diabetic pathologies." We tested this hypothesis and showed that CR decreased the expression of many hepatic molecular chaperones and concomitantly increased the rate and efficiency of serum protein secretion. Our other studies showed that CR alters the expression of key metabolic enzymes in a manner consistent with an increased rate of extra-hepatic protein turnover and renewal during aging. These effects were found even in the hours after feeding. The data are consistent with the idea that CR continuously promotes the turnover and renewal of extrahepatic proteins. Together, these novel results suggest that CR promotes the turnover of total body protein, and the secretion and turnover of serum proteins, thereby reducing the whole body burden of damaged, toxic, glycoxidated and oxidized proteins.

Impact: Knowledge of the genomic and metabolic effects of CR will contribute to the development of

pharmaceuticals and treatments that mimic the effects of CR, acting as prophylactics for the development of age-related diseases such as cancer, heart disease, diabetes, and Alzheimer's Disease. These treatments will lead to longer, healthier lives, and to additional years of experienced productivity.

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

Key Theme: 3.02 Human Health
Title: Mechanisms of Action of Insecticides

Description: The effects of the organochlorine (OC) liver tumor promoter heptachlor epoxide (HE; 0, 0.1, 1, 10, and 50 microM) on several cellular tumor promoter-sensitive parameters were studied in mouse 1c1c7 hepatoma cells in an effort to identify the most sensitive biomarker for OC promoter exposure and the critical pathway and target of OC promoters. The levels of Ca2+ in the endoplasmic reticulum (ER) store, connexin43 (Cx43), PLCgamma(1), nPKCvarepsilon, and AP-1 DNA binding in nucleus were studied to screen for effects induced by submicromolar HE levels. While all the parameters tested elicited effects, particulate PLCgamma(1) and AP-1 DNA binding were found to be the most sensitive parameters affected by HE on both dose and temporal bases. Their levels were increased with 10- to 100-fold lower HE concentrations than were required to affect nPKCvarepsilon or Cx43. Further, with the lower HE dosages, particulate PLCgamma(1) and nuclear AP-1 were positively modulated by HE after 1 h versus 3 or 72 h for nPKCvarepsilon and Cx43. Ca2+ store depletion was probably the third most sensitive parameter, after AP-1 and PLCgamma (1). These results suggest the tyrosine kinase growth factor receptor pathway is the probable critical pathway for HE-induce tumor promotion with the critical target most likely being upstream of PLCgamma(1) and AP-1. This work also demonstrates that upon exposure to a tumor promoter such as HE, many hepatocellular effects or changes result, suggesting that a cellular-program shift occurs similar to that described by the resistant hepatocyte model after exposure to a carcinogen or enzyme inducer.

Impact: Our finding indicates that heptachlor, an insecticide commonly used in the past, shows cancer promoting activities. Our work also provides the mechanistic information why heptachlor causes cancer promotion, and, therefore helps others to formulate the preventative and/or therapeutic strategies to reduce the incidence of this type of cancer.

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

Key Theme: 3.02 Human Health
Title: Identification of Genes Causing Obesity or Diabetes in Response To High Fat Diets

Description: High fat diets and genetics interact to produce obesity and diabetes in some individuals of many mammalian species, including humans and domesticated animals. Novel genes that may influence obesity and diabetes on high fat diets will be identified by data mining of public and private genome databases. Whether of not these candidate genes influence development of diabetes and/or obesity will be tested by Northern blot quantitation of mRNA levels from various obesity models,

including diet-induced obese mice and human adipose tissues. Identification of candidate genes: We have identified differentially expressed genes in lean and obese mice by analysis of our own microarray data and published data. These candidates include leptin, Lipopolysaccharide (LPS) binding protein, CD36 antigen; fatty acid translocase, Peroxisome proliferator activator receptor gamma, and RBP associated molecule RAM14-1. We will test the roles of these genes in obesity during the next few years. Progress on Aim 2 - testing the roles of candidate genes. A recent publication reported the cloning of a novel gene that causes lipodystrophy, type 2 diabetes and increases atherosclerosis. This gene was named Lipin-1. We have been using the NCBI and Celera databases to identify and study a close homolog of this gene named Lipin-3. Lipin3 is also a positional candidate obesity gene in humans as it is located on chromosome 20 in a region that has been shown by several independent investigators to be linked to obesity in humans. We have identified 5 polymorphisms in the human lipin 3 gene by survey of 15 exons. We performed WAVE analysis to identify heterozygotes and confirmed polymorphisms by direct sequencing of PCR products. One polymorphism results in an amino acid change His634Gln. Both alleles are common-the common allele Gln allele is 71% and the rare His allele is 29%. We then performed an association study by genotyping these alleles with the Pyrosequencer in 71 unrelated women. The women were collected in a study of the effects of pregnancy on energy expenditure. These women range in age from 21 to 39 years (mean=31) and have a mean BMI of 22. We found that fat mass per kg body weight (determined by DEXA) was associated with alleles of lipin3 His634Gln ($p = .003$). The results demonstrate that lipin3 is a candidate obesity gene in both humans and mice.

Impact: This work identifies genes that might cause obesity and also provides evidence that one of them, Lipin-3, influences human obesity. These results may lead to better understanding and treatment of a chronic problem.

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

Key Theme: 3.02 Human Health
Title: Host-parasite Interactions in Malaria

Description: Cerebral malaria is associated with the adhesion of the malaria-infected erythrocytes to the microvessels of the brain. The purpose of this study is to identify and characterize the adhesive materials on the red blood cell. Once identified, it should be possible to design drugs for cerebral malaria. Erythrocytes infected with the mature trophozoite and schizont stages of PLASMODIUM FALCIPARUM sequester in the deep tissues by binding to the surface of endothelial cells (EC). Sequestered parasitized erythrocytes (PE) contribute to the pathology of falciparum malaria by mechanically blocking small blood vessels, leading to unarousbale coma and death. The significamce of this research is to use molecular approaches to discover the interactive regions of the PE and EC and then to develop "molecular teflons" that can be therapeutic to unplug the microvessels. To assess the activity of anti-adhesive substances we have developed a rapid, high capacity in vitro assay using 96 well microplates and have tested the effects of cominatorial libraries of peptides on the binding of malaria-infected red cells; we found 11 active mixtures out of 120 mixtures. We have developed a flow system for studying the adherence of P. FALCIPARUM-infected red cells to EC and immobilized proteins. Under physiological flow conditions the effect of recombinant human

lactoferrin has been shown to be anti-adhersive. We have found that exposure of phosphatidyl-serine (PS) on the P. FALCIPARUM-infected red blood cell membrane is involved in the adhesion of PE to CD36 and thrombospondin, and found that small, soluble form of PS, glycerophosphorylserine could inhibit CD36- and thrombospondin-mediated infected cell binding, suggesting that this molecule may assist in the development of novel and effective anti-adhesive agents. We have identified changes in the molecular size of band 3 protein during the intra-erythrocytic growth of P. FALCIPARUM. Further, red cells treated with DIDS (a reagent that specifically binds to band 3 protein) ablates the adhesion of infected red cells by greater than 50%. This suggests that modifications in an intrinsic protein of the erythrocyte play a role in adhesiveness and antigenicity similar to the parasite-encode protein PLASMODIUM FALCIPARUM erythrocyte membrane protein 1 (PfEMP1).

Impact: Malaria results in 3 million deaths, mostly children under the age of 5. Specific information on the molecules involved in the attachment of malaria-infected red blood cells to the cells that line the blood vessels, and that block blood flow, should lead to the discovery of novel therapies that can unblock the blood vessels, thus reversing coma in the tens of thousands of patients who suffer and die from cerebral malaria.

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

Key Theme: 3.02 Human Health
Title: Environmental Sensing and Signal Transduction By the Two Component Regulatory System, EnvZ/OmpR

Description: The goal of this project is to identify the genes that are controlled by two proteins, EnvZ and OmpR. These two proteins have been implicated in environmental sensing and in the pathogenesis of some enteric bacteria. Identification of the genes controlled by EnvZ and OmpR may allow rational design of therapies that specifically target these genes, thereby lessening our dependence on conventional antibiotics to treat bacterial infections. The long-term goal of our research is to understand at a molecular level how cells switch from one pattern of gene expression to another in response to environmental signals. To examine this question, we have chosen as our experimental system the EnvZ/OmpR signal transduction pathway of Escherichia coli K-12. This pathway regulates the cellular response of E. coli to changes in medium osmolarity and plays an important role in the virulence of some enteric bacteria, including Salmonella, Shigella flexneri, and pathogenic E. coli strains. During the period under review, a series of experiments were initiated designed to identify new members of the EnvZ/OmpR regulon and to determine the role of the EnvZ/OmpR signal transduction pathway in environmental sensing and in the virulence of pathogenic E. coli strains. These experiments began in a University of California, San Francisco laboratory with the fabrication of an E. coli microarray containing DNA fragments corresponding to every predicted ORF of the E. coli K-12 strain MG1655. The generation of these E. coli microarrays involves a number of laboratories in the Bay area including the Gross Lab (UCSF), the Kustu Lab (Berkeley), the Cozzarelli Lab (Berkeley), and the Brown Lab (Stanford). The purpose of this collaboration is to provide an inexpensive and plentiful supply of E. coli DNA microarrays to the participating laboratories. Although the initial microarrays contained DNA fragments from only E. coli K-12 strain MG1655, the Bay Area microarray group plans to expand the microarrays to include genes from various pathogenic

E. coli, including E. coli strain O157:H7. Collaboration continued with these groups in the production of microarrays, from the laboratory at UC Davis. This collaboration will insure that the laboratory has a sufficient supply of microarrays to conduct the experiments. The initial experiments have established the feasibility of using microarrays to study the EnvZ/OmpR signal transduction pathway and the ability of the laboratory to carry out this new technology. Moreover, the data collected from these experiments revealed two previously unknown properties of the OmpR regulon: 1) Examination of the changes in global gene expression indicated that only three genes showed over a three-fold decrease in steady state RNA levels under all conditions tested, implying a direct role for OmpR in their regulation. The genes are the previously identified OmpR regulon members, ompF and ompC and an ORF of unknown function, ydgR. 2) OmpR has a greater impact on steady state global gene expression at low osmolarity than at high osmolarity. For example, 129 genes exhibit over a three-fold change in expression at low osmolarity compared to only 3 genes (ompF, ompC, and ydgR) at high osmolarity. This would suggest that the EnvZ/OmpR signal transduction pathway plays an important role in the cellular response to low osmolarity conditions.

Impact: The goal of this project is to identify the genes that are controlled by two proteins, EnvZ and OmpR. These two proteins have been implicated in environmental sensing and in the pathogenesis of some enteric bacteria. Identification of the genes controlled by EnvZ and OmpR may allow rational design of therapies that specifically target these genes, thereby lessening our dependence on conventional antibiotics to treat bacterial infections.

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

Key Theme: 3.02 Human Health
Title: California Agricultural Ergonomic Intervention Project

Description: The success of the smaller tubs led to evaluation of the impact of reducing the lifting and carrying functions even more by providing mechanical systems to lift the tubs of grapes and place them into transport containers. Limited trials of this system were conducted in 2000, and a much more extensive effort was conducted in 2001. Much of the data is still being analyzed, but it is clear that we were able to reduce fatigue by about 25% and that we were able to increase the productivity of an "average" crew up to that of a "high end" crew.

Impact: It appears that removing most of the lifting tasks from manual grape harvest improves crew productivity, and probably also reduces ergonomic hazard levels.

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

Key Theme: 3.02 Human Health
Title: Understanding HIV Sexual Risk Behavior

Description: In 1998, the Alameda County Board of Supervisors declared a State of Emergency in recognition of the AIDS status in Alameda County. AIDS is the number one cause of death for males ages 25 - 44 (Alameda Health Status Report, 2000). This implies that individuals are most likely being infected in adolescence. Further, there is an ethnic disparity such that the African American case rate (51 cases/100,000) is 4 times the cases rates of both Whites (12 cases/100,000) and Hispanics (11 cases/100,000). Nationally, we have found that Asians have the lowest incidence of AIDS cases at 7.6 per 100,000, as compared to the African-American rate of 124.8 and Hispanic rate of 54.4 per 100,000 (CDC, 1999). This study seeks to explore the circumstances and possible explanations for the lower Asian case rate. Researchers wanted particularly to find key protective factors that they could then foster in men of other ethnic backgrounds. Using the survey method, surveys were administered to a random sample of clients from the Asian and Pacific Islander Wellness Center (APIWC). Ten conceptual sections (demographics, sexual risk behavior, safe sex practices, level of being "out", acculturation, depression, self, and friends) were measured. Researchers were particularly interested in the roles that family, friends, religion and how individuals see themselves could be related to one's HIV sexual risk behavior. In collaboration with the APIWC Program Director, a survey instrument was created for use in the study and the survey sampling was determined. APIWC entered all the data while 4-H academic staff analyzed the data using SPSS. The main findings of the study were presented at the 2001 UC AIDS Research Conference.

Impact: We received 144 completed surveys from APIWC clients. Our main finding is that higher self-esteem is positively correlated with safe sex practices (e.g., asking partner's HIV status, able to talk about safe sex, using a condom). In addition, we found that the higher number of individuals the clients were "out to" is positively correlated with higher self-esteem. Therefore, fostering better self-esteem seems to be the key variable in promoting safe sex behaviors. The study has had programmatic impact with regards to the API Wellness Center's clientele of about 1000 gay, transgender, lesbian and straight individuals in the Bay area. They made programmatic changes that focus on fostering the self-esteem of their clients. Further, the findings from this research study were shared at 2001 UC AIDS Research Conference where an estimated 500 researchers and community providers attended.

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

Key Theme: 3.02 Human Health
Title: Early Childhood Dental Health, since 2000

Description: The nation is faced with an epidemic of early childhood dental cavities that puts medically underserved children at risk of serious dental disorders. Public Health nurses that work with the Child, Health, Disability Prevention Program are concerned with the number of children who have been to a physician for a health exam yet were not referred to a dentist. The severe tooth decay, which affects more than one of seven preschool children and over half of elementary school students, is an infectious disease initiated by the bacteria Mutans Streptococcus. Prolonged exposure of the teeth to sugary liquids like milk, formula or fruit juice causes the bacteria to multiply rapidly and demineralize protective tooth enamel, resulting in decay. The Dental Health committee developed a workshop designed to help local health professionals feel more comfortable examining children's mouths and be

better prepared to educate parents about behaviors that can contribute to severe tooth decay in infants and young children.
A workshop for physicians, physician assistants, family nurse practitioners, nurses and registered dietitians was developed, addressing emerging research on bacteriology as it relates to tooth decay and discussion on cultural behaviors and practices that may introduce the Mutans Streptococcus bacteria into a child's mouth. Additionally, a pediatric dentist covered prevention, early diagnosis and referral. Continued education hours were offered to the professionals. An evaluation form was part of the continuing education credits.

Impact: The majority of the workshop attendees (85) were physicians. Mercy Community Hospital provided the dinner meal and workshop site. Attendees rated the workshop excellent and indicated they were better prepared to make dental referrals. In the county of Merced (population 210,554) there is only one pediatric dentist and many other dentists did not want to see children under 5 years of age, thus many children were not being examined. Preschool programs like Head Start were concerned that children were not getting preventative care or advice and thus they have to seek dental assistance for many children suffering from early childhood caries. The goal of providing a workshop to bring experts in to work with physicians was achieved and many physicians indicated they are better informed to counsel parents and to examine a small child's mouth to determine if they need a referral.

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

Key Theme: 3.03 Human Nutrition
Title: Modifying Milkfat Composition For Improved Manufacturing Qualities and Consumer Acceptability

Description: The project evaluates preharvest approaches of nutrition and genetics as methods to modify the fatty acid composition of milk fat. The goal is to alter the fatty acid composition in a direction that improves the nutritional value or the manufacturing properties of the milk fat. To evaluate the effect of lipid on rumen metabolism, gas production from an in vitro rumen fermentation system was utilized. Yellow grease, tallow, corn oil and their potassium soaps were evaluated. Fatty acids in the form of triglycerides have no negative effects on fermentation although there were shifts in volatile fatty acid patterns. Addition of fatty acids in the form of K-soaps depressed gas production and digestibility of NDF. Hydrolysis rate of each triglyceride is now being measured. Processed Pima cottonseed was compared to whole Upland cottonseed in two studies. In the first study, the proportion of Pima to Upland cottonseed was varied from 100:0, 66:34, 34:66, to 0:100. The C18:2 content of milk fat increased linearly with increasing amount of Pima fed. Lipids in the milk fat globule membrane were higher in C18:2 and C18:3 (g/100 g fat) than the corresponding milk fat. Milk fat from cows differing in polymorphism for stearoyl CoA desaturase was evaluated. There was not a clear relationship between specific polymorphism and the C18:1 content of milk fat. Research is in progress to examine the impact of nutritional intervention on stearoyl-CoA desaturase and fatty acid composition of milk fat. Mammary gland biopsies will be obtained for gene expression analysis.

Impact: If an in vitro rumen fermentation system can be used to evaluate the effect of lipid source on microbial fermentation, it will be possible to evaluate fats/oils of differing saturated to unsaturated ratios. Unsaturated lipids in the diet increase the conjugated linoleic acid in milk fat. This source of conjugated linoleic acid may be influenced by the rate of hydrolysis and hydrogenation. It may be

possible to utilize an in vitro system to determine the level of unsaturated lipid that can be fed to lactating dairy cows without negatively impacting rumen metabolism while enhancing conjugated linoleic acid or other fatty acid in milk fat. Modification of milk fat at the preharvest level can be used to change the nutritional value and manufacturing properties.

Funding Source: Hatch Multistate Research and State
Scope of Impact: CA, ID, IL, NYC, OH, SC, SD, UT, VA, IA, MN

Key Theme: 3.03 Human Nutrition
Title: Genetic Improvement of Cattle Using Molecular Genetic Information

Description: 1) Genetic Modification of the Composition of Milk Fat: The objective of this study is to clone genes affecting the composition of milkfat, to identify polymorphisms in this genes, and study their associations with milk composition in dairy cattle. We have cloned and characterized the bovine stearoyl-CoA-desaturase and acyl tranferase gene LPAAT, and mapped these genes to bovine chromosomes 26 and 23, respectively. 2) Development of an AA and BB kappa-casein and beta-lactoglobulin herd of lactating dairy cows, application of marker assisted selection: The genetic variants of milk proteins have an important influence on the composition of milk, on the cheese making properties of milk and structural properties of whey-protein concentrates. We have bred two herds of dairy cattle, herd A with a frequency of 1.0 and 0.7 for alleles A of kappa casein and beta-lactoglobulin and herd B with a frequency of 0.6 and 0.3, respectively. Herd B milks have a higher solids non-fat and casein content in milk, and in 3 trials have produced about 0.5 pounds more cheddar cheese per 100 pounds of milk. Data has been collected from these experiments to complement a linear programming model that maximizes product revenue (cheese and whey components). The model is an important component to predict the marginal revenue associated with producing more cheese due to genetic differences.

Impact: Modification of the composition of milk fat by reducing the proportion of saturated fatty acid and improving the structure of milk fat will have an economic impact on the marketability of milk products and on the nutritional health quality of milk. Genetic selection of cows using molecular markers to increase the yield of cheese in the range of five to eight percent can have a significant economic impact for the dairy industry.

Funding Source: Hatch Multistate Research and State
Scope of Impact: AZ, CA, IL, IA, MA, MI, MN, OH, SD, USDA/ARS, VA, WI, NV

Key Theme: 3.03 Human Nutrition
Title: Nutrient Bioavailability - a Key To Human Nutrition

Description: The aim of this project is to define the in vivo dynamic and kinetic behavior of Vitamin A, Beta-carotene, and folate metabolism in humans and how diet, genetic, and physiologic factors can affect it. One of the techniques used in this project is innovative because it used extremely minute quantities of carbon-14 labeled Beta-carotene that can be detected for extremely long durations using Accelerator Mass Spectrometry (AMS). AMS is an emerging bioanalytical tool that stands to

revolutionize the way in vivo experimentation in humans is conducted. Studies that were once only possible in animals can now be performed safely in humans. To accomplish our objectives we proposed to study the fate of orally administered [carbon-14]Beta-carotene and folate. Using the carbon-14 as a tag, we can follow the fate of the [carbon-14] Beta-carotene and folate dose into the plasma pool. The results indicate that the vitamin A yield from dietary Beta-carotene is variable and low when it is consumed without prior emulsification, the usual practice in the U.S.. Our results also suggest that the behavior of folate metabolism is affected by genetic mutations in key folate enzymes. This suggests the requirement for this vitamin might be fine-tuned to better meet individual needs. We have also been successful in labeling plants with carbon-14 allowing for the production of nutrients and foods for research collaborations. Our future plans in this are include the study of intrinsically radio labeled food as well as botanical-drug interactions using soy isoflavones and carbon-14 Tamoxifen. A second technique is the development of a new analytic method for the measurement of folate. This method was developed to provide a better way to assess folate nutritional status. Whole blood folate is a superior indicator of folate nutritional status. Problems with and lack of confidence in results of current whole blood folate assays have limited its popularity for assessing nutritional status. We have developed a new techniques using acid extraction and GCMS detection. Our method uses readily available chemicals and results agree well using L. casei, the current gold standard reference assay. Presence of folate analogs (methotrexate) or antibacterials (sulfonamines) do not affect our method. This feature makes it useful in monitoring folate status of patents undergoing chemotherapy.

Impact: This information is important and relevant because: 1) Beta-carotene is an important source of vitamin A. Our research suggests the absorption to be variable. Therefore, current recommendations for b-carotene intake may need to be modified to take this knowledge into consideration. In all, more accurate and personalized recommendations can be formulated for optimum health. 2) Plants that are labeled intrinsically will be of great benefit for understanding the interaction of nutrients with the food matrix in which they are contained. 3) The ability to accurately determine whole blood folate will eliminate many of the current problems associated with methods for deterimining folate status. Such information will assist in establishing robust relationships between folate status and disease.

Funding Source: Hatch Multistate Research and State
Scope of Impact: CA, CO, IN, MA, MI, NE, NM, OR, WA, WY, USDA/WHNRC, Protor & Gamble Co.

Key Theme: 3.03 Human Nutrition
Title: Chemistry of Lipids in Foods and Tissues

Description: The lipid component of foods is important to food quality, stability, safety and nutritional value. The proposed research is directed toward an understanding of the basic chemical and biochemical properties of food lipids and how these relate to the organoleptic, structural and nutritional value of foods and diets. This project is helping to build the scientific knowledge necessary to optimize the composition of fats to produce more valuable and healthy foods. During the past year we have demonstrated the importance of lipids to the absorption of essential nutrients, and recommended that fat soluble vitamins be restored to fat-reduced foods. We have demonstrated the potential of complex lipids to modify the growth of cancer cells and argued for the expansion of this

research field as a means to influence the incidence of gastrointestinal cancers in humans and animals. Finally, we have demonstrated the importance of lipid metabolism as a reflection of overall health and argued for the use of metabolomic techniques to accurately reflect the overall status of health of individual humans rather than to rely on simple biomarkers of disease risk. We have moved the laboratory research objectives to include genomic knowledge as an important resource of the future and published on its importance to nutrition in general.

Impact: Lipids of foods provide positive aspects of food from structure to promoting growth and immunity, yet lipids produce negative aspects from food deterioration to promoting heart disease. Thus, the value of foods depends in part on optimizing the lipids. This research has provided means to stabilize lipids, to improve their nutritional impact and to demonstrate their nutritional value in diets.

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

Key Theme: 3.03 Human Nutrition
Title: Bioavailability of Vitamin A and Zinc From Selected Foods of Potential Use For Intervention Programs in Popluations at High Risk

Description: During the past year several studies were completed on: a) mineral (iron) absorption from iron-fortified, genetically-modified, low-phytate maize, b) the effect of multiple micronutrient supplementation on young children's growth, and c) the effects of varied duration of exclusive breast feeding on maternal nutritional status and infant motor development. Additionally, analyses were completed to development estimates of the global prevalence of inadequate zinc intake, using data from national food balance sheets. In previous studies we had found that iron absorption from low-phytate maize was approximately 50% greater than from wild-type maize. In the recently completed studies we learned that there was no difference in iron absorption from porridges that were prepared from the two types of maize when they were fortified with additional iron. Iron absorption was greater when maize was fortified with EDTA-iron than with iron sulfate. In studies of multiple micronutrient supplementation of Mexican pre-school children, we found that supplemented infants, but not older children, had increased rates of growth compared with unsupplemented counterparts. In randomized trials of four versus six months of exclusive breast feeding (EBF), we found that mothers of infants with longer duration of EBF were more likely to be amenorrheic at six months post-partum, and their infants crawled sooner and were more likely to be walking at 12 months. The analyses of national food balance sheets suggest that nearly half the world's population is at risk of inadequate zinc intake.

Impact: The advantage of low-phytate maize for enhanced iron absorption may be eliminated when the cereal is fortified with additional iron. Infants at risk of growth stunting and micronutrient deficiency may benefit from multiple micronutrient supplementation. Exclusive breast feeding until six months is advantageous for both mothers and infants. Zinc deficiency may be common in many parts of the world, and interventions should be considered to improve zinc status.

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

Key Theme: 3.03 Human Nutrition
Title: Genetic Improvement of Beans (phaseolus Vulgaris L.) For Yield, Disease Resistance, and Food Value

Description: Lunasin is a unique 43-amino acid soybean peptide that contains at its carboxyl end: (a) nine Asp (D) residues, (b) an Arg-Gly-Asp (RGD) cell adhesion motif, and (c) a predicted helix with structural homology to a conserved region of chromatin-binding proteins. We demonstrated previously that transfection of mammalian cells with lunasin gene arrests mitosis, leading to cell death. Here we show that exogenous application of the lunasin peptide inhibits chemical carcinogen-induced transformation of murine fibroblast cells to cancerous foci. To elucidate its mechanism of action, we show that lunasin (a) internalizes in the cell through the RGD cell adhesion motif, (b) colocalizes with hypoacetylated chromatin, (c) binds preferentially to deacetylated histone H4 in vitro, and (d) inhibits histone H3 and H4 acetylation in vivo in the presence of a histone deacetylase (HDAC) inhibitor. These results suggest a mechanism whereby lunasin selectively induces apoptosis mostly in cells undergoing transformation by preventing histone acetylation. In support of this, lunasin selectively induces apoptosis in E1A-transfected cells but not in non-transformed cells. Finally, in the SENCAR mouse skin cancer model, dermal application of lunasin (250 ug/week) reduces skin tumor incidence by approximately 70 percent, decreases tumor yield/mouse and delays the appearance of tumors by 2 weeks relative to the positive control. These results point to the role of lunasin as a new chemopreventive agent that functions possibly via a chromatin modification mechanism.

Impact: The lunasin peptide can be used as a novel chemopreventive agent against skin cancer and possibly other cancers.

Funding Source: Hatch Multistate Research and State
Scope of Impact: CA, CO, FL, GA, ID, MI, NE, NYC, ND, OR, PR, WA, WI, USDA/ARS, WI, MT

Key Theme: 3.03 Human Nutrition
Title: Metabolism of Intestinal Epithelial Cells

Description: To further characterize octanoate as a colonic luminal substrate, the influence of substrate concentration and alternative luminal fuels was evaluated in the rat colon in vivo. The appearance of 14C following luminal perfusion with 14C-labeled octanoate stabilized after 20-40 min of perfusion. Increasing luminal octanoate concentrations from 2 to 40 mM resulted in linear increases in total carbon absorption. Maximum CO2 production was reached at 10 mM. A substantial proportion of octanoate was absorbed without being metabolized (59-94%). The luminal presence of a mixture of alternative fuels had no influence on either transport or metabolism of octanoate. Using cultured colorectal adenocarcinoma cells, we hypothesized that the growth inhibiting effect of butyrate was mediated via the cell cycle inhibitor, p21 waf1/cip1. Sodium butyrate significantly inhibited growth in p53 wild type (LS513, Lovo) and p53 mutated (HT29, Caco2) colon cancer cells. HT29 and LS513 cells were arrested in G0/G1, whereas Caco2 and Lovo were arrested in G2 phase. p21 protein levels were elevated by butyrate in all 4 cell lines. The mRNA level of p21 was significantly and rapidly elevated by sodium butyrate treatment in HT29 and Caco2 cells. Differences were not significant in

LS513 and Lovo cells, and these cell lines showed comparatively higher baseline p21 mRNA levels than did the p53 mutated cell lines. In Caco2 cells, transient transfection with a plasmid containing the p21 full-length promoter indicated that butyrate increased transcription of the exogenous p21 gene.

Impact: The medium-chain fatty acid, octanoate, has the to potential to meet the energy needs of patients with compromised small-bowel function. By inhibition growth of colonic epithelial adenocarcinoma cells, butyrate has the potential to reduce or prevent colonic cancer.

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

Key Theme: 3.03 Human Nutrition
Title: Stability of Recombinant Human Milk Proteins

Description: The stability of recombinant human milk alpha-1-antitrypsin (AAT) expressed in, and purified from rice was studied in vitro and shown to exhibit similar characteristics to those of native AAT. Recombinant and native AAT were exposed to different temperatures, pH and digestive conditions mimicking those of the infant's gut and the activity was investigated after these treatments. The ability of recombinant AAT to inhibit trypsin activity in vitro 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. This role may be to limit proteolytic activity in the infant gut and thereby protect other bioactive proteins from being digested prior to exerting their activity.

Impact: Recombinant human milk proteins can now be produced in rice in large quantities. Proteins with biological function, such as alpha-1-antitrypsin, may therefore be added to infant formula to protect the activity of other bioactive proteins. We have already successfully produced recombinant human lactoferrin and lysozyme, which are present in high concentrations in breast milk, at high levels in rice. Addition of recombinant lactoferrin and lysozyme 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.

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

Key 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. We have detected a high prevalence of vitamin B-12 deficiency in U.S. elderly, and in all age groups in developing countries. In a high proportion of individuals the cause of deficiency may be malabsorption

of the vitamin from food, due to impaired gastric function. To test this concept, we developed a new method of detecting vitamin B-12 malabsorption that is suitable for use in field studies. This method is based on assessment of change in serum holotranscobalamin II after an oral dose of vitamin B-12. The first step was to improve the holotranscobalamin II assay by producing goat anti-rabbit antibodies to holoTC II. A pilot study was next conducted with 8 suspected normally absorbing adults and 6 subjects with pernicious anemia (a condition in which B-12 is not absorbed). In normal subjects 7/8 showed a substantial (75-220%) increase in plasma holoTC II at 8 hours after a 12.5 ug dose of the vitamin. In those with pernicious anemia, only 3/6 showed an increase and this was much smaller than in the normal subjects (90-120%). These promising results are being repeated with additional subjects with different doses of the vitamin and times of sample collection. Also, the results are being confirmed with a new commercial assay kit that recently became available. Pernicious anemia patients will be treated with an exogenous dose of intrinsic factor, which should restore their ability to absorb vitamin B-12, and absorption measured before and after this treatment. A USDA Competitive Grant was awarded last year to expand this methodological testing. Our Hatch funds are being used to apply the test on B-12 deficient individuals in developing countries.

Impact: This research will greatly improve the opportunity to detect vitamin B-12 malabsorption in the 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.

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

Key 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, research was conducted to validate the 18-item USDA food security instrument in a Latino population. From October through December, four focus groups were conducted to examine cultural interpretation of the 18 food security questions. A cross-sectional survey was carried out between February and May of 2001, among approximately 250 low-income Latino households in six California counties. The survey included the following instruments: 1) the 18-item food security instrument; 2) a 171-item self-reported household food inventory; 3) a 66-item food frequency questionnaire; and 4) a 16-item family demographic record form. All families included in the study self-identified as Latino, Mexican, or Mexican-American and had at least one healthy child, between three to five years of age. The final sample with complete data included 239 low-income Latino families. About 80% were primarily Spanish-speaking, mostly of Mexican descent. Seventy-nine percent were currently enrolled in the WIC program, and 25% received Food Stamps. Forty-four percent of the families (n=105) reported food insecurity without hunger; 13% reported moderate hunger (n=30); and 3% reported severe hunger (n=8). Across the four levels (food secure, food insecure/no hunger, moderate hunger, severe hunger), the frequency of affirmative responses to each of 18 food security items increased as the level of food insecurity becomes more severe. However, within a level of food insecurity, the frequency of affirmative responses did not always decline as expected as the severity of the items increases. In particular, subjects tended to respond positively more often to some of the child hunger items than to some of the adult hunger items. The

food insecurity scale measure was negatively associated with all categories of household food supplies: dairy, r=-0.19, $p < 0.004$; fruit, r=-0.36, $p < 0.001$; grains, r=-0.27, $p < 0.0001$; meat, r=-0.21, $p < 0.001$; and vegetables, r=-0.28, $p< 0.0001$. Similarly, the categorical measure of food insecurity was significantly associated with lower household food stores. Neither the scale nor categorical measure of food security was directly related to daily servings of fruit or vegetables in preschool children. However, child fruit and vegetable intakes were significantly correlated with household supplies of those foods (daily servings of fruit and household fruit score, r=+0.19, $p < 0.0002$). Food insecurity was associated with declines in household supplies of many nutritious foods (i.e., carrots, tomatoes, whole wheat bread, apples, oranges), as well as several less nutritious foods (i.e., soda, cookies, chocolate powder). Traditional Mexican foods, including beans, corn tortillas, and chili, tended to remain stable, as did several relatively high-fat or inexpensive food items (hot dogs, ice cream, Kool-Aid, instant soup). Thus, the 18-item food security instrument has convergent validity in this population of Latinos, as indicated by the relationships observed between food insecurity and household food supplies.

Impact: Although food insecurity is correlated with lower household food supplies in Latinos, the patterns of response to the 18 food security items suggests that the tool may not be able to tease out the subtle differences in quality vs. quantity of foods available to these households. This is the first study that links food security status to Latino families with an inventory of food items in the home. This gives us tremendous data on the specific food items low-income Latino families have in their homes. The results will help us develop nutrition education interventions through the Expanded Food and Nutrition Education Program (EFNEP), the Food Stamp Nutrition Education Program (FSNEP), WIC and other channels to improve the nutrition of young Latino children. The results of this study will also have important implications for monitoring food security in Latino families. This research has implications not only for effective monitoring of food insecurity and hunger in the United States but also for the design of nutrition education programs in Latinos.

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

Key Theme: 3.03 Human Nutrition
Title: Impact of Dietary Intervention on Cardiovascular Disease Risk

Description: Cardiovascular disease is the leading cause of death in the U.S. Phytochemical-rich foods in the diet such as soy, fruits and vegetables can contribute to decreasing the risk of heart disease. The ways in which these foods and phytochemicals promote cardiovascular health is being studied. This research investigates effects of dietary phytochemicals from foods such as soy protein, nuts and cocoa on lipid and lipoprotein metabolism and cardiovascular risk. The major accomplishments during this period relate to the following two hypotheses. 1) Hypothesis: Soy protein and phytoestrogens improve vascular reactivity and endothelial cell function. A randomized, double-blinded, crossover clinical trial was conducted in post-menopausal women comparing the effects of soy protein with or without phytoestrogens to a control casein protein. Brachial artery reactivity was the primary outcome and secondary outcomes were biochemical markers of cardiovascular risk. A total of 28 women completed the six-month study. Peak flow velocity in the brachial artery was significantly lower for women consuming soy with phytoestrogens compared to the control casein

protein. Current activities on this project are focused on completing the biochemical marker assays, after which time the statistical analysis will be done and a manuscript prepared. 2) Hypothesis: Dietary phytochemicals decrease the susceptibility of LDL to oxidative modification. In vitro studies utilizing phytochemical compounds at levels that occur in the plasma following ingestion of foods (nanomolar to low micromolar concentrations) demonstrated that phenolic compounds from nuts and flavanols from cocoa were protective against oxidative stresses. The oxidative susceptibility of LDL from human plasma was decreased in a dose-dependent manner with increasing concentration of phytochemicals. This suggests that these dietary derived compounds have the potential to act in a protective manner in vivo to decrease oxidative damage and therefore decrease cardiovascular risk. Current activities are directed at extending these observations to humans using food sources of dietary phytochemicals in clinical trials.

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

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

Key Theme: 3.03 Human Nutrition
Title: Role of Retinoid Metabolism in Breast Cancer

Description: This research program was centered on elucidating mechanisms of vitamin A metabolism and homeostasis and understanding the role of these processes in diseases including cancer. In the past year, we continued our studies comparing metabolic characteristics between normal mammary and breast cancer cells. These studies demonstrated that: a) normal mammary cells are growth inhibited to a greater extent by vitamin A (retinol) than breast cancer cells and that this growth inhibition is a function of the extent of metabolic conversion of retinol into retinoic acid; b) the relative ability to generate and respond to retinoic acid decreases in cells representative of more advanced stages of breast cancer; c) there are differences in the levels of transcripts encoding proteins involved in vitamin A transport, metabolism and signal transduction between normal and breast cancer cells. These findings indicate that alterations in vitamin A (retinoid) metabolic capacity are correlated with breast cancer progression and that this likely affects the neoplastic behavior of breast cancer cells. In complementary studies, we have identified a new enzyme involved in retinol metabolism in epithelial cells. While at present it is too early to establish a link between this new enzyme and its possible role in cancer or other conditions affecting epithelial tissues, understanding the role of this enzyme in these processes is an avenue of future research. Another avenue of our research program is involved in understanding the molecular signals and mechanisms regulating the systemic transport protein for retinol, RBP. In the past year, we have shown that reduced zinc status enhances the expression of this transport protein. This observation indicates that the status of both the nutrients zinc and vitamin A are interrelated and provides mechanistic insight into how zinc may affect vitamin A utilization. All of this work will be continued and expanded upon in the upcoming year.

Impact: Vitamin A, including its naturally occurring and synthetic analogs, exhibits a variety of benefits to human health including anti-cancer effects. In aggregate, our findings provide valuable

insight into the molecular mechanisms underlying vitamin A metabolism and homeostasis, which will be built upon to better understand the role of vitamin A in specific diseases. As such, our findings have ramifications for cancer diagnosis and treatment.

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

Key Theme: 3.03 Human Nutrition
Title: Measurement of Cell Proliferation in Response To Nutrients: Role in Carcinogenesis and Atherogenesis

Description: Carcinogenesis and atherogenesis involve a disruption in the proliferation of cells. This project seeks to determine the role of nutrients in modifying cell proliferation and risk for cancer and vascular disease. Proliferation and turnover rates of mammary epithelial cells (MEC), colon epithelial cells (CEC) and vascular smooth muscle cells (VSMC) have been measured in rodents. This has been accomplished by use of a new, non-radioactive (stable isotope)-mass spectrometric technique for measuring kinetics of genomic DNA, based on the incorporation of deuterated water into the deoxyribose moiety of replicating DNA. This technique was developed in our laboratory. Over the past year, the effects of dietary factors on in vivo proliferation of each of these cell types has been investigated. Administration of dietary genistein, a phytoestrogen present in soy products that has been proposed to inhibit mammary carcinogenesis, resulted in complex effects on MEC proliferation in female rats. There were no estrogen-agonist effects observed after either pre-reproductive or post-reproductive age administration of genistein or in ovariectomized rats. A modest (28%) inhibition of MEC proliferation was observed with chronic exposure both pre- and post-reproductive maturation. Dietary cholic acid, a co-carcinogen for colon cancer in rats, markedly increased the proliferation rate and accelerated the transit time of CEC in rats. Moreover, technical progress toward the isolation of long-term, label retaining CEC has been rapid over the past year, leading to the isolation of a subpopulation of cells with kinetic characteristics of colon stem cells. The effects of cholic acid and other factors on proliferation of these cells is being measured. The proliferation of VSMC from aorta has been measured in genetically modified mice (apolipoprotein E-knockouts) that develop atherosclerosis. VSMC proliferation increases with a characteristic time-course, relative to wild-type animals, and precedes the onset of gross histologic changes in the vessel wall. Thus, VSMC proliferation may represent a sensitive biomarker for evolving atherogenesis. The interaction of cytomegalovirus infection with apolipoprotein E-knockouts on VSMC proliferation is now being studied as a model of infectious atherosclerosis.

Impact: Having developed a simple, reproducible, safe and accurate technique for measuring the proliferation and death rates of breast epithelial cells, colonocytes, and vascular smooth muscle cells, the effects of nutrients and genes on these processes is now being investigated. Use of this approach has answered questions concerning the actions of dietary factors proposed to promote or prevent common diseases, including breast cancer, colon cancer and arteriosclerosis. In addition to improving our understanding of the underlying causes of these disorders, this research may lead to strategies for early detection, prevention and improved treatment.

Funding Source: Hatch and State

Scope of Impact: State Specific

Key Theme: 3.03 Human Nutrition
Title: Improving Iron/zinc Nutrition

Description: Iron and zinc deficiencies are highly prevalent and impair health and human development (individual and societal). Several strategies to diagnose, prevent and correct deficiencies are being developed and tested for efficacy and safety. We finished the analysis of samples collected from the human study performed in 2000, designed to validate the measurement of fractional zinc absorption using 65Zn as well as 67and 70Zn. Results show that 65Zn and 70Zn have the same disappearance rates after I.V. administration, that fractional zinc absorption varies both between subjects and and within subject when it is repeated 12 days apart regardless of method. The second measurement was lower than the first: from 45% to 23 % for the stable isotope ratio, and from 54 % to 25 % for the 65Zn method. Results are no different between methods. The 65Zn method must be validated when zinc is ingested together with food because the previous study was done with a zinc solution in the fasting state. The whole body retention of 65Zn in this normal population was a constant at 5 % 6 days after the ingestion of the dose. The 65Zn method appears promising for application in population studies in the developing world. We also continued the study of iron-induced oxidative stress and oxidative damage following our human and animal experimental models of daily and intermittent iron supplementation. We have demonstrated that iron-deficient rats have malfunctional liver mitochondria, and DNA breakage; that a similar effect is observed among rats receiving daily iron supplements, and that these effects are ameliorated by administering the supplements every third day. We have also determined that liver copper is elevated in iron deficiency possibly explaining oxidative damage. This does not occur in kidneys. Zinc levels parallel those of iron in both tissues. In collaboration with a colleague at the Pediatric Hospital of the Province of Buenos Aires in Argentina, we have explored further the effectiveness of purified hemoglobin iron as a source of heme iron under taxing conditions (short bowel syndrome). Results show that 1.25 mg of heme iron ingested with food is comparable to the ingestion of 15 mg of ferrous fumarate in replenishng deficient iron status in these patients. We have continued our collaboration with a researcher at the Instituto Nacional de Perinatologia in Mexico City on the relative effectiveness and safety of weekly and daily iron supplementation to pregnant women. The administration of 60 mg of iron daily to non-anemic women results in elevated hemoglobin levels that have been associated with birth weights below the average for the population. This undesirable effect is rare in women receiving weekly supplementation. The infants of the mothers in this study are being followed to determine their developmental characteristics. Lastly, in collaboration with our colleagues, we researched the literature from the obstetric, perinatological and nutritional perspectives and wrote a document on the "opportune timing of umbilical cord ligation", published by UNICEF, Argentina for use in Latin America. This document is having an important effect in providing proof of the nutritional benefits (mainly iron) and safety of the recommended procedures. It is already in its second printing.

Impact: We have continued to prove that iron deficiency, which is highly prevalent all over the world, has serious consequences; that daily iron supplementation as currently recommended is not innocuous, and that the intermittent administration of iron supplements is safer and as effective as daily supplement administration. We have also continued to provide alternative measures to control, iron deficiency: we have demonstrated the effectiveness of minute amounts of hemoglobin iron as a meal

supplement in children with short bowel syndrome. This may open a new avenue for overcoming iron deficiency; and we have supported the delayed ligation of the umbilical cord. We are also opening the possibility of studying fractional zinc absorption in developing world populations, where zinc deficiency is suspected on the basis of zinc intake and bioavailability.

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

Key Theme: 3.03 Human Nutrition
Title: Etiology of Iron Deficiency and Iron Deficiency Anemia Among Children Aged 12-36 Months

Description: The objectives of our study are to 1) assess iron status in a representative sample of children from low-income families, aged 12-36 months, 2) examine the association of several risk factors with iron status in this group of children and 3) as a long-term goal, the development of a comprehensive nutrition education program to reduce the risk of iron deficiency. To date, 183 subjects have been recruited, mothers have been interviewed, and blood draws have been obtained. The mother was interviewed with the risk factor questionnaire. A venous blood sample was drawn from the child at the clinic for subsequent analysis. In addition to the serum measures of iron status, (serum ferritin, transferrin saturation, and transferrin receptors), C-reactive protein was measured as an indicator of recent illness. Hispanics comprised the highest proportion of subjects, followed by African Americans, Mixed Ethnicities, Asians, Native Americans and Non-Hispanic whites, and others. Approximately 34% of the sample had a family income less than $14,999. The prevalence of anemia in this sample was 12.8%, the prevalence of iron deficiency was 21.5% and the prevalence of iron deficiency anemia was 3.4%. Iron deficiency was defined as serum ferritin concentrations less than or equal to 12 ug/l and transferrin saturation less than 16%. The percentage of iron sufficient and iron deficient subjects who utilized several food assistance programs was similar except for the use of Food Stamps; 24.8 % of the iron sufficient subjects utilized foods stamps compared to only 9.4% of the iron deficient subjects. Maternal anemia was associated with iron deficiency in the child as 38% of the mothers of children with iron deficiency were diagnosed with anemia during their pregnancy compared to 21% of the mothers of children who were iron sufficient. The majority of mothers, approximately 78%, in this sample had breast-fed their infants. There were no differences between groups with respect to breast-feeding. In contrast, current bottle feeding practices were associated with iron deficiency, with approximately 85% of the iron deficient children compared to 50% of the iron sufficient children currently using a bottle. Similar, to what we observed with maternal anemia, 38% of the children with iron deficiency compared to 18% of the children who were iron sufficient had been previously diagnosed with anemia. In summary, results to date demonstrate a prevalence of anemia of 12.8%, iron deficiency of 21.5% and iron deficiency anemia of 3.4%. In addition, factors associated with iron deficiency included: 1) lack of participation in the food stamp program, 2) pre-term delivery, 3) maternal anemia, 4) prior diagnosis of anemia in the child, and 5) current bottle feeding practices.

Impact: Efforts should be made to provide information to this target population regarding the potential positive health implications of participation in the food stamp program. Given the findings that maternal anemia may be a factor contributing to a child's iron status, a greater emphasis must be made to educate women about the need for optimal iron intake during their pregnancy. Appreciation of the health significance and causes of iron deficiency and iron deficiency anemia by members of the

medical community is necessary for a successful iron deficiency anemia intervention program.

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

Key Theme: 3.03 Human Nutrition
Title: TWIGS (Teams With Intergenerational Support) Gardening and Nutrition Curriculum Impact Evaluation

Description: More than 79% of all children and adolescents do not eat enough fruits and vegetables, 64% eat too much fat, and the prevalence of overweight among youths ages 6 - 17 has more than doubled in the past 30 years. Research also has shown that while traditional nutrition education programs increase knowledge and awareness, they impact consumption little. Vegetable gardening has great potential for being an effective nutrition education tool to effect behavior change, and also teaches ecological awareness, community development and pride, and encourages community public and private support and relationships. Internal and external grants supported the development and publication of TWIGS Gardening and Nutrition curriculum in late 1997. This curriculum is approved and used statewide by the Cooperative Extension Youth Food Stamp Nutrition Education Program (FSNEP) with current distribution to extenders over 2200 copies. The curriculum is composed of 30 lessons for elementary age youth. Phase I of this project (Spring 2001) involved focus groups of Youth FSNEP educators who used the curriculum between 1998 and 2001. The goal was to assess TWIGS program implementation, strengths and weakness, barriers to use, lesson preference, and better inform Phase II. Phase II involved assessing outcomes for youth participants. The target audience is youth from FSNEP qualifying schools (50% or more of children receive free or reduced lunch). Youth FSNEP county partners were collaborators, with the goal of obtaining participation commitment from 3 schools per county. The design was quasi-experimental, with committed schools randomly selected as control, T1, and T2 conditions. A designed, refined Pre/Post test was administered in 18 schools. FSNEP Nutrition staff, following training, would consistently teach selected TWIGS gardening and nutrition lessons to participating 3rd grade classes. The objective of the TWIGS program is to examine the impact of a nutrition and gardening curriculum on children's nutrition knowledge, attitudes about fruits and vegetables, and overall attitude about healthy food choices.

Impacts: During the 2001-02 school year, 312 third graders from 18 public schools in six California counties participated in the outcome evaluation. In the fall of 2001, UCCE Food Stamp Nutrition Educators from the six counties met to review selected nutrition and gardening lessons, discuss teaching consistency, discuss Human Subject considerations and complete requirements. Between October 2001 and July 2002, pre tests were conducted at all schools, five nutrition lessons taught at T1 schools, and 10 nutrition and gardening lessons taught at T2 schools. Post-tests were conducted and submitted by the end of July 2002. All cooperating schools were given a copy of the TWIGS curriculum. Data is being analyzed using SPSS software. Pre and post-test questions assessed children's knowledge about plants and food groups. Even though the control group scored higher in the pre-test compared to Treatment 1 and Treatment 2 groups, both groups caught up in their learning and did better in the post-test, with Treatment 2 doing significantly better in the post-test than Treatment 1. This indicates that children who were taught about plants and nutrition as well as gardening, learned or retained more of the information than students who were only given the nutrition lessons. This

project's research findings add to the growing body of research that shows that involving children in gardening does positively influence their knowledge and attitudes about healthier eating habits.

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

Key Theme: 3.03 Human Nutrition
Title: Adult Food Stamp Nutrition Education Program (FSNEP)

Description: The food stamp program is the largest of the federal safety net programs and first line defenses against hunger. Unfortunately, not all who are eligible and can benefit from this program are enrolled. Additionally, even with financial assistance, many families are unable to effectively use this resource to provide healthy diets for their families. The Adult FSNEP program educates these consumers on healthy food choices, wise food purchasing, and safe and proper food handling and preparation. In Placer County in 1997 there were 17,812 low-income residents, 7,412 who received TANF assistance and 9,173 who received food stamp assistance. The Adult FSNEP program provides food stamp eligible families with quality nutrition education to improve their families' diets and health and assist in their transition to self-sufficiency. Programs are delivered through educational classes, mini-workshops, and correspondence courses. A monthly newsletter, Foodlines, is delivered with food stamps to each Placer County food stamp recipient. A Foodlines for Professionals newsletter is distributed monthly to agencies and organizations that work with food stamp eligible families and individuals. Over 1700 individuals received the Adult FSNEP program over the past three years. A total of 82,800 Foodlines newsletters were distributed. Strong relationships were established with other agencies in support of these nutrition education efforts. One television segment was presented on 'Good Day Sacramento.

Impact: Low income families have improved their family's diets, increased the variety of food choices, improved their food preparation, budgeting, and meal planning skills and improved their knowledge of safe food handling practices. Success in this program has contributed to funding for two other Placer County Nutrition Education projects that total over $310,000 annually.

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

NATIONAL GOAL 4

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

Significant progress was made 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 164 peer-reviewed articles and 10 extension publications in the areas covered by Goal 4. Over 480 local extension programs were delivered in this area. UC ANR funded 25 statewide collaborative workgroups composed 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 7 Statewide Special Programs that bring together AES and CE resources and personnel that addressed critical issues in the state that are included within National Goal 4.

FY 2001-2002 Allocated Resources

Extension Federal Funds (Smith Lever 3 b&c)	Extension State Match	Research Federal Funds (Hatch)	Research State Match
$1,573,022	$17,557,515 [106.76 FTE]	$1,506,399	$37,673,090 [118.65 FTE]

Key Theme: 4.01 Agricultural Waste Management
Title: Utilization of Agricultural Wastes in Textile Processing

Description: In the study of utilization of agricultural wastes in textile processing, a drainage by-product, drainage salt, has been found usable for textile dyeing. Agricultural drainage salt generated during irrigation of crops in San Joaquin Valley, California, exceeds 600,000 tons annually and cumulates in the field in a rapid rate. As a result, the waste is taking out more farmlands for salt storage and disposal, imposing serious concerns to environment and local agricultural industry. In searching for a potential solution to reduce or eliminate the waste, this research explored feasibility of producing a value-added product, sodium sulfate, from the waste and utilizing the product in textile dyeing. The results indicated that sodium sulfate could be produced from the salt and could be purified by a recrystalization method in a temperature range within the highest and lowest daily temperatures in summer in the valley. In some locations in the Valley, the salt was almost in a form of pure sodium sulfate. The recovered sodium sulfate samples, with purities ranging from 67% to 99.91%, were compared with commercially available sodium sulfate in reactive dyeing of cotton fabrics. The salt samples recovered from Mendota, California (>98.8% sodium sulfate) cause little color difference in the dyeing with selected reactive dyes, and the purified salt (III) (99.91% sodium sulfate) is more applicable for reactive dyeing of cotton fabrics if it has no other toxic effect. The recovered sodium sulfate from certain areas in the valley could not be employed in reactive dyeing due to the high level of impurities in it.

Impact: We have studied the feasibility of utilizing an agricultuale waste, drainage salt, in textile dyeing. Sodium sulfate, as a value-added product, can be produced from agricultural drainage salt in

California center valley, and can be used in reactive dyeing of cotton fabrics.

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

Key Theme: 4.01 Agricultural Waste Management
Title: Biochemical and Structural Studies of the Rad17 Protein From S. Cerevisiae

Description: We are continuing to determine structures of proteins in the aldo-keto reductase superfamily in order to understand how they bind their respective substrates and promote catalysis. In particular, we are focusing on xylose reductase from Candida tenuis in collaboration with the Nidetzky lab at the University of Agricultural Sciences in Vienna, Austria. This enzyme catalyzes the reduction of xylose, a five carbon sugar to xylitol using either NADPH or NADH as a cofactor. In doing so, it confers upon the yeast the ability to grow utilizing xylose as a carbon source. This is relevant to agriculture in California because xylose is a major component in agricultural wastes. Optimizing C. tenuis to ferment these wastes by improving xylose reductase activity would be an environmentally preferable alternative to the current method of burning these wastes. The crystal structure of xylose reductase reveals that the enzyme folds into a beta/alpha barrel structure with the nicotinamide moiety at the carboxy-terminal end of the beta barrel. The orientation of the nicotinamide shows that the hydride transferred is the 4-pro-R hydride. The rate determining step of the enzyme is the dissociation of the consumed cosubstrate (NAD(P)+). In structural terms, this corresponds to the breaking of a polar interaction fastening a loop on top of the cosubstrate. Removal of this loop is likely to improve the catalytic efficiency of the enzyme. Another unusual property of the enzyme is that it functions as a dimer. Our results provide a structural paradigm for other dimeric xylose reductases. Preliminary observations point to the fact that the dimeric interactions are disrupted by high salt concentrations. Structurally, this is explained by the predominantly hydrophilic interactions seen mediating the intermolecular contact surface. Structurally, little is known about substrate binding to aldo-keto reductases in general and nothing is known in the case of xylose reductase. We are currently in the process of determining the structure of the xylose reductase holoenzyme (i.e. the enzyme bound to NADP+). Although the binding pocket is predominantly hydrophobic, a sub-optimal characteristic for a sugar-binding enzyme, ordered waters are present. We are modeling xylose into the active site by superimposing the sugar hydroxyls on these ordered waters in order to understand sugar binding. This information will then be used to optimize the binding by introducing mutations.

Impact: Straw resulting from rice harvest is a major agricultural waste product. This is typically burned, releasing pollutants into the air. The yeast C. tenuis is able to grow on xylose (a major component of straw) as a carbon source to produce ethanol, a compound that is industrially useful. We are refining the crystal structure of xylose reductase, the enzyme responsible for this in order to understand and perhaps improve catalytic properties.

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

Key Theme: 4.01 Agricultural Waste Management
Title: Alternative Straw Management Practices on Available Soil Resources in Flooded Rice Fields

Description: While burning is the traditional disposal method of straw and stubble in temperate and tropical rice-growing areas, this practice is causing concern because of potential air pollution. In recent years air and soil quality issues have increased the importance of alternative rice straw management practices. California legislation now restricts burning to less than 25% of the rice acreage, and allowable burning will decrease to none. Alternatives to burning include soil incorporation or baling of the straw. Shallow flooding of rice fields in the winter is commonly used in California because of its potential to enhance decomposition of straw and provide winter wetland habitat for migrating waterfowl. An increase soil organic matter content in rice systems and higher rates of net N mineralization following the incorporation of residues will also be beneficial to farmers. The impact of long term residue incorporation on the overall nutrient supply power of the soil remains an important issues. Does residue incorporation lead to an increase in crop available N and if such an increase occurs, by how much can farmers reduce the rate of N fertilizer? An N rate fertilizer experiment was conducted over four years where residue had been burned or incorporated, followed by winter flooding or no winter flooding. The overall grain yield pattern that emerged over the years was that incorporating residue for > 5 years followed by winter flooding increased yield of unfertilized rice by almost 100% compared to the yield of unfertilized rice when residue was burned. However, if the fields were not winter flooded, the yield of the unfertilized rice was not affected by residue management. Under high rates of N fertilizer input, the yield was higher when the residue was burned compared to the yield when residue was incorporated. However, the yield plateau was reached with less N fertilizer input when the residue was incorporated than when the residue was burned. This suggests that when residue was incorporated, some non-N effect manifested itself under high rates of N fertilizer applications which limited its maximum yield potential. Winter flooding also provides a winter habitat for water fowl. The Sacramento Valley is part of the Pacific Flyway and the rice fields are used extensively for foraging purposes. Moreover, a study conducted along the entire Sacramento Valley showed that water fowl increased residue decomposition and reduced the weed population. Therefore, there are mutual benefits for farmers and for wildlife alike when the rice fields are winter flooded.

Impact: This project has resulted in rice farmers flooding their fields to promote straw decomposition, increasing soil organic matter and providing nutrients to the following crop, while also providing winter habitat for migratory waterfowl.

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

Key Theme: 4.01 Agricultural Waste Management
Title: Animal Manure and Waste Utilization, Treatment, and Nuisance Avoidance For a Sustainable Agriculture
Description: Integrated ASBR-SBR systems were experimentally studied in the laboratory for dairy wastewater treatment. The ASBR was used as the first-stage reactor and tested at three organic loading rates with the 3 gVS/L/day found to be the best. The SBR was used as the second-stage reactor and tested with different aeration schemes to achieve nitrification only for ammonia oxidation or nitrification and denitrification for nitrogen removal. Two ASBR-SBR systems were developed. The

first system (System I) used an intermittently aerated SBR to achieve nitrification only. The SBR was fed twice a day with the ASBR effluent. The second system (System II) also used an intermittently aerated SBR but with the aeration and feeding schemes designed to achieve nitrification and denitrification. The SBR was fed six times a day with a mixture of ASBR effluent and raw wastewater supernatant. For System I, the overall removals of COD, TS, VS, TN, TKN, and NH3-N were 54.1%, 39.0%, 43.4%, 16.6%, 58.8%, and 94.5% in the total effluent, respectively; and 90.4%, 70.3%, 79.7%, 45.7%, 87.9%, and 94.5% in the liquid effluent, respectively. For System II, the overall removals of COD, TS, VS, TN, TKN, and NH3-N were 53.6%, 40.2%, 43.5%, 58.2%, 61.2%, and 100% in the total effluent, respectively; and 89.2%, 69.9%, 77.7%, 86.1%, 89.1%, and 100% in the liquid effluent, respectively. There was no significant difference in the effluent quality of System I and System II, except for TN and NOx-N concentrations in the effluent.

Impact: This research project is developing and demonstrating an integrated animal wastewater treatment system to enhance biomass resource utilization, enable on-farm water recycling and reuse, improve animal herd health and food safety, and reduce environmental pollutant discharge. The research findings have significant impact on agricultural sustainability and environmental protection.

Funding Source: Hatch Multistate Research and State
Scope of Impact: AZ, CA, CO, HI, ID, NE, NV, ND, OR, TX, WA, ARS, ERS, KS, UT, NM

Key Theme: 4.02 Air Quality
Title: Pedological Studies of California Soils: Links To Soil Survey, Soil Quality, and Air Quality

Description: We developed a dust generator for lab use to compare field-collected dust with lab-generated dust. A rotating barrel with internal baffles tumbles soil material to produce the dust, and a blower forces the dust through a pipe into a settling/sampling chamber. We collect total dust, PM-10, PM-2.5, and respirable dust (about 4 microns diameter) fractions from soils with a wide array of textures and at a range of water contents. Field dust is similar to lab dust qualitatively, so we are confident we can use the generator to simulate some field conditions. Silty and clayey soils produced the most dust; different textures have different water content thresholds above which little dust is produced. A related project showed that conservation tillage in a cotton-tomato rotation may significantly reduce in-the-field dust measured behind farm implements. Based on mineralogical and spectroscopic analyses, our continuing work on the palagonitization of Hawaiian and Icelandic basaltic glasses suggests hydrothermal alteration and subglacial volcanic eruptions, rather than typical pedological weathering processes, may be reasonable terrestrial models for rock alteration processes on Mars. We finished a comparison of soil acidification by N-fertilization vs. long-term weathering. Al-hydroxy-interlayering appears to be a main sink for solution Al regardless of parent material composition. Greenhouse-produced rhizospheres tend to moderate soil pH and produce non-equilibrium soil solutions that reflect known Al-silicate solid phase composition, indicating the importance of kinetics in determining solid phases. A new project identifies K-fixing soils on cotton ground in the San Joaquin Valley from soil survey information. We speculate that coarse-textured soils derived from granitic alluvium will fix K due to abundant vermiculite.

Impact: The dust research identifies soils likely to produce dust when disturbed, shows that dust might be reduced if soils are cultivated at soil water contents above the dust threshold, and shows that conservation tillage can reduce dust in the field. Research findings are being implemented to

significantly reduce particulate matter in the air.

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

Key Theme: 4.02 Air Quality
Title: Transport and Transformation of Trace Gases in Soil

Description: The gas diffusion coefficient in soil, and its dependency on soil physical characteristics, governs the diffusive transport of oxygen, greenhouse gases, fumigants, and volatile organic pollutants in agricultural, forest, and urban soils. Accurate models for prediction of the diffusion coefficient as a function of air-filled porosity in soils are needed for realistic gas transport and fate simulations. The tortuosity phenomena of the pore space is a critical characteristic influencing the transport of not only gases but also water and solutes. Experiments were conducted to evaluate if there are any consistencies in the tortuosity of the gas and water phases of soil. The tortuosity in the gaseous phase of a wet soil is greater than that in a dry soil and is typically larger in undisturbed soil compared to sieved, repacked soil. Key soil physical parameters controlling diffusive and convective transport in soil are pore size distribution, surface area, and structural parameters such as an equivalent pore diameter index and the soil-air content at -100 cm of soil-water pressure head. Once emitted to the atmosphere, nitric oxide and nitrous oxide regulate several important processes in the troposphere and stratosphere. Understanding controls over N oxide gas emissions from fertilized soils is often complicated by highly heterogeneous and dynamic field conditions. An intact soil core method was developed for examining multiple subsurface controls concurrently with N oxide surface fluxes dominated by Fickian diffusive transport. The method is applied to moderately acidic soil fertilized with anhydrous ammonia. Steady nitrification and persistent nitrite levels resulted in nitric oxide gaseous losses representing 22-37% of the inorganic N initially present and > 50% of the nitrified N. Of the initial N mass present, 96-119% was accounted for as N solutes and gases. High nitrous oxide soil-gas concentrations and fluxes persisted despite extremely small anaerobic soil fractions, suggesting that nitrous oxide sources other than denitrification were important. We compared the predictions of a transport and transformation model to data from the intact soil core experiments and then used the model to evaluate the relative importance of individual processes following anhydrous ammonia application to moderately acidic soil. Soil-gas concentrations of N oxide gases were adequately described using previously obtained kinetic expressions. Net nitric oxide surface fluxes were shown to be the result of high rates of subsurface gross nitric oxide production balanced by gross consumption rates equivalent to 92-97% of gross production. Denitrification was estimated to contribute only 8-14% of the total nitrous oxide source under primarily aerobic conditions, with the balance due to abiotic nitrous acid decomposition. The effectiveness of pH control and subsurface fertilizer injection for minimizing gas losses were evaluated through computer simulations.

Impact: The environmental significance of this research is that we now have an improved understanding and predictive capability of the processes controlling the emission of pesticides, volatile organic chemicals, and trace gases from soil to the atmosphere. For nitric oxide, a precursor to ozone production in agricultural and urban areas, the increased use of ammonium-based fertilizers will have the consequence of decreasing pH in weakly buffered soils, which will tend to increase the emission of nitric oxide from agriculture. The production of nitrous oxide during both nitrification and

denitrification will result in a major challenge in reducing the emission of this greenhouse gas from agricultural land.

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

Key Theme: 4.03 Biodiversity
Title: Conservation and Restoration of Grassland and Oak Savanna Productivity and Biodiversity

Description: The objectives of this research program were to use two native grass species widely planted for restoration in the western U. S. (Elymus glaucus and Nassella pulchra) as model systems to evaluate interpopulation hybridization and the potential persistance of non-local genes within local populations. Our initial approach was to evaluate persistence of maladapted non-local genes due to hybridization between local and non-local populations and to determine the rate of outcrossing between local and non-local populations planted together under natural conditions. An additive planting design, with two N. pulchra populations (a local source and a commercially available non-local source from Southern California) was used. The two populations were known, from previous work, to differ in banding patterns for several isozyme stains. Twenty-five local seedlings were intially planted in the winter of 1998/1999 into each of 18 fenced plots at the Sierra Foothill Research and Extension Center. Plots were located a minimum 30 meters apart within a matrix of exotic annual grasses. In each plot, the local plants were planted in a 5 x 5 grid with an 18 cm spacing between plants. In six of the plots, 16 individuals from the non-local population were planted within the spaces between the local plants, while in another 6 plots, 56 individuals from the non-local population were planted. The remaining six populations were controls, containing no non-local plants. During the spring of 1999, seed was collected from the central nine local plants. This seed, along with seed of the two parental populations, were germinated and fresh plant extracts run on starch gels (using starch gel electrophoresis techniques). The proportion of seed collected from the mixed plots that contained banding patterns associated with the non-local source was evaluated and rates of hybridization were estimated. During spring 2001, mortality was measured in each of the plots and the relative vigor of surviving plants estimated using plant size measurements. Seed collected during this period will be assayed electrophoretically and the relative fitness of local genotypes and hybrids (crosses between local and non-local genotypes) will be compared in a common garden experiment conducted during the upcoming growing season.

Impact: The last decade has seen an enormous increase in using native plant species for restoration and revegetation projects. Our research provides critically needed information on whether genetic pollution is a real risk when translocating different genetic stocks from their source of origin to different locales within the State for use in restoration and re-vegetation.

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

Key Theme: 4.03 Biodiversity
Title: Environmental Informatics

Description: Over the last year, our international projects have concentrated on 2 issues: Biodiversity and sustainable use, and invasive species. Under funding from the National Park Service and UNESCO, ICE has greatly expanded the core databases documenting biodiversity and resource information in UNESCO Biosphere Reserves and other cooperatively managed areas, and has helped lead efforts to develop international data exchanges for the Convention on Biodiversity and related treaties based partially on the standards developed under this long-term project. For invasive species, we have co-developed software and training materials with USGS and USDA to link national invasive species information nodes for the Summit of the Americas, NAFTA, and some bilateral projects, and hosted two major international meetings on standards and protocols. A UC researcher is currently on the technical advisory board for the National Invasive Species Council and the UNEP Global Invasive Species Programme, which are the lead programs coordinating international co-operation on invasive species issues. U.S. projects have centered around ICE's participation in the National Biological Information Infrastructure (NBII), the federal interagency program coordinating exchange of biological (ecological) information among federal agencies and partners. We have recently been funded to operate the California Node of NBII (www.cain.nbii.gov), and have been the lead node in adapting next generation geospatial and semantic web technologies to discovery, searching, and exchange of biological resource information. Other federal grants and contracts include vegetation and fire risk modeling under the Joint Fire Sciences program, completion of multi-state portions of the National Hydrographic Dataset, and analysis of opportunities for integrating fire protection, watershed protection, and emerging biomass fuels markets in western forests. ICE has had numerous new California interagency agreements. Some of the notable accomplishments include establishing a $15 million umbrella agreement with CalTrans for cooperative state-university analysis of environmental planning issues. We completed the state's on-line system to make documents from CEQA freely available to planners, researchers, businesses, and the interested public. Under EPA and State Water Board funding, we have developed much of the databases and GIS systems used by water regulators to address the non-point sources issues under the Clean Water Act, and have a cooperative agreement with Heath Services to develop software and risk assessments required under its drinking water protection program. ICE has co-led efforts to develop data strategies for the CalFed Bay-Delta program, and has recently been awarded a $2.3 million grant to apply those strategies into a watershed assessment of the Cosumnes River floodplain and watershed. Results of other projects can be viewed on ice.ucdavis.edu.

Impact: The data framework developed by ICE has been widely applied in state, national, and international agencies and programs, and has become an important element of proposed new standards for public environmental information. The ICE website is one of the most visited sources of on-line environmental information in California, and is widely used by policy makers, researchers, public policy advocates, schools, and members of the general public.

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

Key Theme: 4.04 Biological Control
Title: Utilization of Entomopathogenic Nematodes in the Biological Control of Pestiferous Insects

Description: The development of five geographic isolates of the entomopathogenic nematode, Steinernema feltiae, was examined in an insect host at 5, 8, 10, 15, 20, 25, and 28 C. Three nematode isolates were from Mediterranean region, two were from the subtropical region, and one was from tropical region. All isolates killed 100 percent of the insect hosts and developed and produced progeny between 8 and 25 C. At 28 C, mortality was 100 percent, but no nematode progeny was observed. The highest infective nematode production was observed at 15 C for all isolates. The tropical isolate had the lowest production of infective nematodes. At 25 C, the infective nematodes emerged from the host cadavers from 5 to 7 days. At 25 C, four out of the five isolates had shorter times to host death. Longer infective nematodes were observed at 8 C than at 15 and 23 C. The data suggest that the developmental time influences the body length of the infective nematode.

Impact: Developmental temperatures of entomopathogenic nematodes can predict whether the nematodes will successfully reproduce and continue to infect pest species in the field. Geographical isolates showed very little differences in temperature tolerance in infectivity and reproduction. All else being equal, these isolates could be used in biological control programs within the tolerant temperature ranges.

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

Key Theme: 4.04 Biological Control
Title: Nutrition of Insect Parasites and Development of Methods For in Vitro Culture

Description: Most recent investigations examining nutritional regulation of metabolism were conducted with M. SEXTA to determine how dietary protein/carbohydrate ratio affects blood sugar level, and in turn, how blood sugar level affects insect feeding. Last instar larvae were maintained on a variety of semi-defined artificial diets with variable levels of casein and sucrose. Both the level of dietary casein and sucrose affected larval growth and diet consumption. Moreover, there was a strong interaction between these two nutrients and their effects. The dietary level of both nutrients also affected blood sugar level, which decreased with increasing dietary protein level and increased with increasing dietary carbohydrate. Blood sugar level significantly affected subsequent dietary selection when larvae, having been maintained on the above diets and displaying variable blood sugar levels, were subsequently given a choice between a high carbohydrate diet and a high protein diet. Those larvae that consumed less than approximately 250 mg sucrose over the feeding period had blood sugar concentrations less than approximately 35 mM and chose the high carbohydrate diet over the high protein diet. These larvae were also gluconeogenic and displayed active blood sugar synthesis from amino acid.

Impact: These investigations establish basic mechanisms of nutritional regulation in insects. They provide a link between animal's external environment and the provision of food to its feeding physiology through metabolic regulation. Such studies will greatly enhance our understanding of insect behavior and may provide a means for predicting potential insect damage.

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

Key Theme: 4.04 Biological Control
Title: Biology, Ecology, and Management of Insects Affecting Woody Ornamental Plants

Description: Research focused on the ecology and management of introduced insect pests on woody ornamental plants. The larval parasitoid, Syngaster lepidus, was released in southern California as part of a biological control program for P. semipunctata and Phoracantha recurva. A biological control program has been established for the chrysomelid, Trachymela sloanei. More than 2000 individuals of the egg parasitoid, Enoggera reticulata, were released in southern California in 2001. Laboratory studies were continued to evaluate the host defenses mounted in eggs of the two different species of Phoracantha species to eggs of the encyrtid parasitoid, Avetianella longoi. Laboratory and field studies are underway to determine seasonal activity, temperature tolerances, and influence of temperature on lifetime fecundity of the two cerambycid species. A field study was initiated to determine competitive interactions between the two borers. Laboratory investigations have been initiated to determine the mechanisms used by the larval parasitoids to detect and evaluate cryptic host larvae. The tree-killing longhorned borers are attracted to stressed eucalyptus trees and the risk of beetle infestations has increased as a result of two new leaf-feeding insects that have been introduced into the state. Prophylactic insecticide treatments continue to be evaluated to protect eucalyptus from infestation by the psyllid, Glycaspis brimblecombei. Plots have been established to investigate management of the complex of introduced insects feeding on eucalyptus requires development of an approach that includes cultural reduction of tree stress, host plant resistance, biological control, and, when necessary, appropriate systemic insecticides. The fourth year of sampling was completed in an investigation of the impact of atmospheric nitrogen deposition and ozone associated with air pollution on the composition and structure of herbivorous arthropod communities on California black oak, ponderosa pine, and bracken fern. Sample sites are located in areas of the San Bernardino Mountains at similar elevations and similar plant communities, but with high or low pollution levels. Studies were initiated to assess the impact of mycorrhizal fungi on the arthropod communities of wild tobacco. Host plant suitability and host plant preference studies of the newly introduced pink hibiscus mealybug have been completed using eight common species of ornamental plants.

Impact: The research blends fundamental and applied elements of insect-plant interactions, biological control, behavior, and insect ecology in efforts to develop comprehensive integrated pest management programs that reduce insecticide applications. The nursery, arboriculture, and landscape industries have adopted the results from the multidisciplinary approach. The biological control programs become the cornerstone of the efforts, and they are supported by modifications in plant cultural practices and host plant selection.

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

Key Theme: 4.04 Biological Control
Title: Development, Evaluation and Safety of Entomopathogens For Control of Arthropod Pests

Description: White grubs are serious pests of turfgrass on golf courses, parks, and home lawns. Six

Korean entomopathogenic nematode isolates Steinernema carpocapsae Pocheon, S. glaseri Dongrae, S. glaseri Mungyeong, S. longicaudum Gongju, S. longicaudum Nonsan, and Heterorhabditis sp. Gyeongsan were tested against larvae of the oriental beetle. In addition, the organophosphate insecticide, chlorpyrifos-methyl, was combined with Heterorhabditis sp. to determine if a synergistic effect upon larval mortality could be obtained. Both laboratory and field tests were conducted. Laboratory results showed that when 300 infective nematode juveniles in 30 cc of soil was applied, Heterorhabditis sp. caused 100 percent mortality of the second instars four weeks posttreatment, followed by S. longicaudum Nonsan and S. longicaudum Gongju. S. carpocapsae Pocheon and S. glaseri Dongrae were the least effective species. When nematodes were applied at the same rate as the second instars to overwintering third instars, the efficacy was low with Heterorhabditis sp. causing the highest mortality at 39 percent four weeks posttreatment. The combination of half the recommended rates of Heterorhabditis sp. (500 million nematodes/ha) and chlorpyrifos-methyl (9.4 liters active ingredient/ha) was more effective than Heterorhabditis sp. or chlorpyrifos-methyl alone at half rate. In the field, Heterorhabditis sp. was the most effective representing 70 percent mortality, but there were no differences in mortality among the Steinernema spp. Combination of Heterorhabditis sp. with chlorpyrifos-methyl resulted in a synergistic effect representing 91 percent mortality compared with 69 percent in the nematode or 22 percent in insecticide alone treatments.

Impact: Different species/isolates of entomopathogenic nematodes cause differential mortality in white grub populations. It is important to select the right nematode species to control the target pests. Combinations of entomopathogenic nematodes and chemical pesticides can act synergistically resulting in economic control of a pest species.

Funding Source: Hatch Multistate Research and State
Scope of Impact: AL, AR, AZ, CA, CTH, FL, GA, ID, IL, KY, LA, ME, MN, NJ, NYC, NC, OH, SC, TN, TX, VA, USDA/ARS, USDA/FS, DE, PA

Key Theme: 4.04 Biological Control
Title: Biological Control and Ecology of Arthropod Pests Attacking Avocado

Description: Significant results have been achieved in the fourth year of work on the biological control avocado pests in California. First, the overwintering ecology of OLIGONYCHUS PERSEAE has been determined. 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. Second we have developed an mechanical dispenser for applying predatory mites (NEOSEIULUS CALIFORNICUS) to avocado trees. 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. The searching behavior of this predator has been studied, and its attack rates quantified. California insectaries have commercialized this predator using the results of our research findings. We are currently developing an automated sorter to count and categorize predator thrips pupae thereby reducing labor costs associated with sorting. Work investigating the suppressive activity of composted organic mulches under avocados for control of pupating SCIRTOTHRIPS PERSEAE is ongoing.
Impact: Growers, grower cooperatives, and insectary managers are using N. californicus and our recommended release rates and frequencies for biological control of persea mite in California. Mass rearing of Franklinothrips orizabensis, the key natural enemy of avocado thrips in California, has been

undertaken by two commercial insectaries using the results of our research.

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

Key Theme: 4.04 Biological Control
Title: Managing Plant-microbe Interactions in Soil To Promote Sustainable Agriculture

Description: One of the first steps in characterizing an ecosystem is to describe the organisms inhabiting it. For microbial studies, experimental limitations have hindered the ability to depict these diverse communities. To address these methodological deficiencies, we have developed a new method termed oligonucleotide fingerprinting of ribosomal RNA genes (OFRG). This method permits the identification of arrayed ribosomal RNA genes (rDNA) through a series of hybridization experiments using small DNA probes. To demonstrate this strategy, we examined the bacteria inhabiting two agricultural soils possessing differing abilities to suppress the plant parasitic nematode Heterodera schachtii. Analysis of 1536 rDNA clones revealed 766 clusters grouped into 5 major taxa: Bacillus, Actinobacteria, Proteobacteria and two undefined assemblages. Soil specific populations were identified and then independently confirmed through sequence specific PCR of the original soil DNA. Near species level resolution was obtained by this analysis as it resolved bacterial clones with an average sequence identity of 96%. The pathogen suppressive soil was shown to contain greater species richness and diversity than the non-suppressive soil, when examined by Chao1 and Shannon analyses and by summing the branch lengths from UPGMA trees. A comparison of these OFRG results with those obtained from a denaturing gradient gel electrophoresis (DGGE) analysis of the same two soils demonstrated the significance of this methodological advance. OFRG provides a cost effective means to extensively analyze microbial communities and should have application in medicine, biotechnology and ecosystem studies.

Impact: This newly developed strategy will enable thorough analysis of microbial community composition. This should assist investigations of disease suppressive soils, which should lead to the identification of new biological control agents.

Funding Source: Hatch Multistate Research and State
Scope of Impact: State SpecificAK, AZ, CA, ID, IL, MT, NYG, OR, WA, USDA/ARS

Key Theme: 4.04 Biological Control
Title: Development, Evaluation and Safety of Entomopathogens For Control of Arthropod Pests

Description: There are two microbial control agents that are currently used in mosquito control programs. These are Bacillus thuringiensis israelensis (Bti) and B. sphaericus (Bsph). Both species produce parasporal crystalline toxins which when ingested by mosquito larvae cause high levels of mortality. Studies have shown that mosquito larvae are capable of developing resistance to the commercial strains of B. sphaericus. However, no cases of resistance have been reported against Bti. Our research focused attention on finding and developing strategies which will have practical significance in reversing resistance or precluding resistance development in the first place. Laboratory

selections of susceptible mosquitoes with Bsph alone, Bsph + Bti mixture and Bsph and Bti rotation have yielded promising results. After 20-25 generations under selection Bsph alone and Bsph and Bti rotation resulted in high level of resistance to Bsph while Bsph + Bti (1:1) mixture showed little or no emergence of resistance to Bsph. A year long study was carried out in the field. Two sites with highly polluted water supporting the cosmopolitan mosquito Cx quinquefasciatus were subjected to repetitive treatments with Bsph (WDG formulation) alone or Bsph +Bti (1:1 mixture) at 100 mg/m2. In Bsph treatments, high level of resistance appeared after 17 treatments. Failure of control was noted at the rate of 100 mg/m2 as well as the higher rate of 200 mg/m2. No failure of control was noted at the site treated with the mixture of Bsph and Bti. It looks like the use of a mixture provides a practical and viable solution.

Impact: The findings of our studies will have enormous impact on mosquito control programs. It appears that we have found a quick solution to the emergence of resistance in mosquitoes to the highly effective agent B. sphaericus. At the present time there are only 3 widely used materials (Bsph one of them) for mosquito control by using a mixture of the two bacteria. With such a few options it is imperative that we save Bsph and the other two from becoming obsolete due to resistance.

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

Key Theme: 4.04 Biological Control
Title: Mechanical Distribution of Lacewing Eggs in Lettuce

Description: In response to requests from the lettuce industry, a better way of utilizing biological controls in lettuce for the lettuce aphid was sought. European literature pointed to the green lacewing as the best candidate organism. Eggs of this insect are readily available for purchase and are relatively inexpensive. The difficulty was thought to be in successfully distributing the eggs. This project sought to adapt equipment that had been developed for grapes to mechanically distribute lacewing eggs to the production system in lettuce. The objectives were to: 1) To determine if lacewing eggs could be successfully applied mechanically, and 2) To determine if lacewing eggs applied in this manner would reduce lettuce aphid populations. A series of field trials was conducted working with grower-cooperators to test the mechanical applicator. Lacewing eggs where purchased for this work and their quality measured before and after application. The field was then monitored for both lacewing larvae and aphids. The initial quality of the purchased eggs was found to vary, but to be acceptable within industry standards. Some difficulty was encountered in properly conditioning the eggs after arrival to ensure egg hatch shortly after application. This would be expected to be even more difficult for a grower without access to a holding chamber with very specific temperature and humidity controls. The results clearly indicated that the eggs could be successfully distributed using this method. Hatch rates of eggs after mechanical application were not significantly reduced; however, the anticipated reduction in lettuce aphid populations was not observed. Our observations indicated that a key problem was in a poor fit of the natural enemy, the green lacewing, to the environmental conditions of the Salinas Valley (cool and windy). Secondly, a very low tolerance for the pest made timing the application of the eggs difficult. Since the newly hatched lacewing larvae must have food to survive, and since growers were unwilling to allow aphid populations to reach the necessary levels, many of the newly hatched larvae died of starvation or exposure. These problems are probably not correctable due to the short duration of the crop and low tolerance for the pest by consumers and by USDA standards.

Impact: A survey of lettuce growers who represented over 50% of the lettuce production in the Salinas area, showed 100% of the growers who had previously tried release of lacewing eggs have stopped the practice, in response to this work and their own experiences. This is expected to save the growers $200 to $300 dollars per acre, which they can use toward more appropriate biological or cultural controls.

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

Key Theme: 4.06 Endangered Species
Title: Comparative Studies of the Vertebrate Eye

Description: Whole mount preparations were made from either mildly fixed or fresh retinas isolated from the fully anadromous green sturgeon (Acipenser medirostris), the semi-anadromous white sturgeon (Acipenser transmontanus), and the freshwater paddlefish (Polyodon spathula), with the intent of (1) determining whether or not acipenseriform retinas contained areas of specialization and (2) obtaining accurate photoreceptor packing density values. The retinas, isolated from the pigmented epithelium were mounted on glass slides and the photoreceptor population (both rods and cones) was mapped using a Nikon Eclipse Model E600 microscope and Scion Image video-enhancement software. At a magnification of 200X, images 0.69 x 0.53 mm were captured and archived so that the entire retina could be reconstructed after the cell counts were made. The data from several retinas were then superimposed and, using the optic disk as the central point, quadrants and radii (at 1.0 mm intervals) were delineated. Composite data were compared first by analysis of variance (ANOVA), after which T-tests were used to determine the significance of differences between specific regions. Data analysis is not yet completed for the green sturgeon and paddlefish. For the white sturgeon, other than a tendency for the photoreceptors to be less densely packed at the far periphery, no region of the retina appeared to be significantly different from any other region. Mean rod density for the entire white sturgeon retina was 15,329 +/- 2,679 rods/mm2, whereas mean cone density for the entire retina was 3,855 +/- 832 cones/mm2. Thus, cones comprise 20% of the total photoreceptor population in the retina of the white sturgeon. These values are substantially lower than previous estimates made from studies with the scanning electron microscope (SEM). However, for several reasons, there is little doubt that the values obtained with the retinal whole mount preparation described here are the more accurate.

Impact: All species of sturgeon and paddlefish are considered threatened to one degree or another. Knowledge gained through study of one of their primary sensory modalities should foster better decisions with respect to environmental policy and management. Farmed sturgeons are becoming increasingly more valuable as a food source. The data may allow for more effective conservation and aquaculture.
Funding Source: Hatch and State
Scope of Impact: State Specific

Key Theme: 4.06 Endangered Species
Title: Immunology and Molecular Biology of Ectoparasitic Mites

Description: During this period, we continued to utilize an ELISA test that we previously developed to screen bighorn sheep for exposure to Psoroptes mites. Annual screening of selected bighorn populations in New Mexico revealed no exposure to mites or active infestations. The California Department of Fish and Game submitted positive mite samples from bighorn sheep in the Cushenbury area (San Bernardino County, CA). Annual serological surveys of bighorn sheep in that area revealed a prevalence ranging from 62% to 100%. By screening populations of bighorn sheep for this parasitic disease, we were able to provide important information to wildlife agencies that aided them in their management programs. Starting September 1999, we participated with the U.S. Fish and Wildlife Service (USFWS) and the New Mexico Department of Game and Fish (NMDGF) in a bighorn sheep reintroduction program in the San Andres Mountains, New Mexico. The population of bighorn sheep in the San Andres Mountains was nearly extirpated due to severe Psoroptes mite infestations. A sentinel cohort of rams was reintroduced in 1999 and was closely monitored to determine if the area would be safe for further restocking. These animals were captured 2 to 3 times a year to obtain blood and ear swab samples. Our laboratory examined the ear swabs and performed the serological assays to determine if exposure to Psoroptes mites had occurred. To date, no evidence of Psoroptes exposure has been detected in these animals and plans are being made to proceed with the next phase of the restocking program. With regard to the molecular biology component of this project, progress was made in determining the genetic relatedness of mites isolated from different animals host species (Ramey et al. 2000; see year 2000 Progress Report publication list). No CFAH funding was received for the entire period. Progress was made possible through contracts with the USFWS and the NMDGF.

Impact: Psoroptic scabies is a contagious and debilitating disease of domestic and wild ungulates. Desert bighorn sheep can be devastated by Psoroptes mites infestations. Monitoring of bighorn populations for exposure to Psoroptes mites will aid wildlife agencies in developing management policies that will help conserve this species, and molecular identification of mites from different hosts will aid researchers in better understanding transmission of this parasite among different host species.

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

Key Theme: 4.06 Endangered Species
Title: A New Model For Olfactory Imprinting in Salmon

Description: The majority of work on olfactory imprinting in salmonids has been conducted on fish reared in hatchery environments. This type of rearing provides a diminished sensory environment compared to wild rearing, but this potentially confounding problem has not been largely ignored in the literature. New results this year suggest dramatic differences in brain morphology in hatchery-reared vs. wild caught fish. This work parallels studies in mice showing enrichment plays a role in shaping the adult brain. Using rainbow trout (Oncorhynchus mykiss), as a model, this year we presented the first evidence that hatchery rearing directly and significantly impacts brain development. The work was highlighted in the "news" section of Science Magazene. By examining approximately 100 brains from different populations, we found that brains from wild fish outscored those of hatchery fish in seven out of eight distinct anatomical measures. When data were normalized to body size and age, several specific brain regions followed growth trajectories that were significantly slowed compared to those of their wild counterparts. These areas included the olfactory bulb, optic tectum and telencephalon. Based in part on this study, we have begun collaborating with a researcher at the

National Marine Fisheries Service in Seattle Washington. Since Spring, 2001, we have sampled over 100 steelhead juveniles (Skookumchuck River stock) reared for 2-4 months in one of three rearing environments: conventional hatchery raceways, enriched (raceways with underwater feed delivery, submerged in water structure and cover), and natural streams. Brains have been dissected, fixed and mounted in paraffin blocks. Tissue is currently being sectioned to compare brain morphology across treatment groups. Finally, we have begun developing techniques for quantifying the rate of neurogenesis in salmon brains. We have sampled approximately 40 brains of coho salmon reared in enriched and non-enriched environments here at UC Davis. Fish were exposed to bromodeoxy-uridil (BrDU) prior to being killed. This agent marks proliferating cells. With some difficulty, we have worked out the BrDU labeling protocols for salmon. Tissue is currently being prepared histologically for morphometric analysis.

Impact: These data suggest that hatchery rearing produces a central nervous system that is optimized for a relatively unenriched environment rather than for living in the wild. Since such phenotypic traits are not generally considered in conservation management, these findings have important implications for the restoration of declining salmonid populations worldwide.

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

Key Theme: 4.06 Endangered Species
Title: Ornamental Fish Culture: Nutrition and Feeding

Description: Diets for aquatic animals can only be effective if they are appropriately formulated so as to support maximal health. Ideally, assessment of nutritional health must be done in a setting of optimum husbandry conditions. Unfortunately, at present, specifications for ideal culture conditions for aquarium fish, particularly marine species, are limited primarily to anecdotal information from hobbyists. Careful studies are needed to determine optimum culture conditions by assessing stress factors with marine aquarium species. Work was begun this year with the common clown fish Amphiprion ocellaris. This species was chosen in that it is one of the few marine species already being cultured and thus removal individuals from besieged wild populations would not be necessary. Baseline studies on normal morphology were completed this year in preparation for further study to develop reliable measurements of stress. Clown fish have the advantage of being small enough that a whole specimen can fit on a single slide. The fish used were aquaria maintained at a normal temperature range, 25-33 Degrees Centigrade, and without any demonstrated physical or behavior abnormalities. Slides are prepared for both dorsal and ventral slices. All five types of tissue: epithelial, supporting, muscular, nervous, and liquid were prepared and presented. Now that the histology in a 'normal' fish is established, pathological changes will be more easily recognized.

Impact: Today's global aquarium fish trade is valued at around $1 billion. While the majority of fresh water aquarium fish species are now being raised in captivity, this is not true of marine ornamentals. In that culture, techniques have yet to be developed for most of the desirable exotic marine species these are supplies by capture from the wild. Destructive capture techniques such as cyanide poisoning or the dynamiting of reefs used in these fisheries have had a horrific effect on many tropical coastal and marine environments. In particular, coral reefs, which are among the most fragile and threatened

ecosystems globally, have been savaged by such collection practices. It is hoped that development of appropriate culture techniques and feeds in the future will allow these marine species to be cultured as are most freshwater aquarium species and thus spare wild populations as well as their habitat. In addition to the value arising from their intrinsic beauty, aquarium fish are rapidly becoming popular experimental animals. As with any other animal, without optimal nutrition research, studies with fish are going to be hampered by potentially abnormal physiological and biochemical responses. Additional use of fish as experimental models will require the sort of information as to their nutritional needs that is presently available for the rat and chick.

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

Key Theme: 4.06 Endangered Species
Title: Sediment Delivery Inventory and Monitoring, 2000

Description: Total maximum daily loads (TMDLs) for sediment are being established for Northern California watersheds to reduce impacts to salmon habitat. These water-quality standards will require landowners to inventory, monitor, and control management-caused erosion on their properties. This project will develop and apply an inventory tool so that landowners will have a better understanding of sediment delivery to not only comply with regulations but also more effectively manage erosion and sediment delivery. Research: In collaboration with Natural Resource Conservation Service and Regional Water Quality Control Board staff, private landowners, and representatives of California Farm Bureau, a California advisor developed a method to inventory and monitor sites of sediment deliver. This inventory method was tested at 117 sites on ten north coast ranches. We also initiated an effort to conduct a statewide survey using this inventory method. Extension: We incorporated the sediment delivery inventory into the UCCE Ranch Water Quality Short Course, including powerpoint presentations and extension publications. We used the results from the north coast sediment survey in shortcourse presentations and conferences on water quality. Over 300 landowners have been trained in the use of the method and the principles of erosion and sediment delivery. Survey results indicate that the majority of deliverable sediment on rangelands is associated with natural and historical influences. Rangeland managers can achieve the greatest reduction in sediment delivery generation from their current management by addressing erosion from roads. Statewide survey efforts continue.

Impact: The sediment delivery inventory is listed in water quality regulations for compliance with monitoring requirements. It has also been adapted by New Mexico State University Cooperative Extension and is being used by resource conservation districts in Yolo, Shasta, and Alameda counties. Resource agency staff and watershed groups are using survey results to prioritize soil conservation and sediment delivery reduction projects.

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

Key Theme: 4.07 Energy Conservation
Title: Development and Application of Crop Models For Cut-flower Roses

Description: Models related to the production of greenhouse flowering crops are being developed to

provide information to help growers with greenhouse management, particularly with regard to energy and irrigation management. The purpose of this effort is two-fold: (1) to increase our understanding of these systems and (2) to develop tools that production managers can use to optimize production. Currently the major focus is on cut-flower roses. Within the area of energy management we developed a large-scale simulation model for greenhouse energetics. For production management we are developing a rose crop simulation model which includes various processes and their response to the greenhouse environment. One finished submodel is a new photosynthesis that combines gas exchange and stomatal conductance. The part of the model that relates to rose development was used as a basis for a grower software tool to assist growers with greenhouse temperature management. The rose modeling work was also used as a platform for analyzing root zone characteristics, particularly moisture status, salinity and oxygen concentration as affected by media properties and irrigation strategy. The work on EC effects on stem elongation showed that rose stem elongation is dramatically reduced as salinity levels increase.

Impact: Greenhouse flower production is currently affected by two important forces: market deterioration due to importation of foreign flowers and unusually high energy costs. The former prevents growers from raising prices to offset the second. These growers are benefitting from our work as this allows them to lower greenhouse temperature set-points to reduce heating costs while still targeting specific holiday sales. The same impact will be felt during the summer when they will be interested in raising temperature set-points to reduce cooling costs.

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

Key Theme: 4.08 Forest Crops
Title: Hardwood Industry Development Program

Description: A collaborative statewide effort was implemented to combine the interests and resources of government agencies, regional groups, manufacturers, and University experts to encourage the development of an indigenous California hardwood industry. It is recognized that many of the California grown hardwoods represent an underutilized resource that can provide economic potential for community development. The focus is to encourage a sustainable California hardwood industry by identifying basic industry needs and raising the awareness of the potential for value-added products. This project was developed as a statewide collaborative project. It was designed to analyze the structure of the existing industry and identify needed efforts to encourage future development and sustainable growth. Regular facilitated meetings and surveys were used to gather information and focus efforts. The objectives are to: (1) coordinate a statewide hardwood training and education program to provide basic processing knowledge, (2) assess the research and training needs of the manufacturing, marketing, and service providers involved in the existing hardwood industry. Activities: Three regional meetings were conducted with the primary stakeholders (USDA Forest Service-Region 5, CA Trade and Commerce Agency, CA Department of Forestry, Mendocino Hardwood Development Agency, Institute of Sustainable Forestry, Arcata Economic Development Corporation, and the Sierra Economic Development District) and other interested stakeholders. Research and training needs were assessed by meeting with collaborators and by conducting a formal, 2-page, mailed survey of the existing and potential hardwood industry in the state. The assessment

survey was mailed to 200 individuals with a response rate of 38 percent. The information gathered from the above activities resulted in 1 peer reviewed article, 1 technical report, and 2 newsletter articles on utilization opportunities. A major outcome of this project was the recognition that a formal organization of manufacturers and other interested practitioners was needed to insure the future support of public agencies and that a strong need exists for sharing knowledge of basic manufacturing principles and recommended practices. Technical reports and web page postings were used to disseminate results to clientele.

Impact: This project clearly demonstrated that utilization of some of the native California hardwood species have potential to create new jobs. The project established a vehicle for interagency cooperation in this important statewide issue. Presentations to forest product industry representatives, small business, and entrepreneur clientele sparked interest in new ventures. A direct result of this project was the creation of a California hardwood industry association that meets to further the collective interests of this new industry segment. Increasing the awareness of the value of California's native hardwood species led to a 5-fold measured increase in lumber production and a 500 percent increase in small businesses working with this hardwood resource during the past 4 years. The positive survey response is strong evidence that the efforts to develop this hardwood industry are highly valued. The results of this project were used to convince the USDA Forest Service to fund a new project to develop a high quality training program for the California hardwood industry.

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

Key Theme: 4.08 Forest Crops
Title: Tanoak Lumber Potential: Recovery and Yield

Description: California hardwoods are an underutilized natural resource. California is a major consumer of hardwood lumber (20 percent of nation's production) but the hardwood lumber production industry in the state is almost non-existent (less than 10 million board feet (BF) annually); this is in spite of a sizable hardwood resource (12 billion cubic feet of timber growing stock). Of the more than 20 native hardwood species with acceptable lumber properties, tanoak has the greatest potential to sustain an industry. The economic viability of tanoak hardwood lumber production depends on a thorough understanding of the lumber recovery and grade yield expected from the resource and a solid knowledge of wood properties and manufacturing characteristics. This study was designed to explore the technical and economic feasibility of producing tanoak lumber by tracking all aspects of processing from the tree to kiln-dried, graded lumber. The objectives were to: (1) develop recommended manufacturing procedures that consider the economic and lumber quality aspects of production, (2) distribute lumber to woodworkers for demonstration projects, (3) disseminate this information to the forest products industry at large. This project involved, as research partners, two community-based organizations with strong interests in helping to develop an environmentally sustainable hardwood industry in their respective regions. Two different sawmill types, representing the range of industry harvesting and manufacturing methods, were used to harvest and mill 70,000 board feet of tanoak timber from 2 different forest types. Data were gathered for each production step and sub-studies were carried out to determine best processing methods. Research objectives/protocols were developed through a series of facilitated meetings with collaborators. Delivery of study results

are through newsletters, workshops to clientele and direct consultation with manufacturers, small business owners, and entrepreneurs. Results: Results were disseminated through 2 technical reports and 1 newsletter article; 1 technical presentation to professionals and 4 to clientele audiences; and regular reporting on the UCFPL hardwood utilization web page. Results verify that high production costs and drying degrade are major concerns. Data gathered on basic properties and drying characteristics provided the information needed to develop recommended processing methods to optimize lumber yield/value and provide a better understanding of the economic potential of the species.

Impact: The efforts of this project have heightened the awareness of clientele groups to the physical properties of tanoak and the challenges that must be addressed to produce quality tanoak products that are accepted in the marketplace. Presentations to forest product industry representatives, small business, and entrepreneur clientele have sparked interest in new ventures that cut across target affirmative action profiles. The project was instrumental in cutting drying costs by 40 percent and dramatically increasing production in two new enterprises. In addition, the results were directly responsible for the best practices being implemented in a hardwood processing demonstration facility. The knowledge gained in this project was directly responsible for elevating tanoak from "weed status" to a recognized option for high quality furniture and flooring. By reducing losses to manufacturing defects these recommendations are directly responsible for a savings of $2 million per year in a developing industry. This project is recognized as a landmark study for the processing of tanoak lumber in Northern California and has the potential to create hundreds of new jobs in a sustainable industry.

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

Key Theme: 4.08 Forest Crops
Title: Utilization of California Hardwoods: A training program to encourage efficient manufacturing methods

Description: Meetings with clientele and other stakeholders suggest that training and education are of vital importance to the growth and stability of a hardwood manufacturing industry based on native California hardwoods. The clientele for this program -the manufacturers of value-added forest products, economic development agencies, woodworkers, and community interest groups- have the interest and desire, but lack the knowledge and expertise necessary for successful ventures. The lack of industry and institutional knowledge of processing characteristics, combined with the fact that most California hardwoods are more difficult to work with than the benchmark commercial hardwoods manufacturers are familiar with, has caused many new ventures to fail because of processing mistakes. This project is focused on providing technical information, training, and guidance necessary to improve manufacturing and marketing methods thus enhancing the likelihood of a sustainable hardwood industry. Objectives: (1) increase the knowledge of recommended manufacturing techniques, (2) evaluate existing training materials, (3) revise and develop new training materials, (4) conduct a series of hardwood processing workshops, (5) develop a train-the-trainer program, (6) coordinate the interests and activities of the project collaborators. A search was conducted for appropriate hardwood processing information and training materials. Additional information was gathered through facilitated meetings with stakeholders. Information was used to revise existing and develop new training materials. The products and knowledge are disseminated through training workshops and publications. Results: Training materials, workshop workbooks, and informational

publications dealing with recommended practices and specific hardwood information were created. This information was disseminated at 4 workshops, in 24 technical presentations, 2 technical publications, and a UC web page. The workshops were presented to 125 existing and potential hardwood manufacturers in northern California. Each workshop was co-sponsored with a local organization to encourage participation of the small business owners in the region and insure adequate affirmative action representation. Technical assistance is also frequently shared with hardwood industry clientele. Information was delivered to 200 clients through telephone, email, and site visits. More than 50 packets of information have been distributed to existing and potential manufacturers.

Impact: The workshops and technical assistance efforts consistently receive excellent reviews by participants and peers, earning a reputation for the UC Forest Products Lab as the leading source for technical information/advice in hardwood processing. The delivery of technical information to more than 200 clients was responsible for increased efficiency in the production of hardwood lumber in California and the recognition that proper practices must be followed to succeed. Training was directly responsible for reducing manufacturing waste and lowering manufacturing costs at a new hardwood business by 20 percent, a savings of $1 million per year. As new businesses are developed, the results of this project have the potential to create hundreds of new jobs in the depressed northern California economic regions. This project is expected to lead to the development of a sustainable hardwood lumber industry in northern California that meets environmental criteria for "green" certification.

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

Key Theme: 4.09 Forest Resource Management
Title: Durability and Performance: Wildfire and Structure Issues

Description: This project is a continuation of a broader research program at UC Forest Products Laboratory (UCFPL), the overall goal of which is to develop and disseminate needed information on how to protect buildings located in the urban wildland interface (UWI). A key component for protecting buildings subjected to wildfires is to understand how common construction materials perform when subjected to wildfire exposures, and how design features and assemblies (how components are put together) affect the performance of materials. This information is important for persons involved in FireSafe groups throughout the state, and also fire officials in UWI areas that must make construction related decisions regarding materials and design. Our study on building performance is unique in that it addresses issues and is generating information that did not previously exist. Test protocols were developed for evaluating materials and assemblies commonly used in the exterior building envelope of buildings, since none existed prior to the start of this research. Common materials used in roofs and wall assemblies, and common types of windows and decking materials were subjected to simulated wildfire exposures (as described in the protocols). Breaking down the building into manageable parts was key to providing a solution to how to address the performance of the building as a whole. The most significant results concern the performance of plastic lumber composites lumber and oriented strandboard (OSB) composite sheathing. Many FireSafe Councils throughout the state have benefited from this research, as have local and regional fire authorities. We know that fire officials in UWI areas, and consultants to fire authorities, use our data when making decisions regarding buildings and housing developments. Knowledge being developed in this research is ground-breaking. Several web-based documents have been prepared, and some publications have

also been prepared.

Impact: Results are posted on UCFPL website as generated. Summary data sheets are also prepared and posted, and sent to interested FireSafe groups, UC Advisors interested in wildfire issues, and local and regional fire officials. We know from conversations with individuals from industry, representatives of FireSafe Councils, fire officials throughout the State, and contact with extension personnel within and outside California, that this research is providing important information related to the performance of structures subjected to wildfires. The summary publications are being distributed and used by both homeowners and fire officials.

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

Key Theme: 4.12 Integrated Pest Management
Title: Genetics, Breeding, and Evaluation of Citrus Fruits

Description: Evaluation of yield and fruit quality of Gold Nugget (released in 1999) and several other mandarins continued. We expect to release other new cultivars during 2002. Low-seeded forms of Encore, W. Murcott and several other mandarins were identified by selection among trees propagated from irradiated budwood. These selections are being propagated for wider testing to evaluate seediness, productivity when isolated from other cultivars, and other horticultural traits. Hybridization to develop new low-seeded triploid mandarin and low-acid grapefruit types continued. Simple sequence repeat (SSR) markers were used to study genetic diversity in over 400 accessions from the University of California, Riverside Citrus Variety Collection. Several new SSR markers were developed from citrus genomic DNA libraries enriched for simple sequence repeats. Development and scoring of SSR markers is complete and data analysis has been initiated. Seedling populations were screened with inter-simple sequence repeat markers to identify genotypes with high priority for inclusion in germplasm collections. These markers were useful for identifying apomictic seedlings that are genetically identical to each other. Only a single seedling of each nucellar type will be retained for the citrus germplasm collection.

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

Key Theme: 4.12 Integrated Pest Management
Title: Characterization of Agricultural Nematodes For Improved Systematics and Identification

Description: This research priority is the resolution of features that can be used to understand character evolution in both plant parasitic nematodes and their non-parasitic relatives. One result of

understanding evolutionary relationships is a basis for a stable predictable classification system of agricultural parasites within the context of their non-parasitic relatives. Using a combination of light, scanning and, transmission electron microscopy we have demonstrated homologies of cuticular layers and esophageal characters between bacterial feeders Cephalobina), and and Tylenchida (plant parasites). Most recently we published convincing fine structural evidence that the glandular basal bulb characterisitic of plant parasitic Tylenchida evolved independently from that of Diplogasterida (Baldwin et al, 2001). This work has important implications in rejecting classical views of homology and evolution of the esophagus and putative lack of a valve and musculature in the basal bulb of plant parasites in Tylenchida. Ongoing work includes a number of taxonomic descriptions of cephalobs, heteroderids, and pratylenchids.

Impact: Results of this project, analyzed in conjunction with molecular data from collaborators, will lead to a sound taxonomic revision and classification of Tylenchida in the context of other Secernentea and consistent with evolution. We will also gain new insight into the feeding mechanisms and biology and ecosystems of plant parasites with potential to manipulate these systems to favor agriculture.

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

Key Theme: 4.12 Integrated Pest Management
Title: Influence of Irrigation Practices on Development and Impact of Phytophthora Root Rot

Description: The occurrence of Phytophthora root and crown rots in California strawberry production systems was investigated. While Phytophthora cactorum was the Phytophthora species found most often causing root and/or crown rot, other pathogenic species were also present at low frequencies. Current fumigation practices are usually effective for controlling Phytophthora species in soil. For example, in field experiments where inoculum was buried in soil, standard fumigations with mixtures of methyl bromide and chloropicrin were highly effective in killing inoculum of both P. cactorum and Verticillium dahliae. While equivalent and some lower rates of chloropicrin alone, 1,3-dichloropropene with chloropicrin (Telone C35), and methyl iodide with chloropicrin were also effective at killing buried inoculum of V. dahliae, many of the same treatments gave incomplete control of P. cactorum. Greater control of P. cactorum in soil was achieved when alternative fumigants were applied using a highly impermeable plastic mulch. The distribution in soil and effectiveness of fumigants that may replace methyl bromide in strawberry nurseries and production fields is being researched further. Fumigation has also been found to reduce other fungi damaging to roots of strawberry and to increase populations of beneficial rhizosphere bacteria.

Impact: The strawberry industry of California has a pressing need to develop alternatives to methyl bromide for pre-plant treatment of soil. This project is currently helping to identify soil-borne disease risks and effective alternatives, both chemical and non-chemical, to methyl bromide fumigation of soil for strawberry nurseries and production in California.

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

Key Theme: 4.12 Integrated Pest Management
Title: Genetics, Breeding, and Evaluation of Citrus Rootstocks

Description: GENETICS OF CITRUS TRISTEZA VIRUS RESISTANCE. In a collaborative project with a researcher at Texas A&M University, we are using positional-cloning to clone a trifoliate orange gene for resistance to citrus tristeza virus (CTV). Sequencing of a 282 kb contig that should contain the resistance gene was completed, the sequence was fully assembled, and annotation completed. Sequence comparisons and database searches revealed a total of 22 putative genes, seven of which are resistance gene homologs that contain NBS and/or LRR sequence motifs. Retrotransposons and other classes of transposable elements were frequent in this sequence. Fine mapping using new markers derived from the DNA sequence data localized the CTV resistance gene to a 173 kb region. Several genes from the contig were shown to be expressed in bark tissue of a virus-challenged plant. Transformation of candidate genes was initiated. Remaining tasks are to further localize the resistance gene, compare sequences of resistant and susceptible alleles of candidate genes, and test whether candidate genes cause CTV resistance by transforming them into CTV-susceptible citrus genotypes. GENETICS OF APOMIXIS. Inheritance of nucellar embryony (a type of apomictic seed reproduction used in citrus rootstock propagation) was studied in two populations derived from trifoliate orange. Preliminary results are consistent with a segregation of a single dominant gene for nucellar embryony in these populations, but some progeny trees were difficult to classify and more complex models remain possible. AFLP markers linked to a gene for apomixis were identified and cloned. Analysis of AFLP markers to be used for linkage mapping and QTL analysis was completed. BREEDING. New hybrids involving Flying Dragon trifoliate orange and other citrus varieties and hybrids were identified. Older hybrid populations were tested for nucellar embryony and Phytophthora gummosis resistance. EVALUATION. We annually evaluate trees in more than 25 field trials to identify superior new rootstocks for various citrus cultivars. C-32 and C-35 citranges continue to perform well as citrus rootstocks at most locations in California. Unreleased rootstocks that show promising characters include hybrids of Sunki mandarin and trifoliate orange, and a pummelo x trifoliate orange hybrid. Three new trials to evaluate citrus rootstocks in calcareous soils were planted.

Impact: Work on resistance to citrus tristeza virus should benefit growers and consumers when varieties with resistance to this disease are produced. Development of new rootstocks with better disease resistance and other traits may reduce environmental impacts of disease control chemicals. The project has provided citrus growers with information on choosing rootstocks to improve yield and fruit quality.

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

Key Theme: 4.12 Integrated Pest Management
Title: Viroids As Disease Agents and Elements of Host Genome Expression

Description: A viroid etiology has been suggested for citrus gummy bark (CGB) disease of sweet orange based on the similarity of symptoms with cachexia. The consistent detection of hop stunt viroid related Group II citrus viroids found in CGB infected Washington navel and the Turkish cultivar,

Dortyol, while not in asymptomatic controls further supports this view. A total of 47 clones constructed from RT-PCR products employing CVd-IIa specific primers were analyzed by sequence homology. The 6 clones derived from the asymptomatic Washington navel were closely related in size (302 nucleotides [nts.]) and sequence to the non-cachexia variant CVd-IIa. The 22 clones produced from CGB infected Washington Navel were almost equally divided between the CVd-IIa class of 301-304 nts. (9 clones) and the cachexia CVd-IIc class of 296 nts. (11 clones) with only single clones of 295 and 299 nts. related to the CVd-IIb class. A more complex collection occurred in the 19 clones derived from CGB infected Dortyol. Three clones of the CVd-IIa class were found among the predominant cachexia related CVd-IIb class of 11 clones (298-300 nts.) and CVd-IIc class of 5 clones (296 nts.). Transmission to citron by transcripts of representative clones from all clusters described by homology has been successful with CGB bioassay and indexing tests currently in progress. Citrus, as a single plant group, harbors a diverse collection of five viroid populations. Although variants from each of the five viroids express symptoms in the indexing and bioamplification host, citron (Citrus medica), only two diseases of economic impact to citrus production, exocortis and cachexia, have been attributed to viroids. This relationship facilitated the proposal for the division of viroid-like molecules into two distinct classes. A class that induce diseases impeding agricultural performance, the viroids, and a class that share physical and biological properties in the absence of pathogenic responses harmful to the crop productivity, the transmissible small nuclear RNA (TsnRNA). Although the process of viroid pathogenesis is still to be clearly defined, it has been conjectured that TsnRNA molecules may affect host metabolism to effect responses of economic advantage. Accordingly, the association for the reduced vegetative growth of scions on Poncirus trifoliata and related rootstocks with the presence of CVd-III variants has progressively gained significance in many citrus growing regions. Performance trials sweet orange on trifoliate rootstock over a period of about 10 years has indicated a consistent increase in fruit yield/canopy from trees reduced in size by 20% with TsnRNA-IIa or 50% with TsnRNA-IIIb.

Impact: The characterization of citrus gummy bark disease as a possible cachexia-related disorder has been tested by assay of selected CVd-II variants. The application of non-disease inducing viroids has been effective for the modification of citrus vegetative growth.

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

Key Theme: 4.12 Integrated Pest Management
Title: Etiology, Epidemiology and Control of Virus Diseases of Vegetable Crops

Description: Research was conducted on several viruses affecting California vegetable crops. We finished up projects dealing with California carrot motley dwarf (CMD). This important disease complex affects carrots worldwide and we documented its incidence in the major carrot production of California, the San Joaquin Valley. However, our work showed that CMD is unlikely to become an important problem for the San Joaquin Valley as spread occurs at the onset of warm weather. Disease development is favored by cool temperatures and the carrot production cycle in the San Joaquin Valley seems to provide a natural means to prevent significant disease development. Work was also conducted on Celery mosaic virus (CeMV), the most important virus affecting celery in California. Collaborative efforts focused on screening celery/Apium germplasm for CeMV resistance and

potentially useful sources were identified. These are currently under further analyses.

Impact: Viruses represent a major group of pathogens affecting worldwide vegetable production. We have developed accurate means to identify specific viruses in their plant hosts. We also researched epidemiological factors affecting disease development and sources of genetic resistance to plant viruses in order to develop and implement environmentally sound approaches for virus disease control.

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

Key Theme: 4.12 Integrated Pest Management
Title: Biology and Integrated Pest Management of Grape Phylloxera

Description: 1) We collected phylloxera-infested roots from 27 vineyards in 8 California counties and isolated fungi responsible for root necrosis from the phylloxera feeding sites. After confirming pathogenicity of each isolate on Vitis vinifera L., we have begun to screen them for virulence on rootstocks (3309C, O 39-16, Freedom, Teleki 5C, 101-14 Mgt, AXR#1). Virulence varies with isolate and root type. Necrosis on V. vinifera roots average 26% (with some isolates ranging to 80%) and while rootstocks average about 13% (ranging to 50%). Individual isolates that are ranked high, medium, or low virulence on V. vinifera, average the same ranking on rootstocks suggesting that the level of damage on V. vinifera predicts the level on rootstocks. These results suggest that rootstocks might be damaged if virulent fungi as well as aggressive grape phylloxera biotypes were to co-exist. 2) We hypothesize that management of soil organic matter will alter susceptibility of grapevine roots to these necrosis-causing fungi. This was the 3rd and terminal year of a field trial of this hypothesis with young grapevines in compost-amended soil. Though the second year results were promising, showing significantly less root necrosis with sterilized or living composts, the third year results showed that the vines outgrew any early protection. A second field trial established last year with mature vines and surface compost treatments is also testing tillage. Second year results have yet to show strong treatment effects with compost, however, the tillage treatments are beginning to show enhanced growth. We worried about the high root necrosis in this trial and set up a third trial in a part of the vineyard with less root necrosis. 3) In greenhouse tests we evaluated vineyard soils and compost for ability to suppress the necrosis. We found that vineyard soils from sites with a high level of phylloxera damage cause a high level of necrosis to wounded vines. However, mixing such soils with compost or soils from vineyard sites with low levels of phylloxera-related root necrosis, decreased that virulence. These results demonstrate that some soils as well as compost suppress root necrosis. 4) Second year field trials with the commercial systemic insecticide, imidocloprid and with the fungicide Ridomil showed little or no protection against root necrosis. 5) Data on overwintering survival of grape phylloxera on vineyard vines showed that it was low but measurable. 6) We began tests with plant hormone treatments of excised roots to determine impact on phylloxera survival. In sealed Petri dishes, indole acetic acid (auxin) and BAP (a kinetin analog) killed phylloxera or caused failure of feeding sites. In contrast Ethrel (a commercial ethylene releasing product) increased phylloxera survival over controls. Ventilation of dishes suggested that the auxin and kinetin results worked directly on the treated roots. The Ethrel results occurred by vapor and on directly treated roots. These experiments will be continued with whole plants.

Impact: The work with fungal isolates suggest that strongly resistant rootstocks are not immune to damage. Although strongly resistant rootstocks have not failed to grape phylloxera, our work suggests they are subject to failure if a virulent fungal isolate and an aggressive phylloxera biotype were to co-exist. Our compost work demonstrates that addition of organic matter to soils will not prevent phylloxera damage. Our work with the plant hormones gives us insights into the way phylloxera form feeding sites.

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

Key Theme: 4.12 Integrated Pest Management
Title: Replication and Control of Plant Viruses

Description: We have characterized the interaction and nuclear localization of the nucleocapsid protein (N) and phosphoprotein (P) of sonchus yellow net nucleorhabdovirus (SYNV). Expression studies in plant and yeast cells revealed that both N and P are capable of independent nuclear import. Site-specific mutagenesis and deletion analyses demonstrated that N contains a carboxy-terminal bipartite nuclear localization signal (NLS) located between amino acids 465 and 481, and that P contains a karyophillic region between amino acids 40 and 124. The N-NLS was fully capable of functioning outside of the context of the N protein and was able to direct the nuclear import of a synthetic protein fusion consisting of green fluorescent protein fused to glutathione-S-transferase (GST). Expression and mapping studies suggested that the karyophillic domain in P is located within the N-binding domain. Coexpression of N and P drastically affected their localization patterns relative to those of individually expressed proteins and resulted in a shift of both proteins to a subnuclear region. Yeast two-hybrid and GST-pulldown experiments verified the N:P and P:P interactions, and deletion analyses have identified the N and P interacting domains. N-NLS mutants were not transported to the nucleus by import-competent P, presumably because N-binding masks the P-NLS. Taken together our results support a model for independent entry of N and P into the nucleus followed by subsequent associations that mediate subnuclear localization.

Impact: This research provides valuable information about the events involved in viral protein interactions and nuclear import, and will help provide an understanding of the molecular and cellular associations of SYNV proteins that are involved in the viral replication cycle. This information may also have utility for development of control strategies for plant protection against SYNV and related viruses.

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

Key Theme: 4.12 Integrated Pest Management
Title: Molecular Identification of Plant-parasitic Nematodes

Description: We have developed a PCR-based assay that can be used to test soil samples for the presence or absence of root-knot nematodes. The test will detect the four most important species of root-knot nematodes when live juveniles are present in the soil. Using soil samples from California

field samples, we carried out parallel analyses by classical microscopy and by our PCR assay. We found that the PCR test was comparable to classical microscopic counting methods in sensitivity. The test should be straightforward to use in extension laboratories that have expertise in molecular techniques and does not require specialized nematology expertise. We have also used molecular markers to identify the species of ethanol-preserved nematode specimens from Australia. This work resulted in a first description of the nematode Meloidogyne fallax in Australia Isolates of the root knot nematode M. hapla that differ in their host range and in molecular markers are being characterized as part of a project to investigate the inheritance of virulence in nematodes.

Impact: Root knot nematodes have broad host range and infect many crops. However, species and strains within species differ in their host range. The availability of diagnostic tools is extremely valuable for management decisions regarding root-knot nematode problems.

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

Key Theme: 4.12 Integrated Pest Management
Title: Characterization of Gene Conferring Nematode Resistance To Plants

Description: California researchers have isolated the tomato gene Mi, which confers resistance to three of the most damaging species of root-knot nematodes as well as to some isolates of potato aphids. Molecular exchanges between Mi and a related, but not functional, gene revealed that the C-terminal region of the protein is responsible for transmission of the plant cell death signal that is part of the resistance response. Detailed in vitro analyses indicate that the signaling involves several amino acids from this region. By altering individual amino acids, we have identified regions of the gene product likely to be involved in nematode recognition and other regions likely to be involved in regulation of the defence response. Tomato proteins that interact with the Mi gene have been identified using the yeast 2- hybrid interaction system and their role in signal transduction is under investigation. Currently only one nematode resistance gene, Mi, is present in cultivated tomato. The value of Mi has been compromised by the appearance of variant nematode strains and species that infect Mi-bearing tomato. We have identified and genetically mapped a new root-knot nematode resistance gene, Mi-3, in the wild tomato species Lycopersicon peruvianum. By a combination of recombination analysis and physical mapping, Mi3 has been localized to a region of less than 40 kb. DNA sequence analysis has identified candidate clones for the resistance gene.

Impact: Root-knot nematodes cause considerable damage to thousands of crops world wide. This research should result in improvements in host resistance by incorporation of natural resistance genes or modified resistance genes into new crops. Host resistance reduces damage caused by parasitic nematodes and at the same time reduces the need for use of chemical pesticides.

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

Key Theme: 4.12 Integrated Pest Management
Title: Phytobacteriology and Bacterial Disease Control

Description: An unreported disease of sudangrass (SORGHUM SUDANENSE) was observed in commercial fields in Imperial Valley of California. Symptoms included light-colored necrotic streaks, and white or tan irregular blotches, often associated with reddish purple to dark brown margins. PANTOEA ANANAS was consistently isolated from the blotches with reddish margins, while PANTOEA STEWARTII or mixtures of both species were isolated from necrotic streaks without reddish margins. Fourteen seed samples harvested in different locations were assayed and found to be 0.0 to 3.6% infested with P. ANANAS. Seed transmission may be a means by which the pathogen is introduced. Symptoms in inoculated plants appeared as early as 2 and as late as 20 days after inoculation, depending on the inoculum level, methods of inoculation, temperature, and available moisture. The initial symptoms caused by inoculations with both bacteria were similar, but as symptoms progressed, P. ANANAS was associated with white streaks or irregular necrotic blotches often surrounded by a reddish or purplish hue. P. STEWARTII was associated with light-colored necrotic streaks. Synergistic or antagonistic relationship was not observed between the two pathogens in co-inoculations. In host range studies, both bacteria caused disease on sorghum and sudangrass at similar levels of severity. P. ANANAS was also pathogenic on corn and oat. P. STEWARTII from sudangrass was pathogenic on corn but did not cause wilting that was observed with Stewart's wilt strains of P. STEWARTII from corn. The sudangrass strains of P. STEWARTII also infected oat and triticale, while the Stewart's wilt strains did not. Both P. ANANAS and P. STEWARTII from sudangrass grew at relatively high temperatures (43 C and 37 C, respectively) and caused disease at elevated temperatures and conditions of relative humidity similar to those in the Imperial Valley during late summer when epidemics of the disease were common.

Impact: Sudangrass production in the Imperial Valley of California was valued at nearly $34 million in 1998, when there were 70,000 acres produced. The new bacterial disease has caused severe losses in recent years. Understanding its cause and the source of the bacterial pathogens is the first step toward controlling this important disease.

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

Key Theme: 4.12 Integrated Pest Management
Title: Interaction Between Plant Viruses and Their Hosts in Natural and Experimental Mixed Infections

Description: Analysis of aphid derived subcultures of a severe from of citrus tristeza virus (CTV) has demonstrated two major strains within the parent isolate, SY568. Four subcultures obtained by grafting were used as inoculum sources for transmission to sweet orange by Aphis gossypii. Aphid transmission ranged from 0-50% and symptoms ranged from asymptomatic to severe stunting and vein corking. Using a probe to the CTV p65 gene, 3 possible RPA patterns were found indicating 2 independently segregating populations, components A, B or A+B. A single plant with component A alone did not react with MCA13 monoclonal antibody and was asymptomatic. The A component has never been separated from the B component using graft transmission. All plants with the B or A+B

components reacted with MCA13 and had severe symptoms. Testing of California avocado plants for avocado sunblotch viroid has continued. Emphasis has been placed on newly introduced varieties, products of the rootstock and scion breeding programs, and the collections of varieties maintained by the University of California. It has been observed that individual symptomatic fruits can test positive by PCR using samples of the fruit flesh without the branch tissue being positive. The importance of this for indexing programs is being evaluated. The three classes of dsRNAs previously described in avocado have now been cloned as cDNA and efforts are being made to determine through sequence analysis whether any or all of these dsRNA have a viral origin.

Impact: The recognition that severe strains of citrus tristeza virus are really mixtures of strain, not all as severe as the parental form and not all having the same aphid transmissibility raises questions for virus testing and management programs that might rely on cross protection or the use of transgenic resistance. The ability to perform rapid indexing for avocado sunblotch viroid has the potential to improve the overall health of the California avocado industry at a time when this pathogen is becoming more noticeable. Continued work on possible true viruses of avocado could establish new needs for certification and testing.

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

Key Theme: 4.12 Integrated Pest Management
Title: Chemical Ecology and IPM Programs For Pest Insects

Description: The pheromone blends of two economically important lepidopteran species have been identified, synthesized, and optimized for use by pest control advisors and growers. In particular, Hemileuca maia is a nuisance pest and a health hazard in the southeastern U.S., because the caterpillars have urticating spines which cause severe irritation upon the slightest contact. The toxins have also caused anaphylatic shock reactions in susceptible individuals. Consequently, public health authorities in the southeast have ongoing monitoring and control programs for this species in parks, schoolyards, campuses, and other public landscape areas to minimize health risks to the general public. The pheromone blend of the grape leaffolder, Desmia funeralis, also has been identified. This insect is a significant pest in vineyards in the Coachella and San Joaquin valleys in California, as well as in other areas of the U.S. where grapes are grown. In addition, we have completed and published a study that documents geographic variation in undisturbed populations of the moth Hemileuca eglanterina. Furthermore, we have located a single population of this species that appears to be bimodal in terms of the pheromone blend produced by female moths, the behavioral response of males, and the antennal responses of males to the individual components of the pheromone blend.

Impact: The Hemileuca maia pheromone study has provided monitoring tools for public health agencies in the southeast. Pheromone-baited traps have found immediate and ongoing use by pest management personnel in the southeast to locate areas with incipient high populations so that appropriate control actions can be taken. The work on the pheromone of the grape leaffolder has been accepted for publication, and the information has been communicated to both the grape industry and to several companies that manufacture and distribute commercial pheromone products. We anticipate that the companies will have monitoring products available for grower use this year. The study on

geographic variation in the pheromone communication system of H. eglanterina has provided one of only a very few concrete examples of reproductive character displacement in response to selection pressure. Even more important, the study system has not suffered disturbance from human activities, so that the patterns of pheromone use are those that have evolved under natural conditions. The population that is bimodal in pheromone use may represent a speciation event that is in the process of occurring, with easily measurable and quantifiable parameters. This study system will be extraordinarily useful to evolutionary biologists, in terms of providing a snapshot in time of one species diverging into two.

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

Key Theme: 4.12 Integrated Pest Management
Title: Tritrophic Interactions in Natural and Managed Ecosystems

Description: DATURA WRIGHTII is polymorphic for trichome morphology, and the two morphs are differentially susceptible to several species of herbivorous insects. Glandular plants produce an exudate containing esters of glucose and several organic acids. Plants with glandular trichomes are resistant to several species of insect herbivore, but they are more susceptible to the mirid bug, TUPIOCORIS NOTATUS. Plants with glandular trichomes are equally susceptible as plants with non-glandular trichomes to the chrysomelid beetle, LEMA TRILINEATA. We continued our studies on the costs and benefits of glandular trichome production by investigating the ecological cost of glandular trichome production over a three-year period. Total seed production increased with increasing size and persistence of the leaf canopy but seed production was unaffected by feeding by T. NOTATUS. Preliminary studies showed that leaf tissue damaged by T. NOTATUS still retained some photosynthetic activity. Although glandular trichomes confer increased susceptibility to T. NOTATUS while conferring resistance to other defoliating insects, T. NOTATUS feeding damage was less debilitating than defoliation, and the potential ecological cost is minimized. Previously, we determined that, although plants with glandular trichomes produced fewer seeds than plants with non-glandular trichomes, plants with glandular trichomes reached a larger size. We tested the hypothesis that the increased commitment to vegetative growth eventually may allow plants with glandular trichomes to compensate for reduced seed production observed in the first year. After three years, plants with glandular trichomes were 187-245% larger than plants with non-glandular trichomes, and total seed production over three years did not differ between trichome types. The advantage of earlier reproduction, however, still caused plants with non-glandular trichomes to have an overall rate of seed production that was from 55% - 230% greater than plants with glandular trichomes, depending upon irrigation treatment. Over three years, exposure to herbivores reduced the rate of seed production from 69% - 83%, depending upon plant type and irrigation treatment, and irrigation increased the rate of seed production by 29% to 175% depending upon plant type and exposure to herbivores. Although there was a large allocation trade-off for plants with glandular trichomes to reduce seed production in favor of vegetative growth, the potential benefits of such a trade-off were not realized before most plants were killed by herbivores. Overall, the cost of producing glandular trichomes strictly for herbivore resistance exceeds its benefits, and in the absence of other, unmeasured benefits from the suite of life history characters associated with glandular trichome production, natural selection is expected to eliminate this costly resistance trait from D. WRIGHTII populations.

Impact: This research continues to document the costs and benefits of the production of glandular trichomes for plant defense against herbivorous insects. Results demonstrate a large pleiotropic or linkage cost so far but no clear allocation cost. Benefits seem to be variable in both space and time based upon differences in the composition of the community of herbivores that infest D. WRIGHTII. in different locations or at the same location in different years. Results are useful to help define why herbivore resistance polymorphisms exist in natural plant populations. These specific results also may be useful in designing plant breeding programs for cultivated solanaceous plants, such as tomato and potato.

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

Key Theme: 4.12 Integrated Pest Management
Title: Fungal Evolution: Pathogen Population Genetics and Identification

Description: We use the variation in fungal DNA to study fungal evolution to understand the basic processes of fungal evolution and to use this information to help control fungal diseases of plants and animals. In the past year, we used phylogenetics to show that cryptic species in the animal and human pathogenic fungus Coccidioides immitis are also found in its close relatives, implying that genetically isolated species arise continually, but rarely persist. We also used phylogenetics to show that cryptic species of of the toxigenci fungus Aspergillus flavus correlate with morphology and with the type of toxin produced, establishing that phylogenetic species have important phenotypic differences. Our phylogenetic analyses of species of the model fungus Neurospora and close relatives showed that ascospore morphology is not a good predictor of generic relationships. Our population genetic studies used nucleotide substitutions and micorsatellite variation to show that populations of the animal and human pathogenic fungus Histoplasma capsulatum in Indiana and Alabama were genetically differentiated, and that both were genetically isolated from South American populations. We also employed microsatellite variation to recognize populations of the animal and human pathogenic fungus Coccidioides immitis throughout the New World and to postulate that Latin American populations are the result of relatively recent migration from Texas and Mexico, possibly via humans. Using the population genetic methods developed for pathogenic and toxigenic fungi, we recognized phylogenetic species in a genus of fungus forming symbioses with photosynthetic organisms, Letharia. This work showed that the classic concept of pairs of species of lichenized fungi, one sexual and one not, is too simplistic. Instead of a pair, we found six species -- all of which showed recombination.

Impact: In 2001, our research has shown that fungal phylogenetic species correlate with important phenotypes, such as toxin production or pathogenicity, more closely than do phenotypic species. Phylogenetic species recognition is applicable to all fungi, no matter how they reproduce or if they can be cultivated. Genetically isolated "cryptic" species appear to be widespread, but short lived, apparently establishment of a new species is not a common event. Within phylogenetic species, microsatellite markers may recognize populations, the analysis of which can reveal historical migration. Many of these fungi lack the morphology of sexual reproduction, but all still show evidence of recombination. In sum, analysis of nucleic acid variation provides information about fungal species and reproduction that cannot be gleaned from phenotype alone. The methods and data used in our

studies provide a means of rapidly and accurately identifying fungi, information basic to the prevention and control of fungal disease.

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

Key Theme: 4.12 Integrated Pest Management
Title: Biology, Behavior, and Ecology of Vectors of Plant Pathogens

Description: We have continued to study various aspects of the silverleaf whitefly, BEMISIA ARGENTIFOLII, and its natural enemies. We learned that parasitoids have different foraging behavior and ovipositional rates on different host plants. We showed that glandular trichomes reduced parasitoid walking speeds and residency time, thereby reducing parasitism. These trichomes on velvetleaf entrap parasitoids. Data support the concept of enemy free space for whiteflies on this plant. We also continued work to determine the taxonomic status of whiteflies in the BEMISIA TABACI species complex. We reviewed existing data and created seven groups of whiteflies within the species complex. These groupings follow distinct geographic patterns. Group 1 consists of New World biotypes. Group 2 is cosmopolitan and consists of B biotype (= B. ARGENTIFOLII). Group 3 is from Benin and Spain. Group 4 is from India. Group 5 is from Sudan, Egypt, Spain, and Nigeria. Group 6 is from Turkey, Hainan, and Korea. And group 7 is from Australia. Research on the epidemiology of arthropod-vectored plant pathogens also has continued. Research in collaboration with a colleague in Hungary has described the epidemiology of zucchini yellow mosaic virus in squash. We identified a new aphid vector, APHIS POMI, suggesting squash should not be grown in close proximity to apple, the preferred host of the vector. The lab also has begun work on the glassy-winged sharpshooter (GWSS), HOMALODISCA COAGULATA, and XYLELLA FASTIDIOSA, the bacterial agent causing Pierce's disease (PD) in grapes. In our first study, we determined that grapes grown adjacent to citrus had a higher incidence and severity of PD than grapes more distant from citrus. We also learned that the epidemiology of GWSS-vectored PD occurs at a much larger scale than PD vectored by other leafhoppers. A minimum of 1000 meters is required to study this pathogen system. The lab has continued studies on agriculturally important mites. In our work on the Banks grass mite (BGM), OLIGONYCHUS PRATENSIS we have shown that BGM is resistant to sulfur used to control the mite in dates, PHOENIX DACTILIFERA. The predatory mites, GALENDROMUS MCGREGORI and NEOSEIULUS COMITATUS are negatively impacted by these applications, providing an excellent system for BGM outbreaks. We have initiated studies on the coconut mite, ACERIA GUERRERONIS, a new pest of queen palms in California. This is a difficult research system due to the fastidious nature of the mite, and the requirements of high humidity and a tight environment afforded by the queen palm. We have created a method for studying the mite by imbedding sections of palm tissue into agar, creating a mite feeding chamber that can be observed. The objectives of our work are to describe the biology of the mite on palms, determine how it disperses, and develop management strategies. We have found that the mite disperses in large numbers in the air, so management will be challenging. We have begun work to determine the relationship between mite infestation and the symptom of mite damage and we soon will begin acaricide trials to determine if the mite can be controlled in pots.

Impact: Our work on BEMISIA is designed to provide information that can be exploited for management of this devastating pest. By understanding the interaction between this herbivore, its predators and various host plants, we hope to identify which plants are beneficial and which are detrimental to crops infested by the whitefly. For example, plants that afford enemy free space by protecting the whitefly and excluding predators should be eliminated from the agricultural ecosystem. Studies on the taxonomy of the BEMISIA species complex further our understanding of outbreak situations in world agriculture. Our epidemiological studies have identified an important vector of zucchini yellow mosaic virus, and important host for vectors of Pierces disease. This information can be used by growers to make decisions about where to plant susceptible crops. Obviously, the crops should be grown distant from potential vector sources. In addition, growers may wish to implement vector control in these alternate crops. Our work on Banks grass mite is aimed at reducing the reliance on chemical control and to develop a biologically-based management program. Based partially on our resistance data, the date growers have switched to a new chemical for date mite control. We are finishing studies on sampling to assist the growers in timing their applications. Many growers do not even know they have the problem. Through our work, we will develop a holistic management strategy. The same can be said for carob moth on dates.

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

Key Theme: 4.12 Integrated Pest Management
Title: Refinement of Arthropod Economic Thresholds on Field Crops California

Description: Studies were conducted on sugarbeets, cotton, field corn, rice, and sweet corn arthropod pest management. The beet armyworm, Spodoptera exigua, has exceeded aphids as the most significant insect pest of California sugarbeets. Armyworms reduce seedling density, defoliate plants, and feed on the sugarbeet root (exposed portion and/or root just below the soil surface). This latter damage is becoming more prevalent and makes the beet root susceptible to root rot disease. This project was undertaken to develop guidelines for armyworm management. The first objective was aimed to determine the causes influencing summer outbreaks through tasks addressing pest interactions and the flaring of pests through organophosphate and carbamate use. The second project contained tasks to determine the best integration of chemical, biological and cultural tactics for optimal management. It involved individual projects to evaluate currently used pesticides for their effects on pests and beneficial organisms, optimal timing experiments for a reduced-risk insecticide, and additional trials on the ability of sugarbeet plants to tolerate defoliation without a loss in productivity. Sugarbeet plants were exposed to single and multiple defoliation events (through artificial means) throughout the summer period of armyworm activity. Sugarbeet response to defoliation events was highly correlated to when the defoliation occurred. Plant regrowth was compromised, regardless of defoliation date, because of a naturally occurring curly top infection. Plants defoliated in early June and early July had significantly reduced yields in October and increased sucrose percentages when compared to plants defoliated late July and late August. Root rot incidence in damaged plots was highest with the two earlier defoliations. In additional studies, naturally occurring armyworm populations were manipulated with selective insecticide applications. Yield data were inconsistent; the two highest yields came from the plots receiving control measures in June, July, and August and from the untreated control. Plots in which armyworms were controlled in only June,

July or August yielded significantly less. Finally, an insecticide efficacy test resulted in a range of beet armyworm levels from nearly 100% control, 75% to 100% of the population in the untreated, and 3X the population of the untreated. Beet armyworms were the only economic insect pest in these plots. The sucrose yields were grouped similar to the control efficacy, i.e., high control=high yield, moderate control=moderate yield, and poor control=poor yield. Analysis showed a positive correlation between the total number of armyworms caught in sweep net samples during the season and incidence of rotten beets.

Impact: Improved information on insect pest thresholds and on management strategies will help to refine integrated pest management systems. A reduction in the use of broad-spectrum insecticides and/or the costs of production will benefit society and the agricultural sector.

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

Key Theme: 4.12 Integrated Pest Management
Title: Moleclar Detection, Characterization and Management of Plant Diseases Caused By Geminiviruses

Description: A new whitefly-transmitted bipartite begomovirus (genus Begomovirus, Family Geminiviridae) infecting cucurbits in the Imperial Valley of California has been identified. This virus has been named Cucurbit leaf crumple virus (CuLCrV). CuLCrV was originally found in watermelon volunteers showing leaf crumpling and distortion symptoms, but in the 2000 melon-growing season it was detected in commercial watermelon and cantaloupe fields in Southern California and Arizona. Thus, this virus has become established in Southern California and Arizona. To gain further insight into the nature of CuLCrV, full-length CuLCrV clones were generated using PCR and overlapping primers. The complete nucleotides sequences of these clones were determined and sequences of genes and the common region (a noncoding region shared between the two components of a given geminivirus species) were compared with those of other geminiviruses. The results of these analyses confirmed that CuLCrV is a distinct geminivirus species (i.e., nucleotide sequences of CuLCrV genes were no more than 87 percent identical to other begomoviruses). Phylogenetic analyses revealed that the closest relatives of CuLCrV are Squash leaf curl virus (SLCV) and Bean calico mosaic virus (BCMoV), which are found in Southern California and Northern Mexico, respectively. Thus, CuLCrV is a new member of the SLCV cluster of begomoviruses.

Impact: A new whitefly-transmitted begomovirus, infecting cucurbits in Southern California and Arizona has been identified and characterized. This virus has been named Cucurbit leaf crumple virus (CuLCrV). The complete nucleotide of full-length clones has been determined and can be used to generate tools for the rapid detection of the virus, which should be useful if this virus becomes a major problem in the near future.

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

Key Theme: 4.12 Integrated Pest Management
Title: Elucidating Fitness Determinants in Epiphytic Bacteria

Description: A set of three sucrose-regulated transcriptional fusions was constructed to assess fructose availability on leaves. Fusions p61RYTIR, p61RYlac and p61RYice, contain the scrR sucrose repressor gene and the promoterless gfp, lacZ and inaZ reporter genes, respectively, fused to the scrY promoter from Salmonella typhimurium. Cells of Erwinia herbicola containing these fusions are only induced in media amended with sucrose, fructose, or sorbose. While a large variation in sucrose-dependent reporter gene activity was observed in cells harboring all gene fusions, fusions to the inaZ reporter gene yielded a much wider range of activity and were responsive to lower levels of sucrose than either lacZ or gfp. The lacZ reporter gene was found to be more sensitive than gfp, requiring approx. 300-fold fewer cells for a detectable response over all concentrations of sucrose. Similarly, inaZ was found to be more sensitive than lacZ, requiring 30-fold fewer cells at 1.45 uM sucrose and 6100-fold fewer cells at 29mM sucrose for a quantifiable response. The fluorescence of individual cells containing p61RYTIR was quantified following epifluoresence microscopy in order to relate the fluorescence exhibited by populations of cells in batch cultures with that of individual cells in such cultures. While the mean fluorescence intensity of a population of individual cells increased with increasing concentrations of sucrose, a wide range of fluorescence intensity was seen among individual cells. For most cultures the distribution of fluorescence intensity among individual cells was log-normally distributed, but cells grown in intermediate concentrations of sucrose exhibited two distinct populations of cells, one having relatively low fluorescence and another with much higher fluorescence. When inoculated onto bean leaves, whole cell ice nucleation and gfp-based biological sensors for sucrose each indicated that the average concentration of sucrose on moist leaf surfaces was about 20 uM. Importantly, the variation in gfp fluorescence of biosensor cells on leaves suggests that large spatial variations in sugar availability occur on leaves. A biosensor for fructose was also constructed. E. herbicola cells harboring a fusion of the fruB promoter from E. coli with an unstable variant of the gfp reporter gene encoding a terminal AAV amino acid extension conferred fructose-dependent gfp fluorescence. The half-life of the unstable gfp reporter gene, ca. 1.5 hours permitted near real-time estimates of fructose availability to be estimated. Most cells of the E. herbicola fructose biosensor exhibited fructose consumption for at least an hour after spray inoculation, but less than 1% of the cells were still consuming fructose after 24 hours on a moist bean leaf, suggesting that most sites on the leaf harbored sufficiently little fructose that it was consumed quickly by immigrant cells. Cells located near glandular trichomes were most likely to have access to fructose over long periods of time, often developing into large cell aggregates of higher metabolic activity that more solitary cells as estimated from measures of rates of ribosomal RNA synthesis.

Impact: The characterization of the nutrient environment on leaves provides a basis for understanding the epidemiology of bacterial diseases and of the incitants of frost injury to plants. The finding that nutrient resources are rather ephemeral, and localized on leaves puts constraints on the successful immigration of inoculum from one plant to another. The localization of nutrients in a few locations on leaves also suggests that important interactions between the bacterium and the plant that lead to disease and the interactions between epiphytic bacteria that can lead to biological control of disease are also very local phenomena. This finding has substantial implications for the design of both chemical and biological controls strategies of disease and frost injury.

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

Key Theme: 4.12 Integrated Pest Management
Title: Integrated Pest Management in Ornamental and Floricultural Crops

Description: Our original studies involving glassy-winged sharpshooter transmitting oleander leaf scorch (XYLLELLA FASTIDIOSA) to various cultivars of oleander have now been expanded to include the development and evaluation of control strategies for this insect in grapes and citrus as a means to limit the spread of Pierce's disease of grapes (also XYLELLA FASTIDIOSA). During this study period we have documented the occurrence in California of a predator wasp which specializes on the glassy-winged sharpshooter. This wasp (PSENEO PUNCTATUS) likely entered the state within the soil of nursery containers. We are currently evaluating this species' potential as a supplementary biological control agent for sharpshooters. Additionally, we have determined the seasonal flight activity of the glassy-winged sharpshooter in Southern California and have shown two distinct flight periods per year (early spring and mid summer). The mid-summer flight period always demonstrated the most sharpshooter activity and citrus groves supported the greatest number of sharpshooters among the habitats sampled. Towards developing a management strategy for glassy-winged sharpshooters, we documented the affects of selected insecticides mortality, feeding behavior, and disease transmission in a greenhouse study. Oleanders treated with fenpropathrin, fenpropathrin and imidacloprid caused significant mortality to caged sharpshooters within 4 h of exposure. Within 24 h, these pesticides caused nearly 100% mortality 3 wk after treatment. In other experiments, acetamiprid and fenpropathrin treatments reduced time spent feeding and total time on plants. Sharpshooters feeding on fenpropathrin-, acetamiprid-, and imidacloprid-treated oleander died in less than 13 min on average. Oleander leaf scorch transmission by glassy-winged sharpshooter was blocked by applications of foliar-applied acetamiprid, and soil-applied imidacloprid and thiamethoxam. Research also was published documenting the existence of intraspecific competition in the Eugenia psyllid (TRIOZA EUGENIAE). Female psyllids oviposit preferentially on the margin of young, incompletely expanded eugenia leaves. As the density of eggs on the leaf increases, females will oviposit on the surface of the leaf blades. The survivorship of eggs laid on the abaxial leaf midrib and near the abaxial leaf margin was significantly greater than that of eggs laid on the leaf margin. The maximum carrying capacity for psyllid nymphs on a fully expanded leaf is approximated closely by the number of eggs that can be laid on the margin of a young, unexpanded leaf. The leaf margin appears to be a proximal cue used by ovipositing females for resources available to developing nymphs. Females that limit oviposition to available leaf margins appear to improve the probability of survival of their progeny through reduced intraspecific competition.

Impact: The glassy-winged sharpshooter work continues to develop novel approaches to control and manage this vector of Pierce's Disease and Oleander Leaf Scorch. To date, we continue to identify and broaden several hopeful avenues of disease management based on applications of neonicotionoid pesticides, release of biological control agents, and direct control of sharpshooters in citrus adjacent to vineyards. The work with psyllids demonstrates a clear effect of intraspecific competition, potentially indicating a limiting resource for these insects. The work with MANDUCA indicates that the effect of parasitism on host physiology may be beneficial with regard to overall parasite fitness.

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

Key Theme: 4.12 Integrated Pest Management
Title: Enhancing Postharvest Quality of Fruits With Reduced Dependence on Chemical Treatments

Description: Biological control of Botrytis rot on harvested strawberries was demonstrated to be effective, but not more so than holding berries in fifteen percent carbon dioxide atmospheres during cold storage. Acetaldehyde (4 percent) was demonstrated effective for control of western flower thrips and two spotted spider mites on harvested strawberries, but the effective levels caused browning of the strawberry calyx. Ethyl formate was shown to be effective for insect control at levels that caused only minor damage to the strawberry calyx. Ethyl formate has also been demonstrated to control grape mealybugs on table grapes when used in conjunction with 45 percent carbon dioxide atmosphere treatments. Table grape tolerance is under investigation. We have also initiated a project to further explore the mode of action of controlled atmospheres in causing insect mortality. We are exploring the effects of carbon dioxide on membrane permeability and ATP production. In addition, we are comparing closely related species of mealybugs that vary greatly in their susceptibility to carbon dioxide treatments.

Impact: Our work on insect control is developing alternatives to methyl bromide fumigation. The availability of alternatives is important to reduce worker safety issues and maintain the competitiveness of U.S. agriculture.

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

Key Theme: 4.12 Integrated Pest Management
Title: Epidemiology and Management of Diseases of Vegetable Crops

Description: Since 1995, Verticillium wilt has appeared on lettuce in coastal California and has the potential to cause significant losses in the Salinas Valley in the coming years. We have therefore begun a program to identify sources of resistance in lettuce germplasm against Verticillium wilt. The identified germplasm resources are also going to be incorporated immediately into the breeding program to generate varieties and cultivars. Thus, when the disease establishes in the Salinas Valley, we will have resistant commercial cultivars against Verticillium wilt. Judging from the scale of destruction observed in fields where the disease has so far occurred, Verticillium wilt has the potential to impact lettuce production significantly. In some plantings, up to 80 percent of the plants were affected. The scale of destruction observed in affected fields, and the ineffectiveness of available soil chemicals other than methyl bromide to completely eliminate the pathogen from soil, or the uneconomical use of methyl bromide in lettuce production, make the identification of host resistance all the more important and urgent. We have tested various inoculum sources, inoculation methods, and incubation conditions to optimize the screening technique. We have also evaluated a number of lettuce germplasm lines for resistance to Verticillium wilt using this technique. Results from field and greenhouse screening experiments have been communicated to representatives from the industry, seed companies, and public sector researchers.

Impact: We have been conducting screening trials of lettuce varieties and germplasm lines in affected commercial fields and have identified sources of resistance against Verticillium wilt. We anticipate screening greater numbers of lettuce germplasm lines and identify sources of resistance to Verticillium wilt in crisphead, butterhead, leaf and romaine types of lettuce.

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

Key Theme: 4.12 Integrated Pest Management
Title: Effect of Cultural Practices on Control of Diseases of Prunus Spp.

Description: Alternaria leaf spot severely defoliates almond trees in late spring and early summer. The disease is associated with areas having high humidity and frequent heavy dews. Leaves exposed to the sky, those on which dew is most likely to form, are infected first thus trees trained to open spreading canopies that have many leaves in that orientation are more severely affected than more upright trees. We initiated a trial to compare the effects of three pruning systems, each designed to alter tree shape, on disease development. The full impact of these systems (hedging, topping, and hedging and topping) will not be manifested for two or three years. In this first season, no significant differences among systems were found. In a separate trial, treatment timing was examined by application of azoxystrobin three times at two-week intervals beginning in mid spring. The treatments were begun at six times. Disease incidence did not differ among the timings. Trees treated with iprodione plus ziram at bloom and two and five weeks after bloom had reduced disease levels compared to the non treated control. This suggests that a fungicide program with less risk of developing resistance in the pathogen may be possible. In a third trial, several experimental fungicides were compared to azoxystrobin. Only the strobilurin fungicides (those with chemistry similar to that of azoxystrobin) were effective. Pathogen population and disease development were monitored on leaves that were collected at approximately weekly intervals from mid March through late July. The pathogen was present at low levels until an increase in early May then population levels remained the same until another increase in mid July and again in late July. There were fewer lesions on external than internal external leaves at the beginning of the season, similar amounts in June, and more in July. Recent work on the taxonomy of Alternaria alternata, the pathogen causing Alternaria leaf spot, indicates that the species is actually a complex of several species. Isolates from Alternaria leaf spot lesions include A. alternata, A. arborescens and A. tenuissima. Inoculations of cultivar Butte leaves were made at approximately 3 week intervals at Kearney Agricultural Center. Intact healthy leaves on trees were inoculated with one isolate of A. tenuissima five isolates of A. alternata. All isolates produced more lesions than the non inoculated control, and A. tenuissima caused earlier in the season and ultimately more lesions than the A. alternata isolates. In spore germination tests, A. tenuissima germinated more rapidly at lower temperatures than A. alternata. This may partially explain why A. tenuissima produced high infection levels earlier in the year than did A. alternata in inoculation tests.

Impact: Pruning systems that shape trees in ways that do not favor disease development would contribute to disease control. Combining pruning with fungicide treatment may further reduce disease. That the pathogen is comprised of several species, each perhaps differing in temperature, moisture and other requirements, may complicate development of monitoring or other predictive methods.

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

Key Theme: 4.12 Integrated Pest Management
Title: Interactions Among Bark Beetles, Pathogens, and Conifers in North American Forests

Description: Circular plots (7-9m radius) were established to test various treatments to enhance Monterey pine regeneration. The plots were divided into 3 sectors and treated as follows: untreated, removal of all understory vegetation to bare soil, and mulching of the vegetation. Preexisting regeneration averaged 579.8 seedlings/ha, and was variable between the plots. At 15 months post treatment, regeneration was higher than after 4 months and was similar in all treatments. Monitoring plots were established in a Monterey and Bishop pine forest regenerating after a 83-ha wildfire in May 1987. Plots consisting of groups of 30 trees closest to a randomly selected tree along a fire trail or other forest edge were established. Assessments of pitch canker mortality were made in October 1998, June 1999, November 1999 and August 2000. In April 2001, pitch canker symptoms were more likely to be observed in Bishop than Monterey pines. Tree mortality was more likely in Monterey than Bishop pines. Pitch moth and western gall rust were more likely to be found in Bishop than in Monterey pines. Branch tips symptomatic for pitch canker were collected from 4 native Douglas-firs within Ano Nuevo State Preserve in Dec. 2000. Tips collected had red, yellow, green, or no needles and were either associated with an apparent insect induced swelling or not. Isolations from 66 symptomatic tips were plated on Fusarium selective media. Of these isolations, 16 tested positive for F. circinatum. Most were from a single tree and associated primarily with insect swellings. These isolations are the first records of pitch canker infections in native Douglas-fir forests in CA. The Fire-Fire Surrogate Study consists of 4 treatments, each replicated 3 times: control, fire only, mechanical only, and fire + mechanical. Treatment areas are 13 to 29 ha and each contains twenty 0.04-hectare plots established on a grid pattern, 60.4 m apart at Blodgett Forest Research Station. Insect and disease pre-treatment data were obtained for all plots in June-July 2001, as well as 360-degree scans to identify symptomatic trees outside of the plot areas. Current mortality levels are 6 sugar pines, 3 ponderosa pines, and 13 white firs. With the exception of fir engraver beetle symptoms, current levels of symptoms are similar across treatments (3.2% sugar pine, 1.2% ponderosa pine, and 10.2% white fir). Disease progression plots in China Camp State Park and Marin Municipal Water District, Marin Co. have been monitored quarterly from March 2000 - Dec. 2001. These plots reveal continuing incidents of new infections of oaks and tanoaks by Phytophthora ramorum, the primary agent of sudden oak death. By 2001, 29% of coast live oaks were infected and 13% had died with P. ramorum infections. In addition, 54% of tanoaks were infected and 17% had died. China Camp has also been surveyed using plotless sampling (center-point quarter method), which shows 30% infection and 14% mortality levels that are generally consistent with those in the disease progression plots. Additional sampling is currently under way near Soquel, in the Santa Cruz Mountains and is planned for other areas throughout the zone of infestation.

Impact: Our research on the interactions among bark beetles, pathogens and trees is focussed on two introduced pathogens, Fusarium circinatum and Phytophthora ramorum. These pathogens cause pitch canker of pines and sudden oak death of oaks and tanoaks, respectively. Through our studies we 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: Hatch Multistate Research and State
Scope of Impact: CO, CA, FL, IA, MN, OH, OR, WI, UT, USDA/FS, NON-SAES: Univ. of MT; MN

Key Theme: 4.12 Integrated Pest Management
Title: Genetic Variability in the Cyst and Root-knot Nematodes

Description: A host plant and nematode database called Nemabase has been developed by faculty at the University of California, Davis. The database includes information obtained from the published literature, and as of Dec. 2000 covered the nematology literature up to ca. 1994, and included approximately 24,000 records. NEMABASE can be interrogated directly via the UCD Dept. of Nematology WWW homePage:(http://ucdnema.ucdavis.edu/imagemap/nemmap/ent156html/contents). NEMABASE is also distributed through the University of California Integrated Pest Management (UCIPM) project, and can be downloaded from the UCIPM web site (http://www.ipm.ucdavis.edu). A few years year ago, we undertook the development of a knowledge-based system ("KNOWLEDGE") using NEMABASE as a core database. To make the KNOWLEDGE database easier to interpret, we removed all records in NEMABASE that originated from Siddiqui et al. (1973) and from Goodey et al. (1965) and placed those into separate databases. The Siddiqui database contains 5,137 records while the Goodey database contains 10,138 records, leaving ca. 24,000 records from NEMABASE in KNOWLEDGE. All three databases have been supplied on a CD ROM for the W-186 membership. During 2001 he information in KNOWLEDGE was updated from the published nematology literature, and during 2001 ca 8,000 new records representing data from the nematology literature published since ca. 1994 was entered into the database to bring the records up to date. There are now 32,382 records in KNOWLEDGE.

Impact: Many clients will use the database to determine the host-range of nematodes, and to plan non-nematicidal nematode management strategies. Use of rotations or resistance to alleviate nematode damage should be significantly enhanced by the availability of this database and so decrease negative environmental impacts of nematicide use, by aiding reduction of nematicide use in agricultural systems.

Funding Source: Hatch Multistate Research and State
Scope of Impact: AR, CA, HI, ID, MI, NE, NM, NC, OR, WA, WY

Key Theme: 4.12 Integrated Pest Management
Title: Management of Aphids, Aphid-borne Viruses and Silverleaf Whitefly in the San Joaquin Valley

Description: New knowledge on the biology and ecology of the silverleaf whitefly, BEMISIA ARGENTIFOLII, was developed. Silverleaf whitefly crawlers move a considerable distance on the plant before settling down. Crawlers moved an average of 6.5 cm on four host plants. Crawlers moved between plants when a leaf bridge connected two plants. Silverleaf whitefly crawlers were positively phototactic and showed no response to gravity. Such activity permits them to move from a senescing host leaf or plant that would not support development to the adult stage to one that will. Such behavior

confers a selective advantages to the crawlers. Citrus was found to be the most important overwintering host of silverleaf whitefly in the San Joaquin Valley. In the fall, adults migrate to citrus in response to cotton defoliation and senescence of other hosts. Eggs are laid on the fall flush of foliage and overwintering occurs as eggs and nymphs. Citrus is protected from freezing temperatures thus increasing winter survival. Adults emerge in March and infest spring vegetables. The most severe summer infestations in the San Joaquin Valley follow the citrus belt. Two new toxicogenic disorders caused by silverleaf whitefly feeding, light streak of pepper and fading of pumpkin were identified and described. Reflective plastic mulch (metalized mulch), polyethylene with a thin coating of aluminum, was highly effective in the management of aphid-borne viruses and silverleaf whitefly. In cantaloupe, cucumbers, squash and pumpkins, the reflective mulch delayed the onset of aphid-borne viruses by six weeks. Silverleaf whitefly infestation were significantly delayed by reflective mulch. The incidence of aphid-borne viruses of squash was evaluated under three management systems: a) reflective mulch, b) virus resistant varieties, and c) systemic insecticide. The insecticide had no significant effect on virus incidence, but did delay onset of squash silverleaf. Although the incidence of virus infection was delayed and reduced in virus resistant varieties, ca. 50% of the plants eventually became infected. Yields from the plots planted to virus resistant plants were significantly lower than those from a susceptible variety planted over reflective mulch. These trials show that reflective mulch is superior to either resistant varieties or insecticides in reducing the incidence of aphid infestations, virus diseases, silverleaf whitefly infestations and squash silverleaf. Metalized mulches were evaluated under commercial conditions in 2 ha grower fields of squash, cucumber and pumpkin. They worked as well in large scale field trials as they did in small plot studies. These mulches also deterred the corn leafhopper, DALBULUB MAIDIS. Sweet corn planted over metalized mulches had significantly lower leafhopper populations and a reduced incidence of corn stunt disease compared to plants grown over bare soil or treated with insecticides. Yields from plots on metalized mulch were significantly higher than those from plants grown on bare soil or treated with insecticides. Studies are underway to evaluate the allopathic effect of sorghum-sudan on tomato, broccoli and lettuce.

Impact: This research has measurably improved our understanding of silverleaf whitefly biology and ecology and has provided an explanation of whitefly infestation patterns in the San Joaquin Valley. It has also shown that metalized reflective plastic mulch can be successfully used to manage aphids, aphid-borne viruses, silverleaf whitefly and selected leafhoppers without insecticides.

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

Key Theme: 4.12 Integrated Pest Management
Title: Development, Evaluation and Safety of Entomopathogens For Control of Arthropod Pests

Description: The mosquitocidal bacterium BACILLUS THURINGIENSIS ISRAELENSIS (BTI) produces four major endotoxin proteins, Cry4A, Cry4B, Cry11A and Cyt1A, and has toxicity similar to synthetic chemical insecticides. Cry11B, which occurs naturally in B. T. JEGATHESAN, is a close relative of Cry11A, but is tenfold as toxic to CULEX QUINQUEFASCIATUS. To determine whether Cry11B added to BTI would improve toxicity, this protein was produced in BTI. High levels of Cry11B were obtained by expressing cry11B under control of cyt1A promoters and the STAB-SD sequence. This construct was cloned into vector pHT3101 yielding the derivative plasmid pPFT11Bs,

which was then transformed by electroporation into acrystalliferous (4Q7) and crystalliferous (IPS-82) BTI strains. Synthesis of Cry11B in BTI 4Q7 produced crystals 50% larger than those produced using natural promoters without STAB-SD. However, less Cry11B was produced per unit culture medium than with the wild-type construct, apparently because the latter produced more cells per unit medium. Nevertheless, the BTI IPS-82 strain that produced Cry11B using pPFT11Bs was twice as toxic as the parental IPS-82 strain (LC50 = 1.4 versus 3.3 ng/ml, respectively) to fourth instars of CX. QUINQUEFASCIATUS. Against fourth instars of AEDES AEGYPTI, no statistically significant difference was found in toxicity between parental BTI IPS-82 (LC50 = 4.7 ng/ml) and the Bti IPS-82 recombinant producing Cry11B (LC50 = 3.5 ng/ml).

Impact: These results in conjunction with previous results with the Cry3A endotoxin show that it is possible to use cyt1A promoters in combination with the STAB-SD sequence to synthesize much higher levels of endotoxin proteins per bacterial cell. This provides a molecular mechanism for developing a wide variety of novel and more effective bacterial insecticides

Funding Source: Hatch Multistate Research and State
Scope of Impact: AL, AR, AZ, CA, CTH, FL, GA, ID, IL, KY, LA, ME, MN, NJ, NYC, NC, OH, SC, TN, TX, VA, USDA/ARS, USDA/FS, DE, PA

Key Theme: 4.12 Integrated Pest Management
Title: Non-chemical Strategies For Managing Plant-parasitic Nematodes

Description: Greenhouse studies showed that a combination of soil heating and amending soil with broccoli residue (bio-fumigation) increased levels of root-knot nematode control compared to the non-amended treatment. However, this effect was dependent on the soil temperature, with the strongest effect of amending soil with broccoli occurring at soil temperatures between 25 and 35C. These results were evaluated in the 2001 growing season at two Research and Extension Centers (Irvine and Parlier). The field trials also showed that a combination of solarization and bio-fumigation resulted in improved yields, but at the same time produced high nematode populations at harvest of the crop (melons). The results could be explained by an initial control of the nematodes, allowing the young seedlings to grow under very low nematode pressure. However, later in the growing season the nematodes that survived at greater depths would infect the well developed root-systems, resulting in large populations at harvest. We showed earlier that plants that are older at time of nematode attack are much more tolerant. This would explain the yield increase combined with the high nematode densities. There is an enormous variety in ornamental and nursery crops and cultivars. As a result, data on nematode susceptibility are available only for a few selected crops. Severe stunting combined with the presence of galls on roots of Lisianthus in a commercial operation, prompted us to study the susceptibility of this popular cut flower crop to root-knot nematodes. Three species of root-knot nematodes were added in increasing densities to pots with Lisianthus transplants in a greenhouse trial.. Results showed that this cut-flower is highly susceptible to root-knot nematodes and that two (M. incognita and M. javanica) of the three species tested resulted in severe growth reduction and flower production even at relatively low densities.

Impact: Our research on solarization and biofumigation indicates the potential of this method for maintaining yields under substantial nematode pressure. It also demonstrates that controlling

nematodes and avoiding crop losses are not necessarily linked, and that they can be two separate objectives. There exist big gaps in information on the host status and damage thresholds to nematodes in ornamental and nursery crops. Our research on a popular cut flower (Lisianthus) is of direct benefit to growers as it will allow them to make rational decisions for nematode control in this crop.

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

Key Theme: 4.12 Integrated Pest Management
Title: Reduced Chemical Weed Control in Field and Vegetable Crops

Description: Dodder is a parasitic weed, which attacks a wide range of crop plants. Once attachment occurs, it is very difficult to control without killing the host plant. In 2001, dodder samples were collected from crop plants throughout California. These dodder samples were grown on tomato, and once flowering began, they were taxonomically identified. We found two species, Cuscuta pentagona and C. californica, which had previously been identified as parasites of crop plants, but also found C. subinclusa in our samples, which had not been reported as a crop pest. We have initiated studies to determine if the Cuscuta species or biotypes differ in there sensitivity to herbicides. Results to date indicate that the species respond similarly to treatment. Field studies were conducted for the control of field dodder (Cuscuta pentagona) in 2001. An herbicide, sulfosulfuron, was examined for control of dodder, applied post-attachment. The sulfosulfuron failed to provide dodder control in this year's field studies, although greenhouse results have been more promising. We combined a resistant tomato variety (Heinz 9492) with sulfosulfuron treatments in field studies but found no improvement in dodder control from the addition of sulfosulfuron. These results will be presented at the 2002 Weed Science Society of America meetings. In 2001, we again conducted studies on variable rate treatments based on weed density and distribution within a field. Field maps of weed distribution based on seedling or mature weeds with seed were created from 2000 data and used to make preemergence herbicide applications in 2001. In the later half of 2001 and in 2002, we will attempt to map weeds with a vision system connected to a computer.

Impact: The dodder-tolerant tomato varieties have been rapidly accepted by growers as a way to avoid dodder problems. These varieties provide a nonchemical alternative for dodder control in tomatoes. Sulfosulfuron has shown potential to also provide effective post-attachment control. Precision weed control is still in its early stages of adoption, but the work on weed mapping and variable rate herbicide treatments based on previously collected weed data could allow large reductions in herbicide use and increase weed control efficiency.

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

Key Theme: 4.12 Integrated Pest Management
Title: Interactions of Bacteria With Insect Vectors of Plant Pathogens

Description: GLASSY-WINGED SHARPSHOOTER (GWSS, Homalodisca coagulata) AND IMIDACLOPRID. Soil treatments of grapevines with the neonicotinoid insecticide imidacloprid at dosages that killed 15% to 98% of the adult GWSS on treated plants within 24 hours drastically reduced levels of feeding by GWSS and reduced transmission of the bacterium XYLELLA FASTIDIOSA (Xf) to grape. Insects removed from treated plants continued to transmit Xf at reduced rates for each of the 2 subsequent days. TRANSMISSION OF XYLELLA FASTIDIOSA (Xf) BY GWSS. GWSS transmitted Xf from dormant grape to dormant grape in greenhouse conditions. Transmission rates were half or less than transmission to grapes with green shoots. These results suggest that vineyards may be susceptible to infection with Xf by GWSS for virtually the entire year. WEED HOSTS OF XYLELLA FASTIDIOSA (Xf). Weeds that are common in central California vineyards were inoculated with Xf by infective sharpshooters and resulting populations of Xf where seven of 19 weed species tested supported systemic movement of Xf and log 5 to log 7 live Xf per gram of plant tissue. Sharpshooter vectors of Xf should be able to acquire Xf from systemic hosts with populations above log 5. Knowing which weeds can harbor Xf is important in efforts to control Pierce's disease.

Impact: The knowledge of how sublethal dosages of insecticides can affect the dispersal and feeding behavior of insect vectors of plant pathogens should guide future experimentation and application of these insecticides to control plant diseases caused by vector-borne pathogens. In efforts to control Pierce's disease, knowing which weeds can harbor Xf is important to enable removal or prevention of sources from which insect vectors can pick up the bacterium.

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

Key Theme: 4.12 Integrated Pest Management
Title: The Biology and Physiology of Perennial Weed Control

Description: Ozone gas as a potential replacement for methyl bromide was evaluated in the greenhouse and field for purple nutsedge (Cyperus rotundus), one of the most persistent weeds facing warm weather vegetable and ornamental growers. Ozone treatments were made in greenhouse studies when shoots had developed approximately two inches in height. Rates of ozone used was 1% or 5% for 5 minutes or 20 minutes every day or every other day over a period of 15, 30 or 45 days. All of the treated plants from the 15-day cycle showed significant leaf necrosis, however, within one week all treatments showed regrowth. Following completion of the 30-day ozone treatment cycle only treatments using 1% ozone every other day showed regrowth. All other treatments showed complete control with no new regrowth at termination of the entire experiment. All treatments in the 45-day ozone treatment cycle showed 100% control. A field experiment was established to evaluate ozone applied under field conditions using 30 feet long beds by 36 inches wide. A double row of drip irrigation tubes were placed on the beds 18 inches apart on the soil surface and the beds were covered with 4 mil clear polyethylene plastic tarp. When the purple nutsedge shoots had emerged approximately one inch the ozone gas was injected under the tarp through the drip irrigation tubes. Ozone was injected at a concentration of 1% (w/w) in air for 10 or 40 minutes per day, which was equivalent to 2 and 8 lb/acre respectively, or for 40 minutes every other day for 30 days. The number of purple nutsedge shoots was reduced by 70% and the overall purple nutsedge biomass was reduced

by 90% compared to the control. The 40-minute treatment made every other day reduced the number of shoots by 60% and the overall purple nutsedge biomass by 80% compared to the untreated control. All annual grasses, primarily brome grass species (Bromus sp.), little mallow (Malva parviflora), birdsrape mustard (Brassica rapa), and lambsquarter (Chenopodium album), were completely controlled. New collections of ryegrass (Lolium rigidum and/or Lolium multiflorum) reported to be resistant to glyphosate continues to show the infestations are primarily located in northern and central Sacramento Valley but new infestations have been found in Northern San Joaquin Valley. These collections from the San Joaquin Valley have shown only moderate resistance to glyphosate being able to survive the commercial applications of 1 pound isopropyl amine salt per acre but exhibit severe chlorosis and stunting at 2 pounds isopropyl amine salt per acre application. None of the San Joaquin Valley collections have survived the 8 pound isopropyl amine salt per acre. However, we have collected two additional accessions from northcentral Sacramento Valley that have survived the 8 pound isopropyl amine salt per acre treatment exhibiting very few glyphosate symptoms.

Impact: Collections of ryegrass plants resistant to glyphosate seems restricted primarily to the Sacramento Valley but may be spreading to northern San Joaquin Valley. By mapping these collections a clearer picture is becoming evident allowing researchers and advisors to focus on management practices that are most conducive in controlling glyphosate resistance plants. With the phase out of methyl bromide, ozone may be an environmentally safe alternative for weed control under plastic.

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

Key Theme: 4.12 Integrated Pest Management
Title: Mechanism of Resistance To Root-knot Nematodes in Tomato

Description: The tomato gene MI is the only commercially available resistance gene that confers resistance against 3 species of root-knot nematodes, MELOIDOGYNE spp. MI also confers resistance to the potato aphid (MACROSIPHUM EUPHORBIAE). MI was cloned and shown to belong to a large class of resistance genes with predicted leucine zipper, nucleotide binding site and leucine rich repeats. This indicates that MI-mediated resistance most likely requires the presence of other genes or factors to succeed. We are using a genetic approach to identify suppressors of MI-mediated resistance. We have identified several mutants that allow different levels of nematode reproduction in the presence of a functional MI. One of these mutants rme1, shows complete susceptibility to both nematodes and aphid. To determine whether RME1 functions in a general disease-resistance pathway, the response against FUSARIUM OXYSPORUM f.sp. LYCOPERSICI race 2, mediated by the I-2 resistance gene, was studied. Both rme1 and the wild type plants were equally resistant to the fungal pathogen. These results indicate that RME1 does not play a general role in disease resistance but may be specific for MI-1-mediated resistance. In conjunction to understanding how MI-1 mediates resistance, we are also mapping novel sources of nematode resistance in LYCOPERSCON PERUVIANUM accessions LA2157 and PI 270435-2R2. LA2157 confers heat-stable resistance to MI-aviruelnt nematodes while PI 270435-2R2 confers both heat-stable resistance and resistance to MI-virulent nematodes. Using both RFLP and PCR-based markers with 216 F2 individuals, we have mapped MI-9 to a small genetic interval between DNA markers CT119 and C8B on the short arm of

chromosome 6. As for mapping the heat-stable resistance in PI 270435-2R2, BSA and AFLP were performed by pooling DNAs from 10 resistant and 10 susceptible individuals. A total of 128 primer combinations were used, which revealed 30 polymorphic markers. Linkage analysis with the whole population identified one marker to be tightly linked in repulsion-phase and another marker in coupling-phase, with a distance of 16 cM from the gene. Work is in progress to clone these AFLP markers for mapping. Resistance to MI-1-viruent nematode was also evaluated with this population. 92 pseudo backcross progeny were screened with MI-1-virulent M. INCOGNITA at 25C. Genetic analysis revealed the presence of 26 resistant and 66 susceptible individuals 1:3 ($X2 = 0.016$ $P < 0.05$) suggesting that the resistance to virulent nematode may be governed by more than one gene. Roots were air dried and weighed. We observed a large variation in the number of egg masses per gram of root. These finding suggest that, resistance to virulent RKN may be quantitatively inherited. Therefore, quantitative trait loci mapping approach will be undertaken to identify loci controlling resistance and the phenotypic contribution of each locus to the trait.

Impact: Root-knot nematodes are serious pest of tomato. Identifying and characterizing novel sources of resistance is crucial for the tomato industry. Understanding how resistant genes work will enable us to engineer durable resistance.

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

Key Theme: 4.12 Integrated Pest Management
Title: Etiology, Epidemiology, and Control of Virus Diseases of Horticultural Crops

Description: Research is underway to determine whether rose mosaic disease can be experimentally transmitted between roses by pollen and/or mechanical transmission. These are modes of transmission which have been shown to be of importance in other crops for the types of viruses which cause rose mosaic disease. A RMV collection has been established and is being characterized by indexing, serology, and PCR. Shoot tip culture has become an integral part of UC Davis, Foundation Plant Materials Service clean stock programs for the elimination of viruses in sweet potatoes, grapes, and strawberries over the last decade. Techniques and media have been optimized; at this writing, shoot tip culture has proved to be reliable and is preferred over other therapy techniques such as heat treatment, chemotherapy, and efforts to identify escapes. Work continues to determine the causal agents of virus-induced rootstock decline, which is highly correlated with the grapevine viruses GVB and GLRaV-2, and to quantify the effect on specific genotypes of Vitis rootstock. Trials have been initiated to determine the effect of Grapevine Rupestris Stem Pitting (RSP) and Grapevine Fleck which are often found in certified grapes with newly developed PCR tests.

Impact: The role of latent viruses in vineyards in California is better understood. PCR tests can be used to reveal the presence of certain virus combinations, particularly GVB and GLRaV-2, which can cause severe disease. Growers can protect themselves by a combination of testing and the use of clean stock. Tissue culture techniques for the elimination of virus are improving, making it possible to produce virus-free explants of strawberry, grape, sweet potato on a routine basis, increasing the availability of healthy stock to growers.

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

Key Theme: 4.12 Integrated Pest Management
Title: Weed Germination Ecophysiology and Enhanced Weed Control Options For California Vegetable Growers

Description: Our principal research objective is to develop improved weed management options for vegetables. The study of weed biology is the basis of the program, since an improved understanding of weed ecophysiology can be used to make more efficient use of available weed management inputs. This project is focused on two principal areas: (1) the development of season-specific weed management programs for vegetables, and (2) the development of more effective common sowthistle (Sonchus oleracea) management systems for lettuce. Season-specific weed management. The goal of this project is to develop season-specific weed management programs for vegetables. To detect shifts in the germination potential of several weed species in the soil seedbank, soil samples from two vegetable fields were taken every 45 days beginning March 1998 until November 2001. These soil samples were assayed to determine the fraction of weed seeds in the soil seedbank that had the potential to germinate. By sampling every 45 days, it was possible to detect seasonal changes in the germination potential of weed seeds in the seedbank as well as seasonal weed emergence patterns. The data indicate that generally there is a relationship between seasonal weed emergence peaks and periods of high seedbank germination potential. Weeds such as annual bluegrass, and southern brass buttons have emergence peaks in the fall, while common purslane; hairy nightshade and pigweeds have emergence peaks in the summer months. Some species such as burning nettle, common chickweed, common groundsel, henbit and shepherdspurse emerge all year. We are currently attempting to develop mathematical models to predict the seasonal emergence of specific weeds in vegetable fields. A practical application of this information, for example, is in organic production fields with heavy infestations of annual bluegrass. In those fields the fall crop should be one that is easy to cultivate and hand weed. Common sowthistle management in lettuce. We are evaluating several methods to improve the management of common sowthistle with cultural practices. Common sowthistle germinates from very shallow layers in the soil. If sowthistle seed in an infested field can be buried by plowing, and left in the soil for a sufficient period of time so that most seed die, then it may be possible to deplete the soil of viable sowthistle seed. For example, we suspect that most common sowthistle do not persist more than 12 to 18 months in the soil once it is buried. We have buried fresh sowthistle seed, and will unearth samples at 12, 18 and 24 months after burial to determine if the seed are still viable. The 6-month seed packets were removed on November 5, 2001 and the seed viability (+ the standard error) was 80.3(+8.1)%. Obviously the seed must be buried for more than 6 months to kill it. The 12-month samples will be dug up on May 5, 2002.

Impact: California vegetable producers sold over $5.6 billion in produce during 2001. 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 that are focused on many of the older vegetable herbicides.

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

Key Theme: 4.12 Integrated Pest Management
Title: Disease Forecasting in Vegetable Crops

Description: A model that predicts outbreaks of black mold of tomato (Alternaria alternata) of tomatoes based on temperature, relative humidity, and duration of leaf wetness was validated in the field. The model resulted in one or more fewer applications of fungicides to reduce the severity of mold when sprays were timed according to the model rather than applied on a calendar schedule. In this year's trials, the percentage of fruit affected by blackmold was reduced by approximately 50 percent when fungicides were applied compared to the non-treated control. The control achieved with one application of a fungicide applied according to the model was similar to control achieved by two or more applications of fungicides applied according to the calendar (applied routinely every two weeks). Weather during the fruit ripening period in one of the trials was relatively dry and the model accurately predicted no disease occurrence. Thus, no fungicides were applied according to the model and savings in the cost of spraying were realized. This was the third year of field trials investigating the control of rose downy mildew in nursery production systems. Pre-plant dips of propagation wood in fungicides or hot water, foliar fungicide treatments, and different combinations of these treatments were evaluated. A 20-minute dip in 1000 ppm metalaxyl reduced the incidence of downy mildew by 76 percent. The environmental conditions that impact disease incidence are under study. In growth chambers, the effects of temperature, leaf wetness duration, and humidity on latent period, infection, and sporulation were assessed. In commercial fields, weather stations that record field microclimate were maintained and disease occurrence measured semi-weekly. These data will be used to develop a predictive model of sporulation-infection periods, which, after validation, will be used to improve timing of fungicide applications.

Impact: Forecast models that predict outbreaks of blackmold on tomato and downy mildew on roses were developed. These models will aid in the more accurate use of fungicides for disease control.

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

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

Description: Two different dispensing technologies were evaluated as potential alternatives to hand-applied pheromone dispensers for control of codling moth, Cydia pomonella, in pear and walnut orchards. Sprayable formulations of micro-encapsulated pheromone were investigated in a variety of orchard settings using different application rates or timings. Effective control of codling moth compared to untreated plots was observed in most trials using application rates of codlemone between 10 and 20 gm active ingredient (ai) per acre at 30-day intervals. Up to 4 applications were made for the season. Within replicated, 2-acre plots, low application rates of 1 gm ai per acre of codlemone did not provide adequate trap suppression throughout the season, as well as adequate damage suppression. Experimental problems were noted for smaller plots that were closely spaced due to apparent moth and pheromone dispersal between plots. Plots were also established that relied on aerosol-emitters

containing codlemone. Emissions of 7.5 mg per 'puff' of aerosol were made at 15 minute intervals during the 12-hour period between 6 pm-6am. Using limited numbers of emitters per orchard within a line perpendicular to the wind provided adequate suppression of codling moth in some orchards, but failed if sources of mated females from control areas were too adjacent to the test plots. Similarly, high-densities of codling moth also were observed to overwhelm the pheromone mating disruption program. Sterilized codling moth males released in a grid pattern within an orchard were used as a means to start to map the area of effective trap suppression from aerosol sources emitting high doses of codlemone. Similar to results obtained in past years, the effective plume length appears to be in excess of 1500 feet downwind of the emitters. Within one orchard, excellent correlations were observed between trap suppression and damage suppression downwind of the emitters.

Impact: Sprayable pheromones are now registered for use in pome fruits and walnuts. Implementation programs, the Pear Pest Management Alliance and a program in walnuts from the Center for Agricultural Partnerships, have already started to deliver preliminary pest management programs to the agricultural communities.

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

Key Theme: 4.12 Integrated Pest Management
Title: Mosquito and Agricultural Pest Management in Riceland Ecosystems

Description: Reduction of coverage by emergent vegetation, biological control using mosquitofish (GAMBUSIA AFFINIS) and both temporal and spatial changes in water quality affected mosquito (CULEX spp.) populations at a constructed treatment wetland designed to provide tertiary treatment of municipal wastewater in San Jacinto, CA. As compared to a previous design in which 80% of the wetland surface was covered by emergent vegetation and mosquitofish were absent from the wetland ecosystem, host-seeking adult mosquito populations were reduced up to 50-60 fold during the third year after renovation and by adding mosquitofish. Three changes in larval mosquito abundance associated with changes in the wetland were a greater than 10-fold reduction in CULEX TARSALIS, comparatively larger variation in dip counts among the seven marshes in the wetland than under the previous design, and an earlier seasonal decline of larval mosquito abundance. The variation in emergent vegetation coverage and mosquitofish populations among the marshes of the renovated wetland contributed to an increased variability of mosquito numbers in dip samples across the wetland. Additional mosquito abatement measures may be needed to supplement changes in design features and operations to reduce mosquito production from constructed wetlands receiving highly enriched wastewater. Ammonium nitrogen additions (15 mg per liter) to constructed treatment wetland research cells in Corona, CA failed to produce a significant increase of mosquito abundance as compared to control research cells and did not sustain mosquito production. Ambient levels of nitrogen were maintained (6 to 7 mg per liter) in the control wetland research cells. The wetland research cells in both treatments contained more than 90% of the surface area covered by emergent vegetation. Volatilization of unionized ammonia appeared to be the predominant mechanism of removal for nearly all of the supplemented nitrogen. Multi-year laboratory selection projects designed to delay the onset of resistance to the bacterial larvicide BACILLUS SPHAERICUS (BS) and to test whether susceptibility can be restored in BS-resistant CULEX QUINQUEFASCIATUS were carried out. We

also tested for interactions among microbial toxins from BACILLUS THURINGIENSIS ISRAELENSIS (BTI) with BS. Susceptible (Syn-C) and resistant (Bsr-X) mosquito strains were selected with either BS alone or the combination of BS and the cytolytic toxin (Cyt 1A) from BTI. The Bsr-X series showed a lower frequency of resistant mosquitoes in the line selected with BS and Cyt1A compared to the line selected with BS alone. No changes of resistance levels have been detected in the Syn-C series to date. In our studies of toxin synergism, the results indicate that synergism is not limited to the cytolytic toxins of BT species; the Cry toxins of BTI also synergize BS.

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

Funding Source: Hatch Multistate Research and State
Scope of Impact: AR, CA, FL, IL, LA, TX

Key Theme: 4.12 Integrated Pest Management
Title: Optimal Management Strategies For Arthropod Pests and Their Natural Enemies on Citrus and Avocados

Description: Research published this last year included a two-year survey of parasitoids of citricola scale, COCCUS PSEUDOMAGNOLIARUM, on citrus in the San Joaquin Valley of California; a review of management options available to growers for citrus thrips, SCIRTOTHRIPS CITRI; evaluation of green lacewings, CHRYSOPERLA spp., as predators of citrus thrips; and biology, pesticide efficacy, and natural enemy studies with avocado thrips, SCIRTOTHRIPS PERSEAE.

Impact: Research on avocado thrips will lessen the impact of this newly introduced pest that was estimated to cause $ 8-13 million in damage and increased control costs to the avocado industry in 1998.

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

Key Theme: 4.12 Integrated Pest Management
Title: Biological Control in Pest Management Systems of Plants

A. Obscure Scale: Post release evaluation of Encarsi a aurantii (Howard), an imported parasite of obscure scale, Melanaspis obscura (Comstock), continued on oaks (Quercus spp.) in Capitol Park of Sacramento. From April through mid-September, biweekly capture of scale crawlers and adult parasites on yellow card traps revealed that both scale and parasite populations were similar to levels observed during previous years. Over ten years after the introduction of the parasite, both pest and parasite populations have stabilized at relatively low levels. There was no evidence of

hyperparasitization of E. aurantii. As chemical insecticides are no longer needed for suppression of obscure scale in Sacramento, this exotic pest is now considered to be under complete biological control.

Impact: This pest problem of obscure scale has been solved through introduction of of Encarsi aurartii, eliminating the need for chemical control.

B.Ecology of Parasitoids and Predators: Our goal is to enhance the efficacy of biological pest control through an improved understanding of the basic ecology of parasitoids and predators. Work is being conducted in two agroecosystems. First, in California cotton we are exploring the ecology of generalist predators, and the ecological significance of predator-predator interactions. We have demonstrated that larval lacewings, CHRYSOPERLA PLORABUNDA, can exploit plant-produced food resources (extrafloral nectar) and survive extended periods when arthropod prey are absent. We have also shown that lacewing populations exhibit source-sink dynamics in cotton. Where herbivore prey are present at low to intermediate densities, higher-order predators exert strong predation on lacewings, producing local sinks. Where herbivores are present at outbreak densities, however, higher-order predation is relaxed and lacewing reproduction is therefore enhanced, producing source populations. Second, in Hawaii papaya, we are exploring control of spider mites, TETRANYCHUS CINNABARINUS, by predatory mites, beetles, and spiders. We have shown that predator-predator interactions are important here as well, and that the nature of these interactions can be predicted from a knowledge of the foraging behavior of the component species. Spiders (sit-and-wait predators) can disrupt biological control that would otherwise be exerted by a high-mobility actively foraging predator, STETHORUS SIPHONULUS. Such disruptive effects are not, however, observed when PHYTOSEIULUS MACROPILIS, a lower-mobility, but still actively foraging predator, is present.

Impact: Our results have helped California cotton growers better manage lacewing populations. In particular, we have shown that releases of commercially-produced lacewings is a misguided strategy, because of the negative impact of higher-order predators. In contrast, predatory mites are very effective for spider mite control in papaya, and are relatively insensitive to higher-order predation.

C. Citrocola Scale: We continue to evaluate the efficacy of Metaphycus species near flavus as a biological control agent against citricola scale, Coccus pseudomagnoliarum (Kuwana), in San Joaquin Valley citrus and black scale, Saissetia oleae 973 (Olivier), in southern California citrus. We are releasing this parasitoid against citricola scale in the San Joaquin Valley of California as an augmentative biological control agent. With the removal of the traditional spray practices in San Joaquin Valley citrus, citricola scale has re-emerged as an intermittent but serious pest of citrus. It was also an intermittent and serious pest in San Joaquin Valley citrus before 1950, but with the use of broad-spectrum pesticides, it was suppressed incidental to the control of other citrus pests such as California red scale. We have conducted a series of field cage tests to evaluate M. sp. nr flavus efficacy when compared to M. helvolus (Compere) on both citricola and black scale. It is the most effective parasitoid of the four species we tested against citricola scale. We have now completed two replicates of uncaged, single-tree, field releases in the San Joaquin Valley against citricola scale on citrus. These releases indicate that augmentative releases of M. sp. nr flavus reduce citricola scale densities significantly when compared to scale densities on non-release trees. The single-tree releases of the parasitoid were made against dense scale populations that would be economic. The purpose of these releases was to determine whether we could detect a significant effect. We are now initiating an experiment to test whether M. sp. nr. flavus releases will maintain light scale densities at subeconomic

levels before these populations become economic, i.e., whether releases of a few parasitoids prophylactically are effective and economically feasible. We have also tested single-tree releases of M. sp. nr. flavus against in a citrus grove infested with black scale. These releases also significantly reduced this scale's density in the release trees compared with that in scale-infested non-release check trees. We are also continuing to develop and improve the mass production protocols for rearing M. sp. nr. flavus on brown soft scale, Coccus hesperidum (L.) in preparation to transfer this technology to several commercial insectaries in California.

Impact: This project documents that an ecologically based pest management program exploiting the natural enemy complex can produce fruit that are equal to or better than the fruit produced under the traditional program, which is based on broad spectrum pesticides, at a cost less than or equal to that of the traditional program.

Funding Source: Hatch Multistate Research and State
Scope of Impact: AZ, CA, GU, HI, ID, KS, MT, NM, NYC, OR, UT, WA,WY, USDA/ARS, USDA/APHIS, USDA/FS, USDA/DFA

Key Theme: 4.12 Integrated Pest Management
Title: Integrated Pest Management For Ornamental Crops

Description: Field studies comparing insect populations in greenhouse crops covered with plastics that block the transmission of UV light in two ranges were completed, analyzed, and submitted for publication. In these studies, crops grown under a plastic that blocked UV light at wavelengths of 380 nm and below had lower numbers of aphids and thrips compared to plastics that only blocked UV light at wavelengths of 360 nm and below. The effects were not as dramatic in field studies, however, perhaps due to unfiltered light entering through the sides and open roof vents in large greenhouses. Our UV-blocking plastic studies also found that the persistence of the biological control agent, Beauveria bassiana was significantly longer under the high-UV blocking plastic (<380 nm). B. bassiana is an insect fungal pathogen used as a biological control agent in greenhouse production. The material is available in commercial formulations and applied in a spray. Ultraviolet radiation is one of the more important factors affecting the survival of this biological control agent. One week after application, percent spore germination was at least twice as high under the <380 nm blocking plastic compared to <360 nm blocking plastics. 2) Xylella fastidiosa is a bacterial pathogen that is the causal agent of oleander leaf scorch and Pierce's disease of grape. Studies examining the flight activity of two vectors of this bacterium, Homalodisca coagulata and Homalodisca lacerta, found that the host preferences of the two species differed, and provided information on the peak time of flight activity in coastal, inland, and desert environments. 3) In nursery environments, frequent (sometimes daily) overhead irrigation can dilute or remove insecticides from ground surfaces, and exposure to sunlight can result in relatively short residual efficacy. Similarly, insecticides mixed in bait formulations become moldy and unattractive to Argentine ants if broadcast in areas with overhead irrigation (Krushelnycky and Reimer 1998). For this reason, studies were conducted to test the efficacy of various granular formulations of products to see if they work on the Argentine ant, Linepithema humile (Mayr) in a nursery setting.

Impact: Due to impending loss of pesticides commonly used to control insect pests, and increased regulations on contaminants in water run-off, growers have shown increased interest in the use of

cultural exclusion practices, biological control agents, and other reduced risk practices to manage pest problems. The results of our studies suggest that the type of greenhouse plastic used in a structure can reduce insect population levels, can increase the longevity of an insect fungal pathogen, and will be useful in developing IPM programs for insect management in certain situations. Reductions in initial insect populations, and increased efficacy of a fungal pathogen, can reduce the number of insecticide spray applications required, and reduce the cost of using low-risk materials. The potential loss of insecticides such as chlorpyrifos and diazinon presently used for ant control in nurseries, and the enforcement of regulations associated with water quality protection, necessitate testing new materials for ant control. The use of baits and materials such as granules with low rates of active ingredient per unit area provides growers with alternative low-risk materials for ant control in nursery situations. Adoption of these practices will reduce the total amount of pesticides used, reduce the environmental risks resulting from contaminated run-off, and increase worker safety.

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

Key Theme: 4.12 Integrated Pest Management
Title: Integrated Pest Management of Insects in and Around Structures

Description: The water-soluble dye Calcofluor M2R and Fluorescent Brightener 28 were readily consumed by Argentine ant, Linepithema humile. As little as 0.01 ng samples of each dye were detectable after ants feed on the dyed sucrose bait. With the aid of the dyes, the foraging range of L. humile around homes in urban settings was at least 61 m. L. humile workers ingested almost 12 times as much hydramethylnon in sucrose water per body weight as did queens. Queens require multiple feedings for increased mortality to occur. Evaporation of water from baits consisting of sucrose solutions is a major problem with many commercially available ant bait stations. Some stations lost as much as 60% of the water in 14 days. Laboratory rearing techniques were developed to rear three species of rodent fleas, Oropsylla montana, Hoplopsyllus anomalus, and Echidnophaga gallinacea. The fleas were confined to California ground squirrels maintained in specially designed nesting boxes.The life histories of each species of flea were studied. An international monitoring program to detect the susceptibility of field -collected strains of cat flea, Ctenocephalides fleas, to imidacloprid was initiated in 2000. Novel larval bioassays were developed to determine the susceptibility of cat fleas to imidacloprid. The technique was verified on four laboratory strains at 3 independent laboratories. Field-collected strains of cat fleas were collected by veterinary clinics throughout the United States and Europe. All of the strains tested to date were susceptible to imidacloprid.

Impact: Laboratory and field studies with baits to control Argentine ants clearly demonstrate that liquid baits containing sucrose are highly preferred by ants. New active ingredients such as imidacloprid, fipronil and thiamethaxom look extremely promising as bait toxicants because of their delayed toxicity and low repellency. These baits are readily transferred between workers and queens. Effective baits will eliminate the broad scale application of barrier insecticides and reduce the amounts of insecticides applied in urban settings. The survey of cat flea populations in the United States and Europe indicates that susceptibility to imidacloprid is still very high. Our data suggest that operational factors such as failure to treat pets properly, failure to treat all pets, and misidentifying the severity of the infestation on the pets are contributing to the reported failures of Advantage against cat fleas by

veterinarians. Over 75 strains were screened for imidaclorid susceptibility during the summer of 2001. Better training and education for practitioners are certainly warranted.

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

Key Theme: 4.12 Integrated Pest Management
Title: Impacts of Mosquito Control Techniques on Target and Non-target Members of Biological Communities

Description: The main goal of this project was to assess the non-target impact of the mosquitofish, GAMBUSIA AFFINIS, on aquatic fauna. The mosquitofish is used to control mosquito larvae in California and elsewhere. It is not native West of the Rockies but is introduced in many waters. Therefore it is important to assess whether mosquitofish are compatible with native aquatic fauna, and also to test whether they have negative effects on species of concern in previously fishless waters (e.g. vernal pools). We performed 4 replicated experiments in field mesocosms to quantify effects of mosquitofish on three species, the vernal pool fairy shrimp (LINDERIELLA OCCIDENTALIS), the California red-legged frog (RANA AURORA DRAYTONII), and the California tiger salamander (AMBYSTOMA CALIFORNIENSE). We performed 2 experiments with salamanders, simulating vernal pools and permanent ponds respectively, because the salamanders breed in both habitats. In all experiments, we collected data on feeding preferences of mosquitofish and their effects on the structure of aquatic arthropod communities. Mosquitofish had a strong negative impact on fairy shrimp survival. Results of two experiments exposing amphibians to predation by initially low densities of mosquitofish (8-12 per 3 x 6 m pond) showed that fish caused a 30% decrease in growth of red-legged frog tadpoles and injured many tadpoles, however the fish did not affect tiger salamander growth or the survival of either species. Laboratory experiments showed that amphibian larvae were not preferred prey of the fish, and this could explain relatively high amphibian survival when fish were at initially low densities. When we repeated the salamander experiment with higher densities of fish to simulate permanent ponds (300/pond initially), fish dramatically decreased salamander growth and survival. Experiments also showed that mosquitofish decreased populations of arthropods. Results indicate using mosquitofish in vernal pools should be avoided because they pose a threat to fairy shrimp. Mosquitofish can also become a threat to California tiger salamander larvae when the fish attain high densities.

Impact: This project provided information to mosquito control agencies and conservationists on where use of mosquitofish should be avoided. Results have informed management recommendations, such as the U. S. Fish and Wildlife Service's draft recovery plan for the red-legged frog, and the Mosquito and Vector Control Association of CA's mosquitofish stocking guidelines.

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

Key Theme: 4.12 Integrated Pest Management
Title: New Approaches To Mosquito Control

Description: Research continued on methods to improve surveillance for mosquitoborne human viral

diseases in California, especially means to detect the arrival of West Nile virus (WN) when it arrives in California. During the past several years numerous improvements were made in testing procedures and in methods for analysis and reporting of surveillance results, including the establishment of a public website. Recent efforts have concentrated on establishment of a state surveillance database server at UC Davis that will serve to (1) supply data for the public surveillance website; (2) provide UC scientists and collaborators access to data for analysis and development of predictive models, and (3) permit local mosquito abatement and public health agencies with real-time and historical data to use for comparison with local agency data for comparisons and decision support models. The database server was established this past year, and a historical database has been established by input of data from local agencies going back to the 1960s. Many more data are available for input, most in the form of paper records that must first be re-formatted before inputting. In collaboration with the California Department of Health Services, a risk assessment model for mosquitoborne virus diseases was created. Validation of this model began this past year using the historical surveillance database. During the coming year we hope to develop and install an application server that will make data access easier and more stable for collaborators using a variety of computer platforms, and will also be scalable to a connection with a national surveillance database. We also hope to develop prediction models for arbovirus diseases that will contain a weather and climate component.

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

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

Key Theme: 4.12 Integrated Pest Management
Title: Gene Transfer in Insect Species of Economic Importance

Description: In the past 12 months we have continued a multifaceted approach into exploring the feasibility of genetic control strategies in insects as well as developing genetic tools for exploring insect genomes. Specifically we have commenced experiments aimed at developing enhancer trap technologies for mosquito species, have continued our examination of the structure: function relationships of two transposable elements - Hermes and hobo - that are used to genetically transform insects with the aim being to develop improved transposable element gene vectors. We have commenced an investigation into the ability of the Hermes element to spread through caged populations of fruit fly and mosquito and we have commenced an investigation into the fitness consequences of transgenesis on mosquitoes. We have also been able to rear olive fly in the laboratory in preparation for a feasibility study on determining whether a sterile insect technique program can be established for this pest insect in southern California.

Impact: We continue to develop and improve genetic transformation techniques for insect species that are of medical and agricultural importance to California and the United States. These techniques will

enable the genetic dissection of biochemical pathways in these insect species and the knowledge gained from this will lead to new approaches to insect pest control. They will also enable new genetic strains to be generated that may be directly used for the genetic control of pest insects and/or the diseases they vector.

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

Key Theme: 4.12 Integrated Pest Management
Title: Identifying a new crown rot pathogen of Romaine

Description: In 2000, the California PI discovered an apparently new crown rot disease of Romaine lettuce. The disease reappeared in 2001 and may be a persistent problem of this crop. The disease was detected in only a few fields in 2000, but in 2001 additional sites were found in various counties. The disease can be very damaging, with a few fields experiencing over 75% loss. Our objectives are to identify the cause of the disease and formulate management options for the lettuce industry. This disease is of significant concern to the vegetable industry because of the increasing Romaine lettuce market. The PI is conducting field surveys to determine disease distribution, analyzing diseased lettuce tissue in an effort to isolate a pathogen, and running appropriate pathogenicity tests, microscope examinations, host range studies, and other standard tests. Five talks were given to clientele on this new disease and three general non-peer-reviewed articles published. Mass media was used to extend research findings. In 2001 we isolated the same fungus as the one found in 2000. This is important confirmation that this particular agent is associated with the disease. Another significant advance in 2001 was our success in inducing this fungus to form structures (pycnidia and spores) for identification purposes. Due to this breakthrough we were able to place the fungus in the genus *Phoma*. No *Phoma* pathogen of lettuce has been reported anywhere in the world.

Impact: In years 2000 and 2001, growers who had fields with the new disease initially believed the problem was caused by other fungi (*Sclerotinia*, *Botrytis*) and therefore applied fungicides. However, with the discovery of the new fungus, these ineffective applications were avoided, helping to reduce the number of unnecessary sprays. Growers are now following a recommendation of using cultural practices (crop rotation) to combat this disease until other measures are developed.

Funding Source: Smith-Lever and State
Scope of Impact: State Specific
Key Theme: 4.12 Integrated Pest Management
Title: Characterizing and managing garlic rust in California

Description: Beginning in 1998 and continuing through 2000, rust disease epidemics occurred on garlic grown throughout CA and especially in the coastal areas. For several years this rust caused almost total failure of the state's garlic crop. From 1999 to 2001, wd set out to characterize the pathogen, establish the pathogen's host range, and find fungicides and resistant cultivars for growers to use. We characterized the rust pathogen by completing morphological studies, host range inoculations, and field surveys. Three talks were presented to clientele on garlic rust and two newsletter and two general non-peer-reviewed articles were published. Research results were extended to ADOGA and to

garlic growers in southern Monterey County via grower appointments. Information was also extended via mass media. The UC Vegetable Research and Information Center posted our research results and other information on their website. Though garlic rust was observed previously in CA (in the 1930s), this was the first characterization of CA isolates. We found that garlic rust could infect onion, chives, and a wild allium weed, but not leek and shallot. Most importantly, two fungicides were identified that provided excellent control of rust. Three peer-reviewed articles were published on this subject.

Impact: In 1998, the disease resulted in a 27% reduction of the projected, statewide gross income for garlic. Our field data provided the basis for a Section 18 registration that allowed growers to apply the fungicide Folicur. From 1999 to 2001, growers followed our recommendations and Folicur was used extensively in coastal counties, restoring garlic yields and value to expected levels. Our research findings were extended to growers and pest control advisors throughout the state, including those of under-represented status.

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

Key Theme: 4.12 Integrated Pest Management
Title: Lettuce dieback disease characterized

Description: A recurring disease of Romaine and other leaf lettuces has caused crop loss for many years. In areas where the disease is severe, well over 50% of the crop could be lost to lettuce dieback. We worked for several seasons to determine if a fungal or bacterial agent was responsible for the disease, but failed to find such a pathogen. In 1998, PI started a collaboration to see if a virus agent was involved. Our objective was to identify the cause of the disease and formulate control strategies for growers. This disease is of significant concern to the vegetable industry because of the increasing Romaine lettuce market. Standard techniques were employed to identify the virus causing lettuce dieback. Field trials tested fumigation as a control measure and evaluated lettuce cultivars for resistance. Disease distribution was determined by collecting and testing samples. Five talks were presented to clientele on this new disease and a newsletter article published. Because of the unusual biology of this virus (only moved by contaminated water and soil), we held a series of individual meetings with growers who had fields along the Salinas River. At these meetings we explained the biology of the virus and the risks associated with the disease. Information was extended via mass media. By 2001, our research team confirmed that a previously undescribed virus, lettuce necrotic stunt virus (LNSV), was causing lettuce dieback disease. This virus is unusual in that it does not have an invertebrate or fungal vector but is a soil- and water-borne virus. All commercial Romaine cultivars were susceptible, as were some leaf lettuce varieties. However, iceberg lettuce is immune. Fumigation did not control the disease. Some developmental lines of Romaine appeared to be resistant to the virus. One peer-reviewed and three general non-peer-reviewed articles were published on this subject.

Impact: The identification of the LNSV pathogen was of great assistance to growers who did not know what was causing the problem and hence could not take steps to manage it. Now that we have identified LNSV, growers are altering crop rotations by planting resistant head lettuce and avoiding Romaine, as per our recommendations. Because of our fumigation study, growers realize chemicals are not effective and therefore are not using them.

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

Key Theme: 4.12 Integrated Pest Management
Title: Investigation of the strawberry bronzing problem

Description: Bronzing is a fruit disorder that causes fruit to turn brown and dry out. Such fruit are completely unmarketable. During severe bronzing episodes, 100% of the fruit in a particular field may be unmarketable for a few to many weeks, creating tremendous economic loss. While bronzing has occurred at varying levels for many years, the cause of bronzing remained unidentified. Our objectives were to identify the cause of bronzing and to form management options for growers. With the collaboration of strawberry growers, we established extensive field plots to test our hypothesis that bronzing is a result of plant stress. Treatments were applied to plants to either lessen or increase stress; we then harvested and evaluated the fruit to determine severity and incidence of bronzing. Promising, preliminary findings were presented at two educational meetings and to individual growers. Bronzing information was included in a newsletter and three general non-peer-reviewed publications targeted for clientele, including a Spanish language publication that discussed bronzing. A Spanish language field day was organized that extended our information on bronzing. The CA Strawberry Commission approached us in 1999 and suggested that we organize the bronzing research project. Promising results were obtained in 2001 as we found that temperature and solar radiation may be important factors in bronzing. Treatments that reduced plant stress (such as supplemental irrigation) significantly reduced bronzing. Interestingly, some UV-light blocking compounds in our 2001 trials, normally used as additives in pesticides, prevented bronzing.

Impact: Based on our work, growers and pest control companies are already exploring the use of UV-light blockers for bronzing prevention. Our outreach coordinator was enlisted to make contacts with small acreage, limited resource Hispanic strawberry growers. We surveyed these growers to determine the extent of bronzing in their fields. Research findings were relayed to Hispanic growers during these surveys. This outreach allowed us to establish field plots with under-served, Hispanic speaking clients. We presented this bronzing project as a model for affirmative action outreach.

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

Key Theme: 4.12 Integrated Pest Management
Title: Lompoc Pest Management Project

Description: The Lompoc Valley in central Santa Barbara County contains a strong viable agriculture community and the City of Lompoc. Over the last 20 years, part of the city has become a bedroom community to persons who commute into Santa Barbara, about 30-40 minutes away. These people have no connection to agriculture. Most of the prime agriculture land is to the west of the city. There is also a prevailing west wind in this valley. A classic ag/urban confrontation developed in the late 80's - early 90's in which a contingent of urban residents accused the agriculture community of applying pesticides, which drifted over the city causing all manner of respiratory distress and illness. The conflict resulted in the involvement of personnel of the Department of Pesticide Regulation (DPR),

who were asked to do air monitoring studies. DPR also asked the University to undertake research, which might lead to "improved" agricultural practices in the Lompoc Valley. A California advisor worked with the local greenhouse industry to improve insect monitoring and control strategies. A second advisor worked with field growers of vegetables and cut flowers to examine ways to improve insect and disease monitoring. Pheromone studies were also undertaken to see if this technology could replace some insecticides. A third advisor worked with the same grower clientele to validate a disease model to predict downy mildew in lettuce, to determine economic thresholds for cyst nematode populations in broccoli and cauliflower, and to find a "soft" chemical replacement for diamondback moth control in cut flowers and cole crops. Studies were set up using research techniques, which would yield scientifically valid data. Throughout the 3-year study field days were held at critical times to show, explain and demonstrate research results from the various trials. Research equipment, which might be used eventually by growers, was demonstrated. We put on a new spray technology equipment show. Field trial results were sent out to growers in special reports, and classroom meetings were held to increase grower and PCA knowledge of insect and disease biology, and potential management strategies. Sixteen "IPM Information Series" bulletins were published and sent out to the grower community in the Lompoc, Santa Maria and Oceano Valleys. These bulletins were also distributed at several state, national and international conferences. Some of the information was published in Spanish, and Spanish translation was available at grower meetings. Articles about the Lompoc Project and segments of the research results appeared in several agriculture trade journals and the local newspaper.

Impact: The studies made during this project helped enlighten the urban residents of Lompoc, and helped reduce tensions within the community. Trial data from diamondback moth control studies helped get Success registered as an insecticide. The greenhouse IPM studies are now in use as standard management practices. The pheromone, cyst nematode, and lettuce downy mildew studies did not yield conclusive results, indicating that further work needs to be done. Pheromone trials are continuing as money allows. The cyst nematode data indicated that late August, September, and early October crucifer plantings in Lompoc were the only ones that needed to be protected in the seedling stage if viable egg counts in the preplant soil test were high (above 8-10 eggs/gm of soil). Treatment for cyst nematode suppression was unnecessary the rest of the year. The Lompoc Valley issue has been almost defused. Our research and the research of other agencies have shown that agriculturally produced substances (dust, spray particles) are not a health hazard to Lompoc residents. We also showed that growers and applicators were using chemicals judiciously and applying them with efficient use equipment. We also raised the knowledge level of the grower community concerning pest management practices. On the east edge of Lompoc City stands a diatomaceous earth processing plant. This plant was closed, for economic reasons, in the late 1990's. Since the closing, the "pesticide, agriculture dust" debate has gone away completely.
Funding Source: Smith-Lever and State
Scope of Impact: State Specific

Key Theme: 4.12 Integrated Pest Management
Title: Root Rot Resistant Rootstock Trials

Description: The ultimate control of avocado root rot lies in identifying rootstocks that are resistant to the disease. The plant pathology department at UCR has been involved in root rot research for over 50

years. Field testing is an essential component of the screening process and the heavy soils and saline waters in Ventura and Santa Barbara Counties are ideal for testing these rootstocks. A California advisor has been involved with this testing process annually. Every year new rootstocks are made available for testing and new sites for the trials need to be found. Each of the trials needs to be evaluated for performance each year. Research methods. Each year a new site is identified for planting out the new rootstocks. The 'Thomas' rootstock is used as a control and 20 replications of each of the new rootstocks is planted for study. There are currently 15 trial sites in the two counties. The trees are rated for visual appearance and growth characteristics each year. When the trees begin producing, yield data is obtained. Results. To date there have been five rootstocks that have been identified that have greater resistance to root rot than 'Thomas'. Two of these are in the process of being commercialized. The results have been presented at the annual avocado research meetings as well as at grower meetings every year (180 in attendance each of the last three years).

Impact: The avocado industry in California generates $500 million annually. The major scourge of the industry has been root rot. To a large degree this problem has been reduced with the introduction of these new rootstocks. Nearly every new orchard that is planted now is with a rootstock that has been through the screening that we have done.

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

Key Theme: 4.12 Integrated Pest Management
Title: Mulch, Amendment and Rootstock Effects on Root Rot

Description: Several techniques have been identified as being useful in controlling avocado root rot. These methods include the use of gypsum, phosphorous acid, resistant rootstocks and mulch. Which of these methods is the most important in controlling the disease is not known or how they interact with each other. The purpose of this study was to evaluate these interactions. A five-acre orchard was planted with three different avocado rootstocks in a regular repeated pattern across the field. Twenty trees were treated with or without gypsum, phosphorous acid or mulch, such that all rootstocks had all combinations of the treatments. Trees were measured for growth on an annual basis and yield figures were obtained in 1997 and 1998. Root growth was evaluated for disease severity. This was the single, largest root rot study ever performed in the world. Results. This was an extremely productive study. It was determined that the clonal rootstocks by themselves are good at reducing disease incidence. When the rootstock with the least disease resistance is treated with mulch, gypsum and phosphorous acid, disease resistance is substantially improved. These results have been shared at numerous grower presentations over the last three years, three poster presentations have been made (1999 4th World Avocado Congress, Uruapan, Mexico; 2001 ISHS Orchard Management Conference, Nelson, New Zealand and 2001 Gordon Conference, Ventura, CA), a California Avocado Society Yearbook article was published and a peer-reviewed article was published in *Acta Horticulturae*. Two further peer-reviewed papers are being prepared for *HortScience*.

Impact: The impact of the mulch work can be readily seen driving around the avocado growing areas. Nearly every new planting of avocados has been mulched. As part of the renovation of old orchards infected with root rot, it is a common practice to haul mulch into the orchard to help with the

rejuvenation process. The control of root rot, though, is through a combined approach of resistant rootstocks, gypsum, phosphorous acid and mulch. These treatments are assuring the profitability of avocado production in California.

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

Key Theme: 4.12 Integrated Pest Management
Title: Control Of the Redgum Lerp Psyllid and Eucalyptus Pests

Description: California receives high numbers of exotic pests through the major points of entry in San Diego, Orange, and Los Angeles Counties. Although many of these are intercepted, some introductions escape detection and become established in the state. Often these pest populations increase rapidly, especially when host plants are widely planted and natural enemies of the pests are not present. The redgum lerp psyllid was first discovered in Los Angeles County in June of 1998 and spread rapidly through the state in a matter of months. The pest defoliates the redgum eucalyptus (*Eucalyptus camaldulensis*) and has caused many tree deaths. We realized that insecticide treatments had minimal effect and would not provide long-term control over the entire State. A California scientist traveled to areas in Australia where the pest is from to search for natural enemies of the psyllid. The main objective of the project is to provide long-term control of the psyllid using biological control. Our research objectives locally are to identify release sites for the parasitoid, monitor the psyllid populations using sticky traps, and observe parasitoid establishment and tree health. Releases of the parasitoid wasp began in summer of 2000. We started to see establishment of the wasp about one year later. However, in the last few months of 2001 widespread distribution of the wasps has been observed in the county. In 2002, the wasps appear to be well established and tree damage from the psyllid is greatly reduced.

Impact: This project has had tremendous impact on the survival chances of remaining redgums. Without the efforts of the UC team, this pest would have gone unchecked and in all likelihood would have destroyed most of the State's redgums. Currently, the team is gathering information on the economic impact of the loss of these trees. Large specimen trees, which did not survive psyllid infestation, were worth thousands of dollars each, depending on the location and historic significance. Many trees will now survive the infestation and recover, reducing the costs associated with tree removals. Locally, the educational efforts helped reduce the unnecessary and ineffective applications of pesticides to the environment. Currently, pesticide applications for this and other eucalyptus pests have been significantly curtailed. Aerial applications of contact insecticides have been almost eliminated on eucalyptus as a result of these efforts. Injection of systemic insecticides into trees has also been greatly reduced due to our educational programs and the establishment of the parasitoid wasp.

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

Key Theme: 4.12 Integrated Pest Management
Title: Demonstration and Implementation of a Reduced-risk Pest Management Strategy in Fresh Cut Roses

Description: This pest management alliance was a statewide program where University of California campus researchers, farm advisors, growers and allied industry representatives worked together to bring all the facets of rose IPM research into a single program. Our objectives were to validate thrips and mite fixed precision sampling plans, demonstrate that natural enemies can successfully control two-spotted spider mites (TSSM) with compatible reduced risk pesticides for other pests, validate powdery mildew and botrytis models for timing pesticide applications, and incorporate cultural control options. Prior to the demonstration, research experiments were set up in Nipomo and Watsonville, California to refine and develop sampling strategies for mites and thrips. After the sampling strategy was refined, demonstrations were set up in three regions throughout the state in eight greenhouse operations. IPM plots were compared to conventional 'grower' plots at each greenhouse operation. Plots were monitored by scouts who met with growers to make pesticide or predatory mite release recommendations based on scouting observations and, in the case of powdery mildew and botrytis, on model predictions for disease pressure. Data was collected for efficacy of treatments, economic analysis, and post-harvest quality of roses in the IPM vs. grower's standard treatments. Biological control of mites was successful at all locations and pesticide use was generally lower in the IPM greenhouses. After several releases had been made and predators became established, costs for the two control programs were comparable. Roses from greenhouses using predatory mites appeared to have improved quality over roses grown under conventional treatments. The largest differences in thrips levels between the two treatments occurred during the summer months when western flower thrips pressure is generally highest. Refinements have been made to the powdery mildew model but more research is required before recommendations can be made. These results were disseminated in statewide meetings, tours, articles in trade magazines and newsletters, poster presentations, and in a Department of Pesticide Regulation website.

Impact: This is the largest biological control industry-wide effort in the U.S. A testament to the effectiveness of the program is that most of the growers wanted to abandon their conventional treatments during the trial in favor of using predatory mites, and that the program was eventually adopted by more than 75% of the growers statewide. This has resulted in reduced pesticide use, increased use of reduced risk management practices, increased crop quality, less potential hazards to workers and to the environment, and less problems with adherence to reentry requirements.

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

Key Theme: 4.12 Integrated Pest Management
Title: Training Scouts and Developing Demonstration Sites to Promote Floriculture IPM Programs

Description: When this project was initiated, timing of pesticides and choice of materials were often mismanaged in California ornamental nurseries because few growers used a scouting system that employed regular monitoring. Fifteen demonstration plots were set up in three regional ornamental production areas by the three cooperating farm advisors and scouts trained by these advisors. Over 100 different flower crops were examined, and biological control programs were implemented on four of

them. Crops included greenhouse and field-grown cut flowers, greenhouse potted plants, bedding plants, and outdoor nursery stock. Most plots were large, and of commercial size, from .5-2 acres. IPM strategies that were incorporated with scouting included the use of reduced risk/biorational pesticides, petunia indicator plants, biological control, and directed spray programs. Monitoring methods included the use of plant samples, sticky traps, and pheromone traps, and took place weekly. Sampling strategies determined the minimum number of plants and traps necessary to obtain sufficient information concerning population trends at a reasonable cost. Scouts met weekly with pest management decision-makers to discuss crop status and to ascertain any required control measures. Data from the scouted areas vs. the areas under conventional pest management strategies was compared. Results showed that gallons of pesticides applied in conventional plots were 2-3 times the amount used in scouted areas in some nurseries, and as high as 13 times the amount used in the scouted area in one nursery. Costs related to pest management were usually significantly reduced in the IPM programs with scouting, especially in the programs that did not emphasize the use of biological control. These cost reductions were achieved with no decrease in plant yield or quality. In fact, in some cases the quality and yield of crops produced were better due to more efficient timing and directing of pesticide applications. This resulted in fewer phytotoxicity problems and crop damage related to insect feeding and disease spread. Results were extended in educational meetings, in articles and on websites. This included nine regional scouting training workshops, reaching an audience of over 300, in which hands-on learning skills were fostered. Four of the workshops were conducted in Spanish, as well as English. Many statewide, regional and national presentations were made.

Impact: Due to the high success of the scouting program in demonstrating benefits, most cooperators continued to use the scouting programs we initiated. Scouts were actually hired away from the University by growers who wanted them as full-time scouts. Many growers have started scouting programs on their own as a result of our extension efforts, as evidenced by calls for more information to the cooperating farm advisors and by survey results. The program contributed to the majority of California ornamental growers adopting scouting and the use of IPM practices, resulting in over-all reduction in pesticide use, improved plant quality, lower production costs, less potential hazards to workers and to the environment, and less problems with adherence to reentry requirements.

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

Key Theme: 4.12 Integrated Pest Management
Title: Grazing for Pest Management in Alfalfa

Description: Alfalfa is an important crop in Imperial County, comprising almost 500,000 of the 1,000,000 acres under irrigation. Weed and insect control are critical issues in the production of alfalfa, requiring substantial amounts of herbicide to applied annually to each acre.
UC Cooperative Extension conducting grazing trials, utilizing sheep to determine its effectiveness in controlling winter weeds in seedling alfalfa and for the control of insects in winter alfalfa. Research results demonstrated that use of sheep grazing was as effective as herbicides in controlling winter weeds in seedling alfalfa, and controlled insects as well as insecticides in winter alfalfa.

Impact: Herbicide and insecticide use has been significantly reduced during the winter on alfalfa in Imperial County. This has provided a benefit to sheep producers, as the demand for sheep grazing has

dramatically increased, alfalfa producers as their costs have decreased as the applications of pesticides has significantly declined, and the environment as herbicide and insecticide applications are greatly reduced.

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

Key Theme: 4.12 Integrated Pest Management
Title: Yellow Starthistle Management

Description: Invasive plant species pose significant threats to a wide array of beneficial uses of rangeland and forest land including wildlife habitat, agriculture, recreation, and biodiversity. Significant acreages throughout have been degraded due to large scale infestations of noxious weeds such as yellow starthistle. Objective of invasive species program is to conduct research and education programs to provide information needed to reduce noxious weed invasions and thereby improve ecosystem function, economic opportunities, and aesthetic values of pasture, range and forest land. UC Cooperative Extension Specialists and Advisors have conducted research on a variety of strategies to control yellow starthistle. These include burning, chemical control, grazing, mowing and biological control. Based upon the results of theses studies, numerous educational programs have been conducted and publications and web sites developed to disseminate this information widely.

Impact: Due to the educational efforts by the UC Cooperative Extension control strategies have been implemented on tens of thousands of acres of yellow starthistle infested range and forest land, significantly reducing the overall population of yellow starthistle. This has improved forage production, biodiversity, wildlife habitat and recreational opportunities on these lands.

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

Key Theme: 4.12 Integrated Pest Management
Title: Walnut Blight Control Investigations

Description: Walnut blight is the most serious bacterial disease of walnuts. Due to its importance, request for help from clientele and industry, it has been an ongoing part of Butte counties Cooperative Extension program. Walnut blight, spread by spring rain, forces an intense control program, two to three times more intense than in southern counties. Efficient and economic control strategies need to be developed so Northern California walnut growers can be competitive. In replicated, scientifically designed trials in cooperators walnut orchards the objectives are to discover the best treatment timing, the most efficacious chemical control, and the most economic control program for this disease. Chemical treatments are applied and epidemiology research conducted, consisting of monitoring the incidence of disease, relating it to weather patterns, and collecting samples for monitoring populations of the bacterium. This work is coordinated with a campus researchers at UC Berkeley and UC Riverside. Chemical control efficacy evaluations are made in early summer, analyzed and reported. Various members of this research team have presented results at eleven clientele and/or research meetings. Each spring, information on walnut blight is shared with clientele through newsletters. The research team meets each winter to review progress and to set new goals. Progress has been presented

to over 600 clients. Results from this research have discovered walnut blight resistance to copper in many locations and that the addition of "Manex" to copper sprays gives enhanced control. Research results have been published over 12 times. Work will continue validating a disease model and to find more sustainable control practices.

Impact: Registration of "Manex" has now been extended into 16 counties. Butte County Pesticide Use Reports indicates over 90 percent of growers use Manex and report it provided an "excellent improvement" to their walnut blight control program. Use of Manex has reduced the incidence of disease by 50 % and has increased yields and profits to walnut growers.

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

Key Theme: 4.12 Integrated Pest Management
Title: The Effect of Walnut Crown Gall on Tree Growth and Productivity

Description: Galls caused by the crown gall bacterium are difficult and expensive to control and thought to be detrimental to walnut tree growth and productivity. New methods of control needed to be discovered and the economic impact of this disease needed to be discovered. In a replicated trial the objectives are to 1) test a "heat treatment" as an improved method of control over surgery and chemical treatment, and 2) determine the effect of this disease on walnut tree growth and productivity. Data was collected on gall regrowth, tree growth and yield, time to conduct treatment and cost. Results from this research are reported to peers and have been reported to clientele at six indoor or field meetings and advise to growers about crown gall has been shared through newsletters and during farm visits. Results have shown the heat treatment to be a fast, effective economical way of controlling crown gall. Over 500 clients have participated in educational activities relative to this project. Research results indicate that the presence of crown galls reduces both tree growth and productivity. Research results generated from this trial have been published in various forms seven times.

Impact: The heat treatment for crown gall has become very popular and has virtually replaced the standard surgery and chemical treatment because it is faster, less expensive and equally effective. The research on the economic impact of crown gall has resulted in guidelines for growers on how to deal with crown gall depending on tree age and severity of the disease. The research results on economic consequences of having walnut trees with crown gall has convinced growers to begin following these guidelines.

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

Key Theme: 4.12 Integrated Pest Management
Title: Environmentally Sound Prune Systems

Description: Economics and regulations are changing the way prunes are being farmed. Cost of production has increased, and the industry has expanded, creating over production so that marketers are paying only for good quality prunes. Federal acts and California ballot initiatives establish expiration dates and/or threaten the continued use of many pesticides. Regulations established by the California Department of Pesticide Regulations have created new requirements and certification for

the application of pesticides. Objectives are to research, demonstrate, and implement alternative practices to the conventional way prunes have been grown in order to keep pace with current economics and approaching and/or existing regulations. To accomplish these objectives over 30, 5-20 acre sites have been established statewide. Each site is used as a replicate to compare alternative pest and disease control practices, plant fertility and irrigation scheduling to the growers standard practice. Data is analyzed as a randomized block and reported. Also, pest monitoring techniques and treatment thresholds are discovered, and validated in this project. As a result of this project 70 educational activities have been conducted reaching over 3,000 clients. Pest monitoring techniques have been demonstrated and treatment threshold information has been provided to clientele as a result of this project. The "Management Team" of this project meets 2-4 times/year. The "UC Pest Management Guidelines for Prunes" has been revised with monitoring techniques and treatment threshold information generated from this research. Results have revealed that dormant sprays are needed only 40 % of the time and can be reduced or eliminated by many growers. Irrigation water savings can be as high as 40 % in prunes by using the irrigation scheduling technique researched. Over 12 articles have been published with information generated from this research.

Impact: According to the California Department of Pesticide Regulations Pesticide Use Reports, the use of pesticides in prunes has been significantly reduced since this project began (in 1998), thus reducing environmental contamination. Growers are realizing that they can reduce the amount of applied water and many have started scheduling irrigations with the methods developed in this project.

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

Key Theme: 4.12 Integrated Pest Management
Title: Severe Pruning for Pierce's Disease Management

Description: Pierce's disease (PD) is a lethal disease of grapevines caused by the bacterium *Xylella fastidiosa* (Xf). Following disease onset, vines usually die within 2-4 years. There are currently no effective therapeutic treatments for infected vines. Diseased vines are removed once they become non-productive and new ones are replanted. Getting new vines established in an existing vineyard is often problematic due to competition from neighboring mature vines. Blue-green sharpshooter leafhoppers (*Graphocephala atropunctata*) transmit PD bacteria (Xf) to grapevine leaves during feeding. Bacteria then multiply in vines and move down towards the roots. We investigated a management strategy of cutting off PD vines just above the graft union. By cutting off vines low on the trunk, we hoped to eliminate many infections before bacteria reached the roots. By maintaining the mature root system, vine growth and re-development should be rapid. This strategy is one of disease management, rather than disease control per se. The goal is to rapidly re-establish productive vines, thereby minimizing the economic consequences of PD due to crop loss and replanting expenses. Trials were initiated in 1998. Vines showing clear PD symptoms in October were identified. Some vines were cut off just above the graft union, others were kept as untreated controls. Data collection occurred in 1999-2002. In all trials, severely pruned vines showed excellent recovery and redevelopment 1 year after pruning. However, in the second and subsequent years, most vines re-developed PD symptoms. In most plots, nearly all vines that had symptoms prior to severe pruning redeveloped symptoms in the second year. However, in one trial, the success rate remained above

50% after 4 years. Economically, this could still be looked at as a successful strategy in a region with high value fruit. This trial had the youngest vines and the earliest date of severe pruning. We concluded that under certain conditions such as these, severe pruning could still be economically advantageous, even with a relatively low success rate.

Impact: In the Napa Valley and other regions with high-value fruit, this practice is now being more widely used. These are also regions where the blue-green sharpshooter is the primary vector of PD. This work also indicated the importance of complete vine removal in areas where the glassy-winged sharpshooter (GWSS), *Homalodisca coagulata*, is the primary vector of Xf. Unlike blue-green sharpshooters, glassy-winged sharpshooters can acquire and transmit Xf throughout the year, and can feed on stems and through bark, as well as on leaves. Because of these differences, complete vine removal is recommended whenever PD symptoms appear in areas with GWSS in order to eliminate these vines as potential inoculum sources. Since we learned that many vines being redeveloped following severe pruning would still harbor Xf bacteria, the practice is discouraged in areas with GWSS.

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

Key Theme: 4.13 Land Use
Title: Working Landscape Project, 2000- present

Description: A "Working Landscape" is the management of human enterprises and activities in a way that is sustainable and beneficial to the environment. For Bay Area urban, rural, and natural environments to persist in harmony will require the commitment and support of the whole Bay Area community: suburbanites, city dwellers, farmers, and ranchers. The problems are complex and range from land management concerns with endangered species, water quality, soil fertility, exotic weeds, and fire hazard reduction, to larger scale issues like development pressures, crop prices, agricultural infrastructure, and recreation access. "The Future and California's Working Landscapes" was a daylong forum to explore how we can develop public and political support for a working landscape. We invited community leaders, planners, educators, media and land managers to learn about working landscapes and to share ideas about their role in open space management and protection in the San Francisco Bay Area. Project collaborators formed a steering committee. The committee settled on a format that would allow maximum discussion and information sharing among the participants. The forum consisted of three panel presentations followed by discussion and synthesis of new concepts in break out groups. Cooperative Extension advisors and USDA NRCS conservationists served as facilitators for the breakout groups. Research: We surveyed program participants (125 people) before and after the forum. The survey was used to find out who attended and what they learned from the forum. A campus researcher and the PI co-authored an article on the Forum for Rangelands.

Impact: A diversity of participants at the forum represented conservation groups, private businesses, and resource agencies. The survey indicated the forum helped to inform participants and get them thinking. For example, the number of participants who were familiar with the concept of "working landscape" increased from 65% to 96% during the conference. Pre-conference, 51% of respondents felt that maintaining a viable ranching community could be a somewhat to very successful way to

conserve wildlife habitat and landscape in the Bay Area. Post-conference, 81% of the participants believed that.

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

Key Theme: 4.13 Land Use
Title: Vineyard Expansion into Oak Woodlands

Description: The impacts of a changing landscape in Santa Barbara County in regards to the intensification of agriculture on the oak woodlands prompted a broad based community interest and concern of the conversion hardwood range by an expanding vineyard industry. This was a classic example of conflict between agriculture and non-agriculture interests prompted a collaborative effort by Cooperative Extension to bring together a multi-discipline approach to design an educational program to address the multitude of issues that surfaced with this change in land use. This controversy provided the opportunity for the UC Integrated Hardwood Range Management Program to develop and deliver an objective educational program to address these issues. This was the beginning of a collaborative educational effort between Cooperative Extension and with an industry that previously had not participated with our natural resource programs in Santa Barbara County. The primary method used in the delivery of this program was a series of informational meetings. The first meeting addressed many of the issues associated with developing a vineyard attracted an audience of 120 people. Topics included environmental issues including my work addressing oak regeneration project. A second meeting held five months later addressed the topic, "How to work with regulatory agencies in the development of vineyards." Following this initial educational effort, a five session short course entitled, Vineyard Development and Oak Woodland Conservation which 55 people attended. Topics focused on habitat elements found within and adjacent to vineyards, county-level habitat attributes, and habitat enhancement procedures. The work in the area of oak regeneration began with a project funded by an RREA grant to develop a nursery to produce oak seedlings. This program was intended to provide demonstration sites on cooperating ranches where other clientele could see regeneration techniques developed by the UC Integrated Hardwood Range Management Program. Working with the vineyard manager, a Hispanic woman of one of the largest vineyards under public attack for removing mature oak trees,a California advisor initiated a regeneration program with the planting of 450 oak seedlings on two vineyards, which served as a model for future plantings by the vineyard industry in Santa Barbara County. In cooperation with the initial program, this vineyard initiated an additional extensive regeneration program on two of their vineyards by voluntarily expanding the program to now include over 3,000 oak seedling that were either planted or naturally occurring. These seedlings are monitored annually for survival and growth. Using this program as a model, other large vineyard companies in both Santa Barbara County and San Luis Obispo County have now initiated their own oak generation programs.

Impact: During this period, there was a lack of trust between both sides of the issue. This included people who owned the resource, the vineyard industry, the environmental community, county planning staff, and the general public. Our efforts brought people of differing views together and provided factual information to consider regarding the issues associated with their concerns. The vineyard industry is more aware and utilizes information learned from attending these meetings.

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

Key Theme: 4.14 Natural Resources Management
Title: Development and Application of Age, Size-specific Population Models

Description: In a retrospective analysis of catch and environmental time series, we showed how coho salmon, chinook salmon and Dungeness crab in the California Current were driven by environmental conditions associated with El Nino. Coho salmon collapsed in the mid-1970s due to a decadal shift in ocean conditions, while chinook salmon did not. We continued sampling marine invertebrate settlement and analyzing the potential of marine reserves, showing that earlier results regarding sustainable spatial configurations held for a wide range of dispersal patterns. We formulated a model of how biological productivity in the coastal ocean responds to wind patterns. We joined with an international group of scientists to show that human impacts over the past several centuries had significantly changed marine ecosystems from their pristine state.

Impact: Information developed was integral to the design of marine reserves along the California coast as mandated by California's Marine Life Protection Act.

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

Key Theme: 4.14 Natural Resources Management
Title: Properties of Selection, Mutation and Drift in Constant and Variable Environments

Description: The main new published work for this year is a major review of current understanding of the process of speciation, i.e., the process by which a single group of reproductively compatible individuals gives rise to two or more groups that are reproductively isolated. The study of speciation has become one of the most active areas of evolutionary biology, and substantial progress has been made over the past decade in documenting and understanding phenomena ranging from sympatric speciation and reinforcement to the evolutionary genetics of postzygotic isolation. Turelli et al. (2001) argue that progress has been driven largely by empirical results rather than mathematical analyses, and most useful theoretical work has concentrated on making sense of empirical patterns. Given the complexity of speciation, mathematical theory is subordinate to verbal theory and generalizations about data. Nevertheless, mathematical theory can: (1) provide a useful classification of verbal theories; (2) help determine the biological plausibility of verbal theories; (3) determine whether alternative mechanisms of speciation are consistent with empirical patterns; and (4) occasionally provide predictions that go beyond empirical generalizations. We discussed recent examples of progress in each of these areas and provided a conceptual framework for future research. Several new projects concerning the maintenance of quantitative genetic variation, the importance of non-additive genetic interactions, and speciation have been started. Most advanced is the new work describing conditions under which "genotype-environment interaction," roughly defined as the production of different phenotypes by the same genotype when exposed to different environments, can contribute to

the maintenance of quantitative genetic variation.

Impact: All four projects described above contribute to understanding two fundamental evolutionary processes: speciation and the maintenance of genetic variation. The experimentally testable predictions concerning the genetics of hybrid inviability and sterility are relevant to the definition of "species," and hence critical to the conservation of biodiversity.

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

Key Theme: 4.14 Natural Resources Management
Title: Genetic Analysis of Recruitment and Dispersal in Coastal Marine Ecosystems

Description: Our current research primarily focuses on understanding the processes that regulate marine populations, especially stock-recruitment relationships. For many commercially important marine invertebrates with sedentary adult phases and planktonic larval phases (e.g., urchins, crabs, sea cucumbers, mussels, and oysters), stock-recruitment models show that spatial and temporal patterns of larval dispersal may be critical determinants of adult population dynamics. The empirical challenge is to measure patterns and levels of dispersal in the sea. We are continuing a project that uses high-resolution microsatellite markers to characterize temporal and spatial changes in the genetic composition of larval and adult populations of the Dungeness crab off the coast of central and northern California. These data are the foundation for delineating management units, and developing sustainable harvest protocols. In previous years, we identified 17 highly polymorphic microsatellite loci, and developed multiplexing techniques that allowed us to assay four loci simultaneously on an automated sequencer. We have now completed our analysis of adult samples collected throughout their range along the West Coast of North America. Our results unexpectedly show that there is a great deal of genetic structure, despite the potential for extensive larval dispersal in this species, with a highly significant break in southern Alaska, and the signature of a similar break in northern California. Just as importantly, many of these markers - while generally assumed to behave as mendelian alleles - do not, calling into question the conclusions of many previous studies. Finally, our results show temporal instability in genetic structure, for reasons that we still do not understand. As this project continues, we plan to increase the spatial resolution of our sampling and broaden the scope of the study to include other nearshore crustacean species, such as the porcelain crab. This will allow us to assess the generality of our findings to other species with similar ecologies, and to develop robust management plans.

Impact: Information developed on patterns and levels of dispersal commercially harvested finfish and shellfish populations provide the foundation for sustainable management policies.

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

Key Theme: 4.14 Natural Resources Management
Title: Bionomics and Control of Mosquitoes Inhabiting Constructed Treatment Wetlands

Description: The effects of mosquitofish (GAMBUSIA AFFINIS) on the aquatic insect community in a hypereutrophic constructed treatment wetland differed both spatially and among four cage treatments in an experiment. These results indicate both strong bottom-up regulation of the wetland ecosystem by nutrient loading and marked top-down effects of mosquitofish predation on wetland community structure. The four treatments in the experiment included screen (mesh size = 530 micrometers) cages without fish, cages containing 15-25 mosquitofish, 3-sided cages to control for changes in water flow by cages, and an ambient control without cages. Four blocks of treatments were placed both near the inlet and near the outlet of the wetland. Aquatic insect abundance in the inlet cages without fish was nearly three times higher than in the outlet cages without fish. A two-fold difference of zooplankton abundance observed in fishless cages in the inlet vs. the outlet was lessened markedly in treatments where mosquitofish were present. On average, mosquito (CULEX spp.) abundance within the fishless cages was approximately 30- and 12-fold greater than in the inlet and outlet marshes of the wetland (ambient levels), respectively; whereas, ambient mosquito abundance in the inlet and outlet marshes containing the cages did not differ significantly across time. These results demonstrate that mosquitofish have an impact on mosquito abundance despite the presence of abundant alternate food resources and strong nutrient-driven effects in the food web. Two parallel, long-term selection projects designed to test the effect on resistance in CULEX QUINQUEFASCIATUS of combining the cytolytic toxin (Cyt1Aa) from BACILLUS THURINGIENSIS ISRAELENSIS (BTI) with BACILLUS SPHAERICUS (BS) are ongoing. In addition to evaluating the effectiveness of toxin mixtures for resistance management of BS, we tested for interactions among microbial toxins to further investigate the phenomenon of toxin synergism that is responsible for the extremely high toxicity of this material. A comparatively more rapid progression of selection was observed in the resistant (Bsr-X) strain due to the presence of resistance genes which predisposed the strain to respond to selection pressure with BS. The second BS-susceptible strain, Syn-C, was more adversely affected by BS selection and exhibited a high rate of secondary mortality after the initial 48 hour exposure. Tests of the Bsr-X series showed a lower frequency of resistant mosquitoes in the line selected with BS and Cyt1A compared to the line selected with BS alone. No changes of resistance levels have been detected in the Syn-C series to date. In our studies of toxin synergism, the results indicate that the different Cry toxins of BTI also synergize BS.

Impact: The results of this study are providing criteria for the management of pest and pathogen-transmitting mosquitoes that utilize 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 is being utilized by a multiagency effort to develop criteria for the construction of large-scale wetlands systems that are being designed to conserve precious water resources, promote the biodiversity of endemic wetlands organisms, and protect the public from mosquitoes and the diseases that they cause.

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

Key Theme: 4.14 Natural Resources Management
Title: Mechanisms For the Maintenance of Biological Diversity in Arid Environments

Description: Studies were continued on an introduced winter annual plant (ERODIUM CICUTARIUM) and its impact on the native community at the field site in the Chihuahuan Desert, USA. These studies continue to monitor the increase of the invader and its apparent displacement of the native community of winter annual plants. New field experiments have shown that this species competes strongly with native species at the site and may explain their displacement. In conjunction with these field studies, new statistical methods were developed to determine how the effects of plant competition are modified by the physical environment. A field survey determined that invasion of ERODIUM CICUTARIUM is not complete, and in sandy soils of the San Simon Valley, Arizona, the native community of desert annual plants still exists in the absence of ERODIUM CICUTARIUM. In those localities, the native community retains the diversity that it had prior to the irruption of ERODIUM CICUTARIUM in other parts of the valley. The understanding of ERODIUM CICUTARIUM's environmental requirements, and its competition with other species, should have broad application, as this species is an invader in many different habitats, especially in California. To gain a better understanding of invasive plants, research was begun on a theory of invasion resistance, and invasion impact. This study involves both theoretical models of invasions, and applications of existing theory in community ecology to the context of invasions of alien species. This work has led to the concept of niche opportunity, which defines conditions that promote invasions in terms of resources, natural enemies, the physical environment, interactions between these factors, and the manner in which they vary in time and space. Niche opportunities vary naturally between communities, but may be greatly increased by disruption of communities, especially if the original community members are less adapted to the new conditions. Applying recent community theory, it was possible to clarify the prediction that low niche opportunities (invasion resistance) result from high species diversity. Conflicting empirical patterns of invasion resistance are potentially explained by covarying external factors. This work provides a predictive framework for invasion ecology.

Impact: This study has shown that an invasive weed is having strong negative effects on native species in parts of the Chihuahuan Desert, USA, but shows also that some specific environmental conditions may limit its impact. This work shows how community ecology theory can lead to a better predictive understanding of alien species and their impact on existing biological communities and is being utilized by management agencies to develop invasive weed control programs.

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

Key Theme: 4.14 Natural Resources Management
Title: Integrating Horticultural Practice and Ecological Restoration

Description: Our research examines various aspects of ecological restoration. The three main areas of research are 1) the effects of horticultural practice on ecological restoration projects has three components, in the context of valley oak (QUERCUS LOBATA); 2) the effects of competition on the success of restoration, particularly in the context of California's grasslands and oak woodlands, and 3) a comparison of restoration issues in California and Catalonia. 1) Our field trail of valley oaks is wrapping up. Three years ago, we planted out several hundred valley oaks plants of differing production history: one year old container stock, three-month old container stock from small

containers, three-month old container stock from large containers, and acorns. This experiment is nested into three irrigation treatments: overhead, drip, and none. In the past year, we did root excavations of all combinations of source stock and irrigation regimes. Oaks planted from containers virtually all had malformed roots at depths corresponding to the pot depths. These deformations included severely bent roots and tap root branching (probably related to the death of the original tap root). Water potentials did not differ among treatments (taken after all irrigation had ceased). 2) Our field experiments in grassland restoration are beginning to bear fruit. It appears that the effectiveness of Telar in increasing the establishment of native grasses is strongly related to the first year suppression of annual exotics. These exotics rebounded in the second year, but the perennials were going best in microsites where annuals had been most suppressed in the previous year. Ongoing research is examining additional correlates of restoration success, including local habitat characteristics, and the relative timing of planting. 3) Our Catalonia research has only just begun, but initial research suggests that the Mediterranean species of annual grasses that are so invasive in California are not invasive in Catalonia. The generality of this pattern and its causes are currently under investigation.

Impact: Our research is specifically designed to make restoration projects more effective. Our valley oak results have shown that the use of container stock is not be preferable to direct seeding, significantly reducing cost of restoration projects.

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

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

Description: Since initiating this project, a team of UC researchers found that (1) Roadside grassland communities (10 m from a road) are more invaded by exotic species than grassland communities 100 or greater than1000 m from the nearest road. The effect of roads on grassland composition also interacts with soil type, slope and grazing; (2) Both fire and grazing by cattle enhance native forb richness in serpentine grasslands, and exotic forb richness in nonserpentine grasslands; (3) Disturbance and seed supply limit the spread of exotic species equally in heavily invaded oak woodland, and lightly invaded serpentine grasslands; (4) Roads and distance from the "mainland" both affect the distribution of exotic species on a peninsular nature reserve.

Impact: This project has successfully demonstrated the effect of roads, interacting with natural environmental variation, on the distribution of exotic species at a landscape scale. This information is being utilized in the development and enhancement of landscape-scale plans for the restoration of natives and the strategic control of exotics.

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

Key Theme: 4.14 Natural Resources Management
Title: Benefits and Costs of Resource Policies Affecting Public and Private Land

Description: The Beneficial Use Values Calculator, a linked spreadsheet method of doing Maximum Extent Practicable evaluations of water pollution control projects, was developed. It links the Beneficial Use Values Database on values of beneficial uses of water to project specific information to allow fairly rapid ballpark benefit-cost evaluations to help prioritize spending on water pollution control. Information from the Beneficial Use Values Database was used to assist in an evaluation of the benefits and costs of installing catchment basins on the San Francisco Bay Bridge during its ongoing retrofit for earthquake safety. The patterns of beach use in San Diego and citizens' willingness to fund pollution control projects were summarized. Also, estimates of the value of improving California's water quality to the level where no water bodies are impaired were developed. A new method of inferring an individual's shadow value of leisure time from their willingness to pay money and of their time for valued environmental improvements was developed. This adds both theoretical and empirical evidence for the monetary value of leisure time, which is important in valuing natural resources, evaluating transportation projects, adjusting national accounts, and in other settings. New theoretical results were derived for consumer demand models where choice is constrained by one's available time as well as one's money budget. These results provide additional structure, in the form of coefficient relationships in the demand model that must be satisfied by empirical two-constraint demand models. They are especially applicable to the analysis of recreation demand, which is an especially time-intensive good. The demand for marine fishing for 8 species of saltwater fish at seven Oregon counties was estimated. This information is needed by regional fishery management councils to help set catch quotas for different groups of users.

Impact: The research on benefits transfer in water pollution control is being used by the California Department of Transportation in its storm water quality program, whose purpose is to direct the allocation of scarce resources to effect the greatest possible improvements in storm water quality.

Funding Source: Hatch Multistate Research and State
Scope of Impact: CA, CA-D, CO, CTS, GA, IA, ME, MA, MI, MN, MT, NV, NH, NM, NYC, ND,OH, OR, PA, SC, TN, UT, WA, WV, WY

Key Theme: 4.14 Natural Resource Management
Title: Effect of a Prophylactic Insecticidal Treatment on Emergence of Western Oak Bark Beetles and Oak Ambrosia Beetles

Description: We report here on the efficacy of Astro (permethrin) in reducing emergence of *Pseudopityphthorus pubipennis* and *Monothrum scutellare* as a possible population suppression technique. On June 17, three 40-cm-long bolts were removed from each of eight heavily infested coast live oaks, *Quercus agrifolia*, and one California black oak, *Q. kelloggii*, in the following sequence: the first bolt, 1 meter above the ground; the second, under the crotch of the major limbs; and the third, from one 3-inch-diameter branch. Each bolt was cut vertically into two halves. One half was selected at random and its bark surface sprayed with the insecticide Permethrin, while the other half (control) was not sprayed. Bolt halves were placed into separate air-conditioned rearing cans to collect daily emerging beetles. Tested insecticide was applied at the label rate (0.5%). Samples were placed with

cut area on the ground and their bark surface treated to the point of runoff, using a hand sprayer. Every morning between 9:00 and 10:00, the collected insects were removed from Mason jar, segregated by species and tallied. In order to prevent fungal growth inside the cans, the bolts were removed every 48 hours and frass at the bottom was swept onto paper to count dead beetles. The walls and bottom of each can were washed with detergent, dried with paper towels, logs placed back inside and covered with a lid. Beetle collection continued until emergence had ceased on December 9. Differences in emergence were analyzed for main effect of chemical treatment using analysis of variance. Permethrin significantly reduced emergence of both oak ambrosia beetles, *Monothrum scutellare*, and oak bark beetles, *Pseudopityphthorus pubipennis*, from the insecticide-treated logs (P= 0.001).

Impact: Both species stopped their development in the permethrin-treated bark surface. This is very important evidence, because the larval development of *M. scutellare* takes place in the wood where the insecticide could not penetrate. Further tests are needed to demonstrate whether application of permethrin reduces the hazard of stem breakage. This research has obvious implications for control of the vectors of sudden oak death, which is becoming a serious problem in California.

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

Key Theme: 4.14 Natural Resources Management
Title: Extension of CIMIS to Baja California to improve irrigation efficiency

Description: The University of California (UC) and the California Department of Water Resources (CDWR) developed the California Irrigation Management Information System (CIMIS) to provide badly needed information on reference evapotranspiration (ETo) rates to California growers. The original idea was to improve irrigation efficiency to reduce demand for water from the developed supply, which reduces the need to build more dams. The ETo information from CIMIS is used in conjunction with crop coefficient (Kc) values to estimate crop evapotranspiration (ETc). The number of weather stations in CIMIS has increase to more than 100 (compare to 43 when CIMIS was started in 1982). Growers in California extensively use evapotranspiration information from CIMIS. It was estimated that California growers save approximately $64,700,000 per year in water and energy savings as well as improve production by using CIMIS. The reduction in water applications also reduces fertilizer usage and ground water pollution. In this project, our objective is to expand the CIMIS network by installing two CIMIS weather stations in Baja California. Our goal is to provide ETo information, an improved weather data set, and to foster joint teaching and research between UC and the Autonomous University of Baja California. Two CIMIS weather stations were calibrated and installed in the Mexicali Valley. An alfalfa irrigation scheduling program was developed that was translated to Spanish in 2002. Two CIMIS and irrigation management workshops were conducted in Imperial Valley and Mexicali Valley in 2002.

Impact: The utilization of weather data for irrigation scheduling in Mexicali Valley will likely result in efficient use of Colorado River water in Mexico. The additional weather stations will help growers on both side of the border. It will help growers in southern part of the Imperial Valley to utilize CIMIS data for irrigation scheduling. It will also benefit U.S. vegetable growers in the Mexicali Valley as well as the Mexican growers. Our alfalfa irrigation scheduling program that was developed

specifically for this region and based on local Kc values was translated to Spanish and we made it available for growers and irrigators on both sides of the border.

Funding Source: Smith Lever and State
Scope of Impact: State Specific/Mexico

Key Theme: 4.14 Natural Resources Management
Title: The National Center for Ecological Analysis and Synthesis Marine Reserve Working Group

Description: Studies are needed to develop design strategies for marine reserves, and the performance of area closures from a resource management perspective must be modeled. In turn, this information must be made available to resource management agencies to enable them to make more informed decisions about Marine Protected Area (MPA) design and implementation. The National Center for Ecological Analysis and Synthesis (NCEAS) (affiliated with the University of California Santa Barbara) facilitates integrative research aimed at synthesizing existing data and subsequently making that data useful to researchers, resource managers, and policy makers.
In response to conservation concerns, the number of marine reserves will undoubtedly continue to grow. With appropriate input from the academic community, it is possible to plan these reserves and networks of reserves based on sound ecological principles. Both the fishing industry and marine conservationists have requested additional input from the research community, but the scientific community has been unable to provide much guidance. The primary goals of the working group were to provide practical advice to improve the design, placement, and monitoring of marine reserves. The second goal was to advance the theory of marine reserves and hopefully stimulate additional theoretical and empirical efforts. The workgroup met for two years, for approximately five days at a time, for a total of eight meetings. In addition, subgroups met several times on their own.
Impact: The methodology that we developed in the NCEAS group was used to design the network of reserves for the Channel Islands in 2002. The PIs participation on the NCEAS workgroup enabled her to later directly help stakeholders in the Channel Islands National Marine Sanctuary Marine Reserve Working Group (MRWG). Because of the NCEAS experience, she was able to help MRWG stakeholders to better understand the information that the MRWG's Science Panel was using to design the network of marine reserves for the Islands because it was the methodology we had developed in the NCEAS Marine Reserve Workgroup.

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

Key Theme: 4.14 Natural Resources Management
Title: Channel Islands National Marine Sanctuary and CA Department Fish and Game Marine Reserve Working Group

Description: As in many regions, a steady deterioration of marine resources in the California Channel Islands has led biologists and resource managers to question the ability of current fisheries management approaches to provide long-term environmental and economic viability. No-take marine reserves can be used to supplement traditional fisheries management. To achieve maximum

ecological, economic, and cultural benefits, it is important to design reserves using sound ecological principles, while maximizing long-term economic potential, and enhancing educational and research opportunities. To be accepted, marine reserves must minimize short-term economic impacts and maximize long-term economic viability of fisheries. Thus, ecology, social science and economics should contribute to, but not compromise, marine reserve design. We need to help organize and participate in forums that discuss MPA issues among the wide range of those interested and potentially affected by MPAs (Marine Protected Areas). Strategies to design and implement reserves also need to incorporate the economic and conservation implications of different reserve network scenarios.
In 1999, a process to develop a network of marine reserves in the California Channel Islands was initiated by a group of federal and state agencies, commercial and recreational fishermen, environmentalists, and other members of the Santa Barbara community, hereafter called the Marine Reserves Working Group (MRWG). Two advisory panels were formed to assist the MRWG, a science advisory panel (15 members) who evaluated ecological and physical data, and a socioeconomic panel (5 members) who evaluated economic data from commercial and recreational industries in the Channel Islands. The science advisory panel developed recommendations for the Channel Islands within the scientific framework suggested by the NCEAS working group on marine reserves (of which the PI was also a member). The PI was nominated (by a fishery representative, CDFG and the Center for Marine Conservation) to serve on the CINMS)/ CDFG MRWG which had the task of considering how to design a Channel Islands reserve network. e MRWG developed approximately 20 different reserve network scenarios. However, consensus could not be reached mainly because recreational fishing interests would not compromise. It seemed that consensus could be reached with the commercial fishermen. The group ultimately came up with two reserve network scenarios. After the MRWG was completed, the CDFG and CINMS used the maps as a basis to create another map that was very similar to the more restriction map proposed by the MRWG. They submitted that map to the Fish and Game Commission.

Impact: The CA Fish and Game Commission approved one reserve network design put forth by the MRWG to CINMS and CDFG. The design is science-based and incorporates stakeholder concerns. The network consists of 12 MPAs that cover 142 square nautical miles within the Channel Islands National Marine Sanctuary boundaries. Ten of the 12 MPAs are no-take reserves (132 square nautical miles). There also now exists a better-informed stakeholder community in terms of conservation and resource management. The PI provided her insights and experiences from this effort at three conferences and two Universities (Yale and UCSB) in 2002.

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

Key Theme: 4.14 Natural Resources Management
Title: California Department of Fish and Game Marine Life Protection Act (AB 993)

Description: There is currently no network of Marine Protected Areas (MPAs) (with a common goal) in California, just an assemblage of individually designated sites that provide very limited restrictions on extractive uses. Most of the California MPAs were intended to protect resources from a specific threat, such as pollution or to control human activities such as access for recreation or fishing. However, no MPAs use an ecosystem-wide approach to integrated management of marine resources.

A first step in developing an effective California MPA network is to evaluate and improve existing MPAs. The establishment of new marine protected areas is currently receiving considerable attention. At the same time, there is also a recognition of the need to evaluate and improve existing ones. After individual agencies review their existing MPA assemblages, multi-agency cooperation at a statewide level could allocate coordinated mixes of protective measures for various agency objectives and mandate the regulations needed to meet those objectives.
We need improved resource management capabilities to prevent continued unsustainable use of our ocean resources. These include long-term ecosystem-based management strategies such as MPAs. MPAs are an ecosystem approach to marine resource management and their implementation could benefit fishermen, kelp harvesters, aquaculturists, tourists and the general public by sustaining marine resources on a long-term basis. We need to assist in the review of existing reserves and design of potential reference sites (e.g. MPAs/reserves) that provide representative natural systems in the state water of California. The requirements of Assembly Bill 993 address both of those needs.
In 1999, the California Assembly established the Marine Life Protection Act (AB 993) to develop a comprehensive MPA program in California's marine waters. The Bill requires a review of existing MPAs and development of a master plan to establish guidelines for a coordinated network of effective MPAs in California state waters. The Science Panel used California Marine Protected Areas as a foundation for reviewing the existing MPAs and as starting point for designing the proposed statewide network of reserves. In January 2002, a California advisor was nominated to the Southern Region MLPA stakeholder panel, which will review the statewide reserve network proposals.

Impact: The MLPA Science Panel has developed potential reserve network scenarios for the four geographical regions of the state. The state is required to design a network of reserves for all state waters in the next few years. All of the reserves fit under the categories that we developed in the Resources Agency Workgroup. In addition, the Channel Islands MRWG process is consistent with the provisions of AB 993 and it is anticipated that the recommendations of the MRWG will be incorporated into the master plan for California's marine waters. Thus, the outcome of the Channel Islands process will influence fisheries regulations and the distribution of future reserves in the State.

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

Key Theme: 4.14 Natural Resources Management
Title: California Resources Agency Marine Managed Areas Working Group

Description: Because there was neither a logical sequence followed nor consistent set of criteria used in establishing many existing Marine Protected Areas (MPAs), it is difficult to assess their efficiency by looking at only the number of them or the area they cover. In addition, there is no single definition of what constitutes a marine protected area causing them to vary greatly in purpose, design, size, name, level of restriction, etc. Nine agencies established the 101 California MPAs using twelve classification types. Of these agencies, none had a clear leading role and consequently the agencies' multiple objectives often conflicted. Moreover, the responsibilities of individual agencies were not always clearly defined causing their conservation objectives to sometimes conflict with their own resource use objectives. A coordinated approach to MPA establishment would also prevent conflicts among local, state and federal jurisdictions. Clearly the objectives of California MPAs will vary

according to specific criteria and priorities among agency and jurisdictional goals. However, the existing objectives of the agencies are diverse and with multi-agency cooperation a framework (consisting of existing and possibly new classification types) could be developed to create a true network of effective MPAs in California.
The PI served as a technical assistant to the Marine Managed Areas Working Group by the California Resources Agency. One of the problems with the historical process used to establish marine reserves is the lack of interagency coordination and communication. Recognizing this, the Governor of California called for a working group to be formed that would consist of representatives from all of the state agencies that create reserves in California. The goal of the group was to work together to create a more effective classification scheme for reserves in California.

Impact: The product of this effort was a plan that recommended a new MPA classification scheme. Four new MPA categories were created. The Interagency Workgroup Plan was adopted by the Legislature in August 2000 (AB 2800). All of the existing MPAs have been placed into one of these four categories to simplify the statewide system. This was done as an initial step in the Marine Life Protection Act process. All new MPAs must also be proposed as one of these four categories, including those proposed in the Channel Islands National Marine Sanctuary Process.

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

Key Theme: 4.14 Natural Resources Management
Title: Sudden Oak Death

Description: Throughout many of California's coastal counties tanoaks (Lithocarpus densiflorus), coast live oaks (Quercus agrifolia) and black oaks (Quercus kelloggii) are dying in large numbers. The unprecedented level of dieback of tanoak, coast live oak, black oak poses several immediate and future environmental threats:

- Dead and dying oaks have worsened the already severe fire hazard conditions in both wildland and developed hillside areas.
- Many wildlife species depend on these major acorn-bearing trees for habitat.
- Oaks are highly valued trees in an urban setting, providing beauty, shade and property value to homes. The loss of these trees is both aesthetically and financially costly.
- Reduction in tree cover is resulting in significant risks for increased sediment production and impaired beneficial uses of water.

A collaborative effort of AES faculty, CE specialists and advisors and collaborating agency personnel (state, federal and California State University) developed a comprehensive research and education program on sudden oak death.

Impact: The causative agent of sudden oak death has been identified as a Phytophthora species. Based upon morphology, the isolates examined in detail do not match any Phytophthora species currently known from California. The identification of this causative agent provides the first opportunity to develop a strategy for reducing the spread of sudden oak death and eventually solving this serious problem. Researchers must now search to understand the fungus' biology, its role in Sudden Oak Death, and what role, if any, bark beetles and other fungi consistently associated with the

dying trees play. The public and resource professionals are better informed about sudden oak death and the findings of the research program have been developed into interim guidelines for controlling the spread of the organism. These guidelines have been successful in significantly reducing rate of spread of Sudden Oak Death, and to date, has kept it confined to coastal woodlands.

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

Key Theme: 4.14 Natural Resources Management
Title: Salmon Habitat Restoration

Description: Russian River salmon and steelhead populations have declined drastically in recent years as a result of habitat loss and degradation. Improvement of in-stream habitat will result in a rebound of fish populations. UC Cooperative Extension has developed a program to accomplish habitat enhancement. This educational program targeted landowners in areas critical to salmon habitat. The program taught landowners about land management and revegetation methodologies to decrease erosion, stabilize streambanks, and decrease streambed downcutting, and thus reduce sediment delivery to important streams and rivers.

Impact: Sediment delivery has been significantly reduced in the Russian River watershed and the resulting improvement in habitat has benefited threatened anadromous fish.

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

Key Theme: 4.14 Natural Resources Management
Title: Restoration of Native Oyster Habitat in Bodega and Tomales Bays

Description: Olympia oysters in California's estuaries historically provided a significant food resource for Native Americans as evidenced by extensive shell middens around San Francisco, Tomales, Bodega and Humboldt Bays. These oyster populations were exploited by early European American settlers and in serious decline by the end of the 18th century due to overharvesting, sedimentation and degraded water quality. This population decline, in addition to depriving people and other wildlife of a valuable food resource, also resulted in the loss of extensive complex three dimensional habitat created by clusters of oysters that can be utilized by a myriad of fish and invertebrates. Also lost was the ecological role oysters play as filter feeders, transferring phytoplankton and other suspended solids from the water column to the sediments, thereby enabling nutrient transfer and increasing water clarity. Native oyster populations remain in serious decline today. To restore these populations UC Cooperative Extension developed a project to outplant settlement substrate and document oyster recruitment while at the same time outplanting hatchery produced oysters and monitoring native fish and invertebrates.
We deployed oyster arrays in Tomales Bay and also shell necklaces at various locations around the Bay to document recruitment growth and survival. Reef modules were outplanted in the spring prior to the natural spawning cycle of oysters in the Bay and monitored for recruitment, growth and survival.

Impact: Outplanted oysters are beginning to improve water quality and provide valuable habitat.

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

Key Theme: 4.19 Riparian Management
Title: Biology of Pathogens and Insects in Natural Forest Ecosystems of California

Description: Extensive mortality of tanoak, coast live oak and black oak has been reported in coastal areas of California over the past 5 years. We have recently isolated a new species of Phytophthora that is the underlying cause of this mortality. Cultural and molecular studies have confirmed that this fungus does not match any of the 60 described species of Phytophthora. The new Phytophthora causes aerial cankers on the stems of infected trees; it does not appear to colonize the roots. We have completed a series of inoculation tests that confirm that this pathogen is the underlying cause of the disease. A field survey has narrowed the current range of the pathogen from Monterey County to central Sonoma County. In order to understand Arceuthobium patterns of spread, host effects, and bark beetle interactions in the Sierra Nevada we chose to study dwarf mistletoe in 2 different areas (with different management histories) and 2 different Arceuthobium species over 3 study sites. We found the highest prevalence of dwarf mistletoe on Jeffrey pine in the Lake Tahoe Basin (87 percent), followed by dwarf mistletoe on white fir in Lake Tahoe (30 percent), with the lowest prevalence on white fir at the Teakettle Experimental Forest (27 percent). We found that dwarf mistletoe prevalence and severity on white fir in our Lake Tahoe grid was not correlated to density but severity was significant and positively correlated to host size. At the Teakettle Forest, dwarf mistletoe prevalence and severity on white fir was significantly correlated with host density and host size. Dwarf mistletoe prevalence and severity on Jeffrey pine was significantly and positively correlated with host density but severity was not correlated with host size. Individuals, of both white fir and Jeffrey pine, in all diameter size classes are susceptible to dwarf mistletoe with the lowest infection rate in the seedling-10 cm diameter size class. Arceuthobium on white fir in Lake Tahoe showed a certain degree of spatial aggregation up to 40 meters. However, random spatial patterns were found for Arceuthobium on Jeffrey pine in Lake Tahoe and on white fir at the Teakettle Forest. We found no relationship between white fir trees with dwarf mistletoe and the prevalence of bark beetles but there was a significant positive relationship between Jeffrey pine trees with dwarf mistletoe and the prevalence of its associated bark beetle. The degree of infection and logging history appear to be important in the spatial dynamics of Arceuthobium species in the Sierra Nevada. As part of the Teakettle Ecosystem Experiment we have mapped all pathogens (root rots, dwarf mistletoe, Elytroderma) and bark beetles on 12 four hectare plots. All stems greater than 5 cm diameter were examined and mapped on the plots (approximately 18,000 trees). This information is currently being analyzed to determine spatial patterns of pathogens and insects at landscape scales. Plots will be treated by a combination of thinning and prescribed fire.

Impact: The information we are gathering will be important for managing California's forests. Information on pathogens and insects will be necessary to determine the impacts of current management (thinning, prescribed fire) on forest health. The data on sudden oak death is the first to determine the cause of this mortality and how to manage it.

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

Key Theme: 4.21 Soil Quality
Title: The National Atmospheric Deposition Program (NADP)

Description: This project is studying the chemistry, mineralogy and fertility of acid soils and ways to ameliorate this acidity. With respect to amelioration of soil acidity, we found that calcium acetate is a good alternative to liming and we found that it moves downward in the soil more readily than lime. We are now in the process of trying to find ways to apply this material and ways to decrease the cost of the material. We are investigating the roles of acidic conditions and polyphenols on the forms of nitrogen in soil solutions and the role of tannins in mineralization processes. In an acidic forest soil located in coastal California, a large fraction of the total soil nitrogen is found in the dissolved organic fractions. Analysis of the dissolved organic fraction revealed that much of the nitrogen was in amino acid or peptide forms. We are also investigating the role of polyphenols extracted from conifers and forest shrubs on nitrogen mineralization in the acidic soils found at the pygmy forest near Fort Bragg Ca. Purified tannins from several local species including pines, cypress, rhododendron, huckleberry and manzanita are being evaluated with respect to their effects on gross and net mineralization of soil nitrogen. We have published our findings on the uptake of mercury and arsenic by Zorro fescue from highly acidic mine spoils. We are also investigating the ability of amorphous iron hydroxides to remove arsenic from acid mine drainage.

Impact: We identified the role of revegetation and soil amendments on arsenic and mercury uptake from acidic mine spoils, information that has been used to develop management practices to assist in clean up of mine spoils.

Funding Source: Hatch Multistate Research and State
Scope of Impact: National

Key Theme: 4.21 Soil Quality
Title: Soil Biology in Vegetable Crop Systems

Description: The effects of cover crops, compost, and crop rotation in vegetable production in the Salinas Valley were the focus of the project. 1) An on-farm study was completed that showed that organic matter inputs (compost and cover crops) increased soil microbial biomass and crop yield, decreased weeds and nitrate leaching, but had no effect on total soil carbon, nor on insect pests and diseases. Less pronounced responses occurred with reduced compared to conventional tillage. The typical practices of conventional tillage with no organic matter inputs, however, gave the highest net economic returns. 2) A two-year project on a growers' field in Salinas is showing no differences in soil quality, soil microbial activity, and crop yield between two kinds of compost, or between two input rates. 3) Numerous samples were taken to document the second year of the transition from conventional to organic production on a large-scale farming operation, which is being documented by monitoring 81 points on 9 fields for yield, crop nutrient content, soil microbial biomass, soil organic matter, diseases, pest damage, and weeds.

Impact: These on-farm projects are showing the optimal management regimes for organic matter inputs, i.e., compost and cover crops in an intensive cropping system that normally has little return of organic matter to the soil.

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

Key Theme: 4.22 Sustainable Agriculture
Title: Managing Plant-microbe Interactions in Soil To Promote Sustainable Agriculture

A. Verticillium Wilt: In continued work on suppression of verticillium wilt by green plant residues, we demonstrated that soil organic matter, organic nitrogen and increased nutrient availability were most closely associated with wilt suppression. Investigations on the relationship between phylloxera and soil microbes that colonize grapevine roots were continued. The work is part of a cooperative project with Dr. J. Granett at U.C. Davis. Previous work (Granett) had indicated the grapevine decline induced by phylloxera may involve invasion of wound sites by soil fungi and that use of high organic matter levels appears to suppress root necroses. Additional field plots with organic matter (composts and fresh residues) additions were set up in a phylloxera invested commercial vineyard. The influence of these treatments on phylloxera incidence, soil microbial populations and root colonization by fungi and root necrosis is being followed. Initial data show that the treatments induce significant changes in the soil microbial community. However, in the first year, no significant effects were observed for the organic treatments on root colonizing microflora or phylloxera incidence or damage.

Impact: Our trials are directed at suppressing the damage done to vineyards by phylloxera. Since severe phylloxera damage necessitates replanting of vineyards, growers could realize significant economic benefits from practices that slow the vineyard decline.

B. Phytophthora Cinnamomi: Infection of avocado seedlings by PHYTOPHTHORA CINNAMOMI in infested soil was decreased by 71% with the addition of gypsum soil amendments in replicated greenhouse experiments. The significant reduction in avocado weight caused by P. CINNAMOMI was largely eliminated by the addition of gypsum. Avocado seedlings grown in gypsum-amended soil were no more resistant to zoospore infection by P. CINNAMOMI than were seedlings grown in unamended sol. Permeability of avocado root membranes, as determined by rubidium exuded from root segments over time, was unaffected by growth in gypsum-amended soil. Drainage was not correlated with root infection of avocados grown in soil infested with P. CINNAMOMI and amended with gypsum. It appears that large reductions in infection of avocado seedlings by P. CINNAMOMI in gypsum-amended soils are not caused by an avocado growth response, increased root resistance, reduced root permeability or improved soil drainage. Sporangial production of P. CINNAMOMI buried in gypsum-amended soil for two days was reduced by as much as 74% in greenhouse trials. P. CINNAMOMI sporangial volume was reduced an average of 64% in gypsum amended soil. Soil extracts from gypsum amended-soil reduced in vitro sporangial production and volume. Irrigation of buried mycelium with gypsum solutions also reduced sporangial production and volume. Zoospore production and colony-forming units of P. CINNAMOMI were reduced in soil amended with calcium sulfate, calcium nitrate or calcium carbonate. Zoospore encystment or passive

movement through soil was not significantly affected by gypsum amendments. We have been testing the EcoSoils field fermentor as a means to continuously apply a biocontrol agent in the irrigation water. The field fermentor effectively, automatically distributes PSEUDOMONAS PUTIDA into the irrigation system at every irrigation. The fermentor automatically produced a clean high-density inoculum in as little as 12 hours. Dilutions of P. PUTIDA UP TO 1:100,000 effectively colonized soil in greenhouse experiments. In citrus field trials with Phytophthora root rot, P. PUTIDA applied continuously in the irrigation water gave higher populations than single, yearly applications and improved biocontrol of PHYTOPHTHORA PARASITICA comparable to the fungicide metalaxyl. Populations of continuously applied P. PUTIDA increased during the irrigation season, reaching a maximum of nearly 100,000 cfu/g soil. Single applications of P. PUTIDA rapidly declined after each yearly addition. The effects of applications of P. PUTIDA on the resident microbial communities was studied with fatty acid methyl ester profiles (FAME), ribosomal intergenic spacer analysis (RISA), substrate utilization patterns (BIOLOG), and plate counts. With all methods utilized except for plate counts, spatial, seasonal, and yearly effects on variation within microbial communities was much greater than effects of either P. PUTIDA or yearly applications of a fungicide and a nematicide. Repetitive applications of P. PUTIDA appear to be a safe, cost effective method of controlling Phytophthora root rot of citrus.

Impact: Gypsum applications act as a weak fungicide and significantly lower the inoculum potential of PHYTOPHTHORA CINNAMOMI in soil. We believe that the EcoSoils field fermenter effectively produced and distributed bacterial biocontrol organisms. Continuous application of biocontrol bacteria have tremendous promise and our bacterial biocontrol agent applied in this way gave increased populations in the soil over the growing season. We have documented reduction in PHYTOPHTHORA PARASITICA populations in the field using this method, while single applications of the biocontrol agent did not reduce P. PARASITICA populations. It appears that the EcoSoils field fermenter is an effective delivery method for biocontrol agents. Furthermore continuous application of biocontrol agents considerably improves their effectiveness.

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

Key Theme: 4.22 Sustainable Agriculture
Title: Biology, Ecology, and Physiology of Weeds and Their Relationships To Weed Management

Description: Arundo donax L. is a perennial, asexually reproducing species that has invaded riparian habitats throughout Mediterranean climate zones. Little is known about its development, phenology, and rate of spread or its response to environmental factors. Research was conducted to evaluate ramet demography of A. donax in two California riparian communities. Sites differed in the seasonal pattern of precipitation and in resource availability, as effluent from a water treatment plant enriched nitrogen in surface waters at the inland site. Quadrats were established along 100 m transects at each site and oriented across the advancing fronts of established populations. Morphology and phenology were assessed monthly from September 1998 to September 1999 for calculation of demographic parameters and rhizomes were excavated and mapped at the end of the experiment. No shoots in any of the quadrats flowered during the experimental period, supporting the observation that A. donax is obligately asexual in California. Seasonality affected the number of recruits, colonists, and recruit

deaths, and net recruitment and ramet addition rate at both sites. Plant factors related to rate of spread included spatial advance of ramet populations from buds on rhizomes and shoots as well as age and maturity of the populations. A. donax at the nutrient-enriched inland site appeared to be spreading more rapidly than at the coastal site as evidenced by greater production of colonists and higher linear and areal additions to clumps. At the coastal site, most clumps were dense at the beginning of the research and A. donax spread more slowly there than inland. However, several recently established clumps were found in gaps at the coastal site suggesting a greater frequency of flood-mediated dispersal of A. donax propagules. Inferences about local population invasiveness and hence, development of local management strategies for A. donax, could be made from the condition of the populations and their habitats.

Impact: Research conducted under this project focuses on fundamental questions related to ecological, physiological, and genetic aspects of weed adaptation and invasiveness. Results have potential value for developing sustainable vegetation management strategies that are based on ecological processes.

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

Key Theme: 4.22 Sustainable Agriculture
Title: Population Dynamics and Genetics of Cyst and Root-knot Nematodes in Sustainable Cropping Systems
Description: Experiments are being conducted to assess the efficacy of broccoli mulch as a biofumigant to manage Heterodera schachtii. In field trials were conducted to assess the efficacy of broccoli biomass to reduce nematode populations, with treatments 1) No broccoli soil amendment, although roots of previous broccoli crop remained in place, 2) 2x broccoli shoot residue; 3) 1X broccoli shoot residue; 4) 1x broccoli shoot residue with tarp; 5) 1x broccoli plus Telone (rate of 9 GPA); 6) 1x broccoli plus Telone (rate of 18 GPA). Broccoli amendment biomass was grown in place, chopped, and added to the soil at two rates. Three weeks after treatment application, the tarps were removed and plots were planted to a broccoli crop that was grown for approximately three months. Soil samples were collected immediately prior to biomass incorporation and also at three weeks after treatment application. Samples were processed to extract cysts, cysts were crushed to allow enumeration of eggs, and cysts were placed on Baermann funnels as a hatching bioassay to determine egg viability. A primary finding of a summer field trial was that broccoli residue at twice normal field density reduced larval densities and also egg hatch, indicative of effective biofumigation; however a fall field experiment with cooler temperatures did not show the same reduction in hatching. The research is continuing. The influence of biological control agents on eggs and juveniles of Heterodera schachtii and Caenorhabditis elegans was investigated. During the research the reproductive pathway of C. elegans was investigated because although the development and genome of Caenorhabditis elegans have been extensively studied, many aspects of its natural life history have been surprisingly little explored. We found that in response to starvation, C. elegans changes its reproduction from ovipary to vivipary. Viviparity is induced by starving late L4s, young adults, or gravid adults, and is reversible to oviparity by restoring food. Viviparous larvae engage in matricide by consuming the parent body contents, and the resources so obtained allow some larvae to become dauers under complete starvation. Vivipary, androdioecy, and dauer formation are life-history traits that together

ensure survival of dispersal propagules under extreme food limitation.

Impact: This research that addresses biofumigation using cole crop residues to reduce cyst nematode densities has application to nematode management. This cultural control is an alternative to chemical control, and the nematode reductions will be less than with nematicides. Effects on the soil are likely to be more complex and subtler than with the chemical approach, and will protect the environment.

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

Key Theme: 4.22 Sustainable Agriculture
Title: Engineering Systems For Sustainable Crop Production

Description: An RTK GPS-based auto-guidance system was tested in transplanted and direct seeded tomato fields. A split-plot experiment was conducted in four blocks with forward speed as the main factor (5-kph and 11-kph) and cultivator knife spacing as the sub factor (5-cm and 10-cm). Results indicate that in the transplanted field there was hardly any damage at the 11-kph forward speed and the 10-cm cultivator knife spacing. In the direct seeded field virtually no plant damage occurred even at the 5-cm cultivator knife spacing and a forward speed of 11-kph. A weed detection algorithm was developed using a neural network-based computational engine. The algorithm successfully identified weeds, cotton plants, and soil in images from a commercial cotton field with 93% of the weeds correctly mapped for precision micro-dosing herbicide application and 91% of the cotton plants correctly mapped for no herbicide application. A micro-dosing system was developed for treating spray targets on a 1-cm scale with dose pulses down to 6 ms. Effects of liquid velocity, jet exit diameter and liquid properties on deposition, splash and drift were determined. Efficacy of micro-dose application of nonselective herbicides against common weeds was determined through bioassays. A study was conducted to determine the feasibility of using near infrared spectroscopy as a sensing technique to determine soil moisture content. Near infrared absorbance in the 1400-2400 nm region correlated well, r=0.98, with soil moisture content. The study determined that a site-specific calibration was required when the model was applied to soils that were different from those in the original calibration process. Research was conducted on the design of electronic hazing systems for improved control of birds in orchards and vineyards. The original concept was to develop a sensor-based unit to detect when birds entered an area and activate the hazing sounds only when they were present. In this way, habituation would be minimized, thus prolonging the effectiveness of control in the field. Due to the complexity and potential cost of the sensor-based system, a simplified non-sensor unit was subsequently designed with the intention of large scale field use by growers. A manually operated optoelectronic system was developed to count and size fruit and nut trees in commercial nurseries. Calibration tests showed that the system could measure trunk diameter to +/- 1.9 mm (99.7 percent confidence) with the sensor 15-23 cm from the tree line. Leaves, low-level suckers, weeds, and trunk stakes all had the potential to cause inaccurate counting and sizing.

Impact: Intelligent, precision systems for agricultural operations will greatly improve their efficiency and efficacy. Dramatic economic and environmental benefits will result from lower fuel consumption due to fewer tractor trips through a field, less chemicals required, fewer chemicals applied to non-target areas, less menial labor required, and more effective mechanical weed control.

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

Key Theme: 4.22 Sustainable Agriculture
Title: Precision Technology, Institutional Change, Productivity, and Environmental Quality in Agriculture
Description: This year we investigated alternative mechanisms to compensate for provision of environmental services, for example, practices such as low tillage that aim to prevent soil erosion, restore environmental quality, and sequester carbon. We found that policies that maximize environmental benefits per dollar spent may be more attractive to society as a whole but less desirable from the perspective of producers than traditional conservation reserve policies to maximize acreage in the program. We also found that environmental payment programs may affect commodity prices and result in slippage that may lead to increased production and increased environmental damage. These can be prevented by compensating for conservation activities that have already occurred. Another line of research studied the role of sampling in marketing and management. Buyers of products and inputs based their decisions on accumulated impressions and goodwill. Goodwill may tend to decline with infrequent use of products or purchases, so sampling is especially effective as new products are introduced or to overcome loss of memory. We developed formulas for optimal sampling strategies under alternative scenarios.

Impact: The results of this project identified a better mechanism to allocate Conservation Reserve Program funding. Targeting lands with higher benefits per dollar spent can yield significant increase in environmental benefits obtained with the current budget.

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

Key Theme: 4.23 Water Quality
Title: Nitrogen Utilization Efficiency in Deciduous Fruit Trees

Description: Field-grown peach trees were used to assess the possibility of exclusive reliance on foliar-applied nitrogen (N) (urea used as the N carrier) rather than soil N application. Foliar-applied urea has long been used to supplement soil N applications, but there have been no attempts to replace soil N applications completely. In a 3-year experiment, a total foliar urea regime, applied in October, was compared to an equivalent amount of N applied to the soil. Adequate N was applied to the tree foliarly, but mean fruit weights were lower than in the soil-fertilized treatments. In a 2-year experiment, a 50%-50% combination treatment of soil applied N in late summer with foliar-applied N in October, maintained yields and fruit weight equal to the soil-fertilized control. Some soil-applied N appears necessary for optimum fruit growth. The presence of plant-available N in soil may be necessary to support root proliferation and associated processes. We did not determine a threshold amount of soil-applied N needed.

Impact: The impetus for this work was evidence that significant quantities of urea-nitrogen can be

absorbed through leaf surfaces, especially if applied in autumn (October), when natural leaf senescence and abscission is imminent, and there is less concern with urea phytotoxicity. More than 50% of the annual N requirement of the tree can be applied foliarly, thus, reducing the likelihood of the contribution of soil-applied N to nitrate pollution of groundwater.

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

Key Theme: 4.23 Water Quality
Title: Mechanisms and Mitigation of Agrochemical Impacts on Human and Environmental Health.

Description: Determinations of runoff from orchards continued supported by CalFed and growers led by a team of UC researchers. The studies revealed that very low levels of the pyrethroid esfenvalerate (Asana) was toxic to fat head minnows; diazinon was much less toxic. A project is planned to examine the effects of diazinon and esfenvalerate on the development of the neuromuscular system of developing Medaka and salmonids. Studies are underway with clinical laboratories to standardize their cholinesterase assays. A new project is beginning with the Department of Defense to standardize and harmonize their cholinesterase assays amounting to approximately 25,000 per year.

Impact: There are concerns that the runoff of dormant sprays is affecting the commercial fisheries. In addition, it is important to find out whether the runoff poses a danger to the safety of agricultural workers, and consumers. Standardizing and improving clinical cholinesterase assays are important matters in providing for the safe use of pesticides.

Funding Source: Hatch Multistate Research and State
Scope of Impact: CA, FL, HI, NV, NM, NYC, OR, UT, WA, ARS/USDA, IN, HI

Key Theme: 4.23 Water Quality
Title: Aquatic Invertebrates in Assessments of Anthropogenic Impacts in Calif Streams, Rivers and Wetlands
Description: A multivariate, predictive model based on the reference-condition approach using benthic invertebrate assemblages and environmental descriptors from more than 200 sites from western North America has been developed. Reference sites were classified into groups representing similar invertebrate assemblages. Five classifications have been produced, using three taxonomic levels (family, genus, and species) and species and family multimetrics. For each of the classifications, discriminant function analysis was used, with environmental descriptors, to develop a predictive model for the reference sites. These models predicted from 43.8% (species) to 61.6% (family) of the reference sites to the correct benthic group. Each model was used to assess deviation from reference condition for test sites exposed to either agriculture, logging, or mining impacts. The models were examined with regard to their sensitivity, robustness, usability, temporal variability, predictive performance, and model certainty. The family and family-metric models were ranked best, followed by the species-metric, genus, and species models. The family-level model is recommended for assessment purposes; its overall performance was slightly superior to the family-metric model and it avoids an extra step in calculation of the metrics. However, the species-level model is recommended for conservation or biodiversity issues.

Impact: Throughout the industrialized and developing world, water quality monitoring approaches are being based on benthic macroinvertebrate assemblages. This model uses the largest data set available for North America to evaluate the accuracy and usefulness of these multivariate modeling approaches.

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

Key Theme: 4.23 Water Quality
Title: Irrigation Management Under Saline Conditions

Description: The simulated results using the ENVIRO-GRO model were compared with the measured values in a field experiment to test the validity of the simulation results. The experimental variables were salinity of irrigation water and frequency of irrigation. The simulated results agreed very well with the measured results providing confidence in using the model to simulate the various consequences of managing irrigation under saline conditions. Irrigation with saline waters can affect hydraulic conductivity of soils. However, laboratory experiments demonstrated that the prewetting rate of the soil can influence the hydraulic conductivity of soils. The detrimental effects of sodicity can reduced if the soils are wetted rather slowly as compared to more rapidly.

Impact: Verification of the ENVRIO-GRO provides the basis for its use to establish optimal irrigation management strategies reducing the need for extensive expensive field experiments.

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

Key Theme: 4.23 Water Quality
Title: The National Atmospheric Deposition Program (NADP)

Description: This study was conducted to determine the relative contributions of nitrogen from atmospheric deposition and weathering of bedrock containing nitrogen. A laboratory study was performed to simulate field weathering and nitrogen release from bedrock in a setting where geologic nitrogen has been suspected to be a large local source of stream water nitrate. Two rock types containing nitrogen, slate (1370 mg N/kg) and greenstone (480 mg N/kg), were used along with saprolite and BC soil horizon sand from soils derived from these rock types. The fresh rock and weathered material were used in batch reactors that were leached every 30 days over 6 months to simulate a single wet season. Nitrogen was released from rock and soil materials at rates between 10E-20 and 10E-19 moles N per centimeter squared per second. Results from the laboratory dissolution experiments were compared to in situ soil solutions and available mineral nitrogen pools from the BC horizon of both soils. Concentrations of mineral nitrogen (ammonium and nitrate) in soil solutions reached the highest levels at the beginning of the rainy season and progressively decreased with increased leaching. This seasonal pattern was repeated for the available mineral nitrogen pool that was extracted using a KCl solution. Estimates based on these laboratory release rates bracket stream water nitrogen fluxes and changes in the available mineral nitrogen pool over the active leaching period. A

paired watershed approach showed stream water nitrogen fluxes greater than 10 kg N /ha/yr (maximum fluxes were about 20 kg N/ha/yr) in low-order Sierra Nevada foothill watersheds containing geologic nitrogen compared to values

Impact: Results of this study confirm that geologic nitrogen, when present, may be a large and reactive pool that may contribute as a non-point source of nitrate contamination to surface and ground waters. This information has been critical in developing accurate TMDL standards for many CA watersheds.

Funding Source: Hatch Multistate Research and State
Scope of Impact: National

Key Theme: 4.23 Water Quality
Title: Reducing the Potential For Environmental Contamination By Pesticides and Other Organic Chemicals

Description: MTBE is a ubiquitous groundwater contaminant that does not respond well to conventional treatment technologies. Growing evidence indicates that microbial communities indigenous to groundwater can degrade MTBE when oxygen is added or available and also under anaerobic conditions. In a pilot study conducted in a contaminated groundwater aquifer at Vandenberg Air Force Base in Lompoc, CA, native microbial communities stimulated by diffusive release of oxygen have been demonstrated to biodegrade MTBE in situ. Using DNA fingerprinting of microbial communities in groundwater samples, we found DNA sequences almost identical (>99% homology) to those of bacterial strain PM1, an organism originally isolated from a biofilter reactor at a sewage treatment plant in southern California. Using a Taqman quantitative polymerase chain reaction (PCR) technique with DNA primers specific to strain PM1, we found higher numbers of PM1 in the presence than absence of oxygen and little change in PM1 numbers when toluene was added to the MTBE plume. We also found strain PM1 to naturally occur in MTBE-contaminated groundwater resulting from MTBE spills at service stations in Carmel and Port Hueneme Naval Facility in CA. At all 3 sites, the removal of MTBE corresponded to increases in PM1 density in laboratory microcosm studies. Quantitative PCR methods provide valuable information about how microbial populations responsible for the biodegradation of specific pollutants respond to different management practices and will help in developing more effective treatment strategies.

Impact: Bioremediation is an important treatment method for cleaning up many pollutants in soil and groundwater. It has previously been almost impossible to measure the population sizes of specific microorganisms responsible for pollutant biodegradation in the field. Using the molecular methods described here, it is now possible to determine the success of different in situ remediation strategies in stimulating native biodegrading organisms.

Funding Source: Hatch Multistate Research and State
Scope of Impact: AL, AZ, CA, CTH, CO, DE, FL, HI, IN, IL, IA, LA, KS, MN, MT, PA, SD, WA, USDA/ARS, AR, MI

Key Theme: 4.23 Water Quality
Title: Nitrogen and Water Management in Vegetable Crop Production

Description: Drip irrigation trials were conducted in three commercial lettuce fields in the Salinas Valley in 2000. In each field, replicated plots of drip irrigation tape with flow rates either above or below that used in the field system were patched into the field system. As the grower managed the field system, graduated levels of water, and fertigated N, were applied in these plots. In one of these fields, the total water applied by the grower was substantially in excess of estimated crop evapotranspiration; in another the grower seriously underwatered the crop, inducing severe moisture stress. None of the growers used reference evapotranspiration (real-time or historical mean) to determine irrigation volume, nor was there evidence that irrigation frequency or water volume per irrigation was tailored to match prevailing field conditions. These results reinforced the results of earlier field trials with celery, which showed that many growers were not managing drip irrigation in their fields to take maximum advantage of this technology. These commercial field trials have provided the basis for extensive Extension educational efforts to improve irrigation practices.

Impact: This research is beneficial to the growers of cool-season vegetables in the coastal valleys of central California, the nation's primary area of supply. This industry faces serious environmental issues relating to water availability, quality, and groundwater nitrate pollution. The drip irrigation research has proven the utility of water budget-based scheduling, and the importance of matching irrigation frequency with field-specific conditions. Improvements in irrigation management practices are required to meet the non-point source water pollution regulations associated with the Total Maximum Daily Load (TMDL) process.

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

Key Theme: 4.23 Water Quality
Title: Microirrigation Technologies For Protection of Natural Resources and Optimum Production

Description: As part of a large reduced input management study in prunes, regulated deficit irrigation (RDI) was managed using the plant-based method of midday stem water potential (SWP) in a number of demonstration orchards. A study demonstrating a substantial savings in irrigation water using this method was also published. In 5 of the demonstration sites, RDI has been compared to conventional irrigation practices for the last 3 years, but because these are grower orchard sites, our ability to control irrigation practices in the conventional plots is limited. As of 2001, most of these growers had apparently determined that our RDI strategy is superior to their conventional practice, and as a result the conventional plots are being managed similarly to the RDI plots. In an additional 11 demonstration prune orchards, only RDI is being practiced. In almonds, 10 grower demonstration plots were established across the state, and were managed using SWP to impose RDI in a strategy to reduce hull rot and improve nut harvestability. This was the first year of a multi-year study, and in many cases we found that growers were already imposing a certain degree of RDI as a normal horticultural practice. This year there was no apparent effect on nut harvestability, but in all cases where hull rot was observed, the RDI treatment was associated with a reduction in this disease.

Impact: Our research gives prune and other fruit tree growers the tools necessary to reduce irrigation while maintaining or improving tree productivity. Compared to the currently recommended levels of

irrigation for prune, the substantial water savings we have documented (57% - 70%) will be of great benefit to the states water supply, and the reduced levels of irrigation in orchards will also reduce non-point sources of groundwater pollution.

Funding Source: Hatch Multistate Research and State
Scope of Impact: AZ, CA, FL, GU, HI. ID, IA, KS, MN, NM, TX, VA, WA, WY, USDA/CPRL, USDA/CPSWPRC, USDA/WMRL

Key Theme: 4.23 Water Quality
Title: Developing Plant-based Irrigation Strategies To Improve Irrigation Efficiency in Orchards

Description: Results of the bagging duration study were summarized and published. These results represent a substantial practical improvement of our plant-based monitoring technique of midday stem water potential (SWP), because only a short time between bagging and measurement (about 10 minutes) allows for much more flexibility in the scheduling of orchard monitoring. This has made the SWP technique more attractive to growers, advisors and consultants, and as a result a small number of workshops demonstrating the technique were held. In addition to prune, plant- based monitoring was conducted in walnut and pear orchards, as well as in an experimental vineyard at UC Davis. For walnuts, SWP is being tested both as an irrigation scheduling tool and as a method for diagnosing root physiological problems such as nematode or disease related damage. As an irrigation scheduling tool, SWP was just as reliable as the more commonly used soil-based method in this first year of study. As a diagnostic tool, SWP has not detected any differences yet in a nematode and a phytopthera study in walnuts, but neither are differences yet apparent in the trees, so this may be an accurate reflection of the continued health of the roots. In pears, SWP was monitored in 5 experimental sites, and early season irrigation was withheld from half of the trees at each site to determine whether root damage was being caused by over- irrigation. Substantial water stress was measured at many of the sites despite irrigation, indicating that there is a root-related problem causing water stress, but withholding irrigation did not alleviate this problem in the first year. A number of methodological studies were performed on grape vines, demonstrating that SWP is independent of leaf position, as found in other woody perennial crops.

Impact: Our methodological studies have greatly simplified and streamlined the protocol for SWP monitoring, and so will make the technique much more likely to be adopted by growers, advisors and consultants. Using plant water status as a guide to irrigation need allows growers to use less water while maintaining, or in some cases improving plant productivity.

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

Key Theme: 4.23 Water Quality
Title: Agricultural Water Management Technologies Institutions and Policies Affecting Economic Viability and Environmental Quality

Description: Another line of research identifies possible irreversibility in ground water extraction. Excessive pumping may lead to compaction of soil or salinization that prevents buildup of aquifers in

the future. By introducing extra costs for these resource damages as well as introducing incentives for adoption of water conservation technologies, these irreversible damages can be eliminated.

Impact: Aquifers in the Central Coast are threatened by the buildup of salinity. These projects identified that the introduction of extra pumping fees and incentives for technology adoption will reduce the threat.

Funding Source: Hatch Multistate Research and State
Scope of Impact: AZ, CA, CO, HI, ID, NE, NV, ND, OR, TX, WA, ARS, ERS, KS, UT, NM

Key Theme: 4.23 Water Quality
Title: Predicting Impacts of Non-point Source Pollution on Ground-water Quality

Description: Progress on development of methods for advanced characterization of hydrostratigraphic architecture in a stream-dominated alluvial fan and research on nonpoint-source groundwater contamination continued. Our 73 hydrostratigraphic models and flow and transport models of the Kings River fan aquifer system were refined with further interpretation of core data. Additional investigation into effects of heterogeneity-driven dispersion on mixing of groundwaters of different age was also carried out. Results reconfirm earlier conclusions and indicate that measurable changes in groundwater age should occur during pumping of wells - suggesting a new transient-age monitoring approach for assessing local- and regional scale dispersion processes through a groundwater-age-inversion procedure. We also made improvements to the random-walk transport modeling code used in our vulnerability and groundwater age studies. Lastly, we began extending our work into analysis of connection between surface water and groundwater processes in the Cosumnes watershed and south-Sacramento County groundwater system. It appears that the same techniques developed to investigate nonpoint-source groundwater contamination will be essential for new research on stream-aquifer connection and for determining feasibility of artificially recharging groundwater in complexly stratified sediments that typify most groundwater basins of California.

Impact: This work is providing more efficient, scientifically accurate 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

Key Theme: 4.23 Water Quality
Title: Management of Nitrogen Fertilization in California Cotton Production Systems

Description: This project integrates a molecular approach focused on the regulation of N with a field program to develop updated guidelines for N fertilization in cotton. Time sequence analysis showed maximum transcript levels of a putative high-affinity NO3- transporter (NRT2) 8 to 16 h after first exposure to 0.1 mM NO3-. Relative expression of nitrate reductase (NR) was very high 1 hour after first exposure then stabilized for the next few hours at about half the initial level. Glutamine

synthetase (GS) transcription increased as the result of a 1h induction of seedlings with NO3- and levels changed little with longer induction periods. On average over the 48-h period relative expression decreased in the following manner: NRT2 > NR > GS. Thus, although expression levels varied, there was only a short delay in the expression of NR and GS in respect to NRT2 when cotton seedlings are induced with NO3-. After 12 h induction with NO3-, transcript levels of NRT2 and NR were greater when exposed to 0.01 mM NO3- compared to exposure to 0.1, 0.5, or 1.0 mM. Glutamine synthetase mRNA levels were similar when seedlings were induced with 0.01 and 0.1 mM NO3- but lower when induced with 0.5 and 1.0 mM. After a 12-h induction with 0.1 mM NO3-, relative expression of NRT2 and NR was greater in lateral roots than in root tips and in the zone of lateral root initiation of the tap root. This supports the importance of lateral roots for NO3- uptake A five-year study on nitrogen (N) fertilizer management in San Joaquin Valley Acala cotton production was completed. Fertilizer N treatments of 56, 112, 168 and 224 kg/ha were applied after correction for soil residual N concentration. Over the five year period yield reduction occurred in the untreated controls in only 16 of 39 locations. Detailed N budget analyses confirm that cotton requires on the order of 20-25 kg N/bale lint produced. It is this latter factor that governs N application recommendations. Our results indicate that soil residual N must be considered when N fertilizer recommendations are made. Thus, soil nitrate-N concentration in the upper 0.6 m of the profile is one indicator that can contribute to this decision. Seasonal weather patterns, cropping history, N in irrigation water, yield history should also be considered. The potential for ground water contamination by applied N must also be considered. Soil NO3-N monitoring to a depth of 2.4 m in the spring (after planting) and fall (post-harvest) indicate most changes in soil NO3- occur within the upper 1.2 m of soil. However, some sites (those most prone to leaching and losses of soluble nutrients) also exhibited net increases in soil NO3-N in the 1.2 to 2.4 m depth zone when comparing planting time versus post-harvest data. The lack of yield responses and soil NO3-N accumulations at some sites indicate that more efforts should be put into identifying the amount of plant N requirements that can be met from residual soil N, rather than solely from fertilizer N applications.

Impact: This project resulted in new guidelines for nitrogen fertilization of San Joaquin Valley cotton. This will result in the overall reduction of N use in California. Benefits include increased return to the grower through reduction in fertilizer costs and a lessening of the negative impacts of N on the environment.

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

Key Theme: 4.23 Water Quality
Title: Non-point Source Pollution Best Management Practices – “The Clean Water Program"

Description: The 1987 Clean Water Act requires municipalities to eliminate the discharge of pollutants into their storm water conveyance systems through the development of a comprehensive storm water management system. This can be accomplished through structural methods, non-structural methods (education and training) and by adopting Best Management Practices (BMPs). Although the horticulture industry is not singled out in these regulations, no water other than storm runoff will be allowed to leave properties and enter gutters or storm drains. he overall objective of our Best Management Practices Program is to assist the horticultural industry in coming into compliance with the Clean Water Act by reducing/eliminating runoff. This is being accomplished by: 1) providing

information and resources on BMPs, 2) conducting a voluntary Clean Water BMP Program to avoid mandatory 'one-size-fits-all' regulations, 3) assessing the impact of individual BMPs in reducing/eliminating runoff, 4) highlighting horticulture as a proactive industry in complying with environmental regulations, and 5) by extending what is learned through the program to the industry Statewide and beyond. We are currently conducting replicated small plot trials to evaluate the contributions of individual BMPs to reducing runoff. Specific practices being addressed include irrigation system hardware upgrades, improvements in irrigation uniformity, and accurate irrigation scheduling. We have also accumulated data on runoff flow and concentrations of fertilizers leaving nursery and greenhouse operations. A number of methods are used, including regularly scheduled hands-on workshops, tours, and seminars, confidential individual consultations, and meetings, newsletter and trade journal articles and a website. The UCCE Advisors collaborate in the project design, staff supervision, identifying clientele training needs, identifying research needs, training of staff and industry, and information dissemination.

Impact: We have conducted numerous workshops and tours and more are planned for 2003. Approximately 90% of the horticulture growers in Encinitas (our initial pilot site) enrolled in our Clean Water Program, and have begun adopting the best management practices recommended. As a result, growers have significantly reduced or eliminated runoff leaving their properties. Through voluntary adoption of BMPs, these participants have successfully avoided, to date, more onerous regulatory 'fixes' to the runoff situation. This will allow growers to stay in business by working with the jurisdictions and agencies to reduce pollution and improve water quality in the region. Although difficult to measure, we feel that our efforts have resulted in water savings through the improvements in irrigation uniformity and efficiency, and enhanced the environment through improved water quality. The pilot program has been so successful that we received Prop 13 monies to expand this program to all agricultural industries county-wide and beyond. This program has received national attention and been nominated for a national award.

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

Key Theme: 4.23 Water Quality
Title: Improvement of Water and Nitrogen Use Efficiency in Ventura County Nurseries

Description: Sustainability of the woody container industry depends on implementation of practices that reduce nitrogen in runoff water. This project provided information about nitrogen and water requirements of representative crops and nitrogen use efficiency using common fertilizers. Objectives were: (1) Determine water and nitrogen (N) requirements of important species; (2) Determine N release rates and effects on plant growth of controlled-release fertilizers (CRF) in different media; (3) Evaluate current irrigation, fertilization and cultural practices for Ventura County nurseries for development of best management practices (BMPs). Researchers at UC Davis and UC Riverside conducted laboratory studies to determine the water and N uptake of five container-grown woody plants and to determine N release rates and effects on plant growth of CRF in acid- and normal-pH container mixes. A field study was conducted to evaluate current irrigation, fertilization and cultural practices for Ventura County nurseries. At 6 cooperating nurseries, we collected the following information: nursery size, crop type, fertilizer method, water source, irrigation method, irrigation uniformity, N content of irrigation water, N content of leached water, and waste water disposal. At 3

nurseries we also determined the amount of N retained by plants relative to total applied N. The daily water and fertilizer requirements of crops varied widely depending on species and size. For one-gallon stock, daily water use was usually between 160-500 milliliters and N uptake was between 5 and 30 milligrams. The ratio of N uptake to water uptake varied less among species, ranging from 23 to 54 mg/L. Nutrient release rates from 4 CRF fertilizers differed from each other and varied with medium pH and time. Release rates of all products tended to be higher in neutral media than in acidic ones. As release rates decline over time, there may not be sufficient fertilizer available for healthy plant growth towards the end of the production cycle. There is considerable variability in nursery facilities and practices of the nurseries we evaluated which will complicate BMP development. However, it is clear that most nurseries could decrease runoff of N by improving irrigation system uniformity and decreasing the application rates of N fertilizer. Presentations have been made to numerous industry associations and in University meetings. Results of this project are being incorporated into documents for publication by U.C. in cooperation with the Water Quality Work Group. Additional publications in scientific and trade journals are anticipated.

Impact: As a result of this study and on-going efforts in Ventura County, we have increased grower awareness of the importance of improved water, fertilizer, and pesticide management to minimize runoff and comply with increasing governmental regulations. We are working with growers to develop appropriate BMPs for their operations. This will eventually contribute to less nitrogen and pesticide runoff and to reduced water use, which will help to improve overall water quality in Ventura County.

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

Key Theme: 4.23 Water Quality
Title: Farm Water Quality Planning Program

Description: Irrigated agriculture is one of the sources of pollutants in watersheds throughout California. Regional Water Quality Control Boards regulate water quality through their total maximum daily load and permit programs for agricultural runoff. Growers can avoid external regulation by managing their agricultural operations to meet water quality standards. Voluntary implementation of management practices to reduce pollution is an opportunity for the industry to demonstrate environmental stewardship and reduce regulatory oversight.
A working group of 25 Cooperative Extension Advisors and Specialists have developed the Farm Water Quality Planning short course, in partnership with USDA Natural Resource Conservation Service. This program provides technical information and a template for irrigated agriculturalists to implement and document efforts to protect water quality. Individual water quality management plans are developed during the course, including methods for evaluating the efficacy of selected water quality management practices.

Impact: This new program is still in its pilot stage. Initial short-courses were attended by 100 growers, resulting in 60 water quality management plans. These plans, and implementation of the practices identified, have significantly reduced the sediment, pesticides and nutrients running off of these agricultural operations. This is the beginning of a larger scale implantation of Farm Water Quality Planning Short-courses which have an even more substantial impact in the future.

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

Key Theme: 4.23 Water Quality
Title: Ranch Water Quality Planning

Description: Livestock grazing and associated ranch practices have the potential to pollute surface water if not properly managed. Increased sediment created from improper grazing management can induce soil erosion, increase stream water temperature from removal of streamside vegetation, and nutrient loading all have the potential to degrade aquatic habitats critical to several endangered species and to impair other beneficial uses of water.;
UC Cooperative Extension Specialists and Advisors developed and implemented a Ranch Water Quality Planning short course. This short course is designed to enable rangeland owners to complete comprehensive non-point source pollution management plans. These courses have been headed up by UC Cooperative Extension specialists and advisors, often in collaboration with the Natural Resource Conservation Service and the California Cattlemen's Association. The Ranch Water Quality Planning Short course is based upon research conducted by AES faculty and CE Specialists and Advisors. A parallel outreach effort has resulted in the production of over 40 watershed and water quality fact sheets, which have been distributed to land owners, decision makers, and the general public, among others.

Impact: Over 1,300,000 acres of rangeland are now covered by ranch water quality plans. These plans have resulted in significant reductions in sediment and pathogen loads in water bodies across California. These non-point source pollution reductions have resulted from improvements to grazing management, ranch road construction and maintenance, and re vegetation projects. The final resulted is improved water quality for a variety of beneficial uses downstream from livestock grazing operations.

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

Key Theme: 4.23 Water Quality
Title: Tomales Bay Water Quality

Description: The Tomales Bay Shellfish Technical Advisory Committee (TBSTAC) confirmed that excessive winter fecal coliform levels within Tomales Bay are caused by runoff from lands used primarily for animal agriculture production and dairy farming. These agricultural practices, while seasonally degrading water quality, are thought to be less damaging that other potential land uses. The University of California Tomales Bay Water Quality Project (UCTBWQP) was established to improve water quality in the Bay by documenting the sources, environmental fate and transport of coliform bacteria in the watershed, and then implementing and evaluating best management practices to reduce coliform loading.
Using a "systems approach" ten individual dairies and ranches in the Tomales Bay watershed are being evaluated for both point and non-point source pollution loading units. Storm-event runoff from these loading units is sampled and analyzed for fecal coliform, nutrients, and other water quality parameters.

Ranch evaluation was conducted during the 2 winter seasons and management practices to reduce pollutant loading have been implemented and are being evaluated for their effectiveness.
A properly functioning manure management system controls over 90 percent of the potential fecal coliform load to the Bay. Outside of these systems, lots and corrals, stockpiles, and smaller intensively managed pastures are sites of the greatest potential fecal coliform load to Bay tributary streams.

Impact: Cooperators have implemented management practices that are reducing fecal coliform levels and improving water quality.

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

Key Theme: 4.23 Water Quality
Title: Selenium Management with Wetlands

Description: The toxic effects of selenium made headlines in 1983 when high levels from polluted farm water were found at Kesterson National Wildlife Refuges in the San Joaquin Valley. The soil on the west side of the valley is naturally rich in selenium, which leaches into the shallow groundwater of the region. Excessive agricultural irrigation accelerated this leaching process. This selenium has been linked to severe deformities suffered by birds and other wildlife at the Kesterson Refuge.
UC researchers (Cooperative Extension Specialists and AES faculty) tested the effectiveness of wetlands in cleaning selenium out of agricultural drainage water, building 10 separate wetland ponds in the Central Valley. Research determined that most of the selenium was captured in the sediment of the wetland, with only 5 percent accumulating in plant tissue. Researchers also found that almost half of the selenium volatilized in one summer month, effectively removing it from the system.

Impact: Use of wetland systems to remove selenium has proven to be an efficient and affordable wastewater remediation process. Increased use of the wetlands in the Central Valley has contributed to a significant reduction if selenium in free and ground water.

Funding Source: Hatch, Smith Lever and State
Scope of Impact: State Specific

Key Theme: 4.23 Water Quality
Title: Tomales Bay Water Quality Project

Description: During winter storms, fecal bacteria levels within Tomales Bay are above water quality standards for shellfish harvesting areas. The San Francisco Bay Regional Water Quality Control Board is overseeing the Tomales Bay Shellfish Technical Advisory Committee and implementing a Pathogen Total Maximum Daily Load with the aim of reducing the number of closure days for harvesting at shellfish leases. Agricultural lands were identified as one of the sources for this bacteria loading. To assist with the water quality efforts, a UC team implemented a systems approach study of animal agriculture facilities. Water quality data has been collected from dairy, beef, and horse operations to identify and prioritize areas and land use practices that can reduce bacterial loading to the bay and its tributaries. Results from the past two winters (1999-01) have provided the data to confirm that 90% of

the potential fecal coliform is being contained by present manure management systems in place. Outside of these systems, lots and corrals, stockpiles, and smaller intensively managed pastures are sites of greatest potential fecal coliform loading to the Bay. Cooperators are implementing water quality management practices to improve water quality.

Impact: By providing water quality results to area dairy and ranch operators, these producers have been able to prioritize and implement water quality improving management practices in collaboration with other technical and financial assistance agencies. The State Water Resources Control Board approved a Proposition 13 funding request to support management practice implementation based on project results. Recently, four of the project cooperators were recognized by the San Francisco Bay Regional Water Quality Control Board for their efforts to implement appropriate practices and improve water quality on their ranches and dairies. This ongoing period of proactive solution implementation continues to stay threatened lawsuits against agriculture. The project research results and education efforts also serve as direction for the local watershed council, governments, and non-profit organizations working on natural resource conservation and agricultural viability thus contributing significantly to cost effective and beneficial planning and policy setting. As the Regional Water Quality Control Board TMDL standards are put into place this project and the collaborative processes it has brokered serves as a statewide model of cooperation and problem solving.

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

Key Theme: 4.26 Wildfire Science and Management
Title: The Tunnel Incident - Oakland 1991 - Ten years after - After action report

Description: The 1991 Tunnel fire in Alameda County caused the largest residential loss from wildfire in both the state and the nation. 47% of the residences destroyed in California by major wildfires have been located within the community boundaries. In the early 1900s large dense plantations of pine and eucalyptus were introduced to many wildland areas changing fuel types and hazard levels. Many formerly grazed grasslands have been encroached by more flammable brush stands. In addition to wildland hazards, homeowners have landscaped their property introducing more fuel and wider vegetation types next to homes. In the fall of 1991, shortly after the Tunnel fire the Hills Emergency Forum (HEF) was established to develop a sustainable framework to achieve both short and long term fire mitigation improvements in the Oakland/Berkeley Hills. In 1999 the HEF requested a Ten years after - After action report. The California Department of Forestry and Fire Protection (CDF) was invited to be the lead agency and join with the Governor's Office of Emergency Services (OES) and a representative of the University of California Forest Products laboratory to accomplish this review. This report focused on the recommendations made in the original report by OES titled "The Oakland Hills Fire - A multi Agency Review of the October 1991 Fire in the Oakland/Berkeley Hills" dated February 27,1992. The original report was organized in sections that addressed firefighting, training, preparedness, mop-up, demobilization, public information, law enforcement and emergency management operations. Each of the HEF member agencies was provided a list of the original recommendations as questions to determine the changes in the past ten-years. The report is based primarily on the responses given by each HEF member agency. The results were divided into Accomplishments and Opportunities. Each of the aforementioned sections of the report

compared the original 1992 findings with the 1999 responses. A substantial amount of follow-up was required to specifically quantify the results. An example of this was: At the time of the 1991 fire the City of Oakland had pipe threads on it's fire hydrants. Most Fire agencies, other than Oakland, had previously switched to National Standard threads (NST). As a result non-Oakland Fire Apparatus responding to the Tunnel Fire were unable to draw water from the fire hydrants. Discussions with the East Bay Municipal Utilities District (EBMUD) and the City of Oakland revealed the EBMUD had completed the change over of all 6500 hydrants in Oakland to NST in July 1998.

Impact: The impact of the specific comparisons between the 1992 and 1999 reviews allowed HEF member agency representatives and the general public to assess the specific accomplishments and opportunities affecting fire mitigation in the Oakland/Berkeley Hills. Additionally the report motivated a number of existing local agencies and homeowner groups to intensify their efforts and strengthen the working relationships between community groups and individual property owners. One example of this is the Claremont Canyon Conservancy. 140 property owners in Claremont Canyon have assessed themselves $1,000.00 each to do hazard reduction in their fire prone canyon community. The After action report has proved to be a useful tool in identifying both accomplishments and opportunities for all interested stakeholders. Ultimately when the next catastrophic wildfire happens the loss of life and property will be reduced by untold millions of dollars there by benefiting both property owners and taxpayers.

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

Key Theme: 4.27 Wildlife Management
Title: Ecology and Conservation of Inland Fishes of California

Description: (1) The third year of study of the Cosumnes River watershed and floodplain was completed. We surveyed streams throughout the watershed for fish to establish monitoring stations for long-term studies and to gain an understanding of the patterns of fish distribution and abundance. A key finding was that much of the watershed had been invaded by alien redeye bass, a little-known fish. During the winter months we studied the use of the restored floodplain along the lower river by fishes demonstrating rapid growth by juvenile chinook salmon and extensive use by larvae and juveniles of native and non-native fishes. Additional information on the life history requirements of splittail, a listed species, was developed. These results are being compared to studies conducted on the Yolo By-pass, an artificial floodplain. (2) The study of Putah Creek, a regulated stream, continued, demonstrating the positive effects of enhanced flows on native fishes, including anadromous lampreys and salmon. (3) The final year of study of the fishes of the Navarro River watershed, a degraded watershed on the North Coast, revealed patterns of fish distribution and abundance related to patterns of land and water use. Coho salmon numbers were up slightly but continued to reflect the degraded condition of the watershed. (4) Year 23 of monthly fish sampling in Suisun Marsh was completed, with most fish continuing to be in relatively low abundance. An analysis of 22 years of data was completed and submitted for publication. Papers on the invasive shimofuri goby were also published. (5) Studies on brook trout invasions on Sierra Nevada waters continued, focusing on finding alternatives to poisoning to remove them from alpine lakes (where they eliminate native amphibians). (6) Studies on the status and life histories of Central Valley salmon and steelhead continue, including a study of the life history of steelhead in the Yuba River (being written). (7) The first in a series of papers analyzing patterns of fish invasions in California was published. (8) Final editing of Inland

Fishes of California was completed. This book should be the standard reference on California freshwater and estuarine fishes (to be published in early 2002). A "spin-off" of this book is an authoritative and up-to-date "official" list of the common and scientific names of inland fishes of California.

Impact: The information obtained from the Suisun Marsh and Cosumnes River studies is utilized by CALFED in setting priorities for research and restoration activities. In particular, new information on splittail was utilized to determine management strategies and studies on Chinook salmon status are the basis for restoration programs.

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

Key Theme: 4.27 Wildlife Management
Title: Population Biology and Population Genetics of Declining Amphibians in California

Description: My work in California examines the influence of agriculture and urban land use on native amphibians, particularly in the Central Valley. Major projects which are now complete include: 1) a large study of population genetic variation in the California Tiger Salamander, AMBYSTOMA CALIFORNIENSE, 2) completion of a phylogenetic analysis of the red-legged frog, RANA AURORA, demonstrating that a previously undescribed cryptic species exists in this taxon, 3) completion of a project on the metapopulation dynamics of the threatened California Tiger Salamander, 4) completion of a project on the effects of agrochemicals on 8 species of sensitive species of amphibians in the state. Our major results demonstrate that 1) amphibian populations are very differentiated, even in the relatively homogeneous Central Valley, and 2) that windborne agrochemicals may be having a major detrimental impact on amphibians. Two relevant publications were accepted during this review period, several talks at major universities were given, and two major grants were funded based on this work.

Impact: Our work on population genetics continued to define management units of several sensitive species of amphibians, guiding resource agencies on conservation prioritization decisions. Our work with pesticides on amphibian populations demonstrated that agrochemicals can profoundly influence amphibian populations, information that is being utilized to develop policies on agrochemical effects on wildlife.

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

Key Theme: 4.27 Wildlife Management
Title: Population Models For Improving Management of Ground Squirrels in California

Description: Several populations of California ground squirrels were identified for demographic study. All individuals of one population were trapped and fitted with radio collars to collect information on home range. This same population was then subjected to a baiting procedure (using bait stations) and the control effectiveness measured. Other baiting strategies (broadcast baiting, spot

baiting) and the effect of reducing the concentration and amount of poison bait applied on control efficacy were tested at another 4 sites. The effectiveness of a burrow exploding device on ground squirrel control was also tested. Populations at these sites will be re-assessed in 2002 to determine the resiliency of ground squirrel populations to the control procedure. Results will provide the basis for modeling the long-term effects of control on squirrel populations.

Impact: This project has provided much needed information on the effectiveness of various baiting strategies for short-term control of ground squirrel populations. Results suggest that squirrel populations can be effectively controlled using much less anticoagulant bait (20% of that currently used) than currently recommended on the label. Reducing the amount of bait applied will minimize the potential for non-target poisoning.

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

Key Theme: 4.28 Yard Waste/Composting
Title: Pilot Mid-Scale Vermicomposting Units as a Technology for Food Waste Reduction

Description: In December 2001 San Jose was still above compliance with the ordinance imposed by Assembly Bill 939, because it is diverting 53% of its waste from landfills. About 35% of the waste that still goes to the landfills is food waste, organic in nature. Composting became the most popular choice of environmentally sound waste management. Vermicompost is a process of composting using worms. Worm castings are the final product of vermicomposting. The objectives for this research project are: A) Built an operational vermicomposting windrows under shed (greenhouse); B) Handle and process vegetable and fruit waste; C) Demonstrate Mid to Large Scale Vermicomposting as a valid food waste reduction mechanism; D) Provide training in vermicomposting process; E) Maintain a continual demonstration site for the vermicomposting techniques; F) Report on the quality of the vermicompost produced. A team of California advisors built four vermicomposting windrows, 24 ft. long by 6 ft. wide under an old (non-operational) greenhouse at a UC Research and Extension Center. They have been operating since March 1999 to date; we sent samples to ANR Analytical Lab and to an independent laboratory that can further analyze composts (Soil Web Lab). Parameters required for vermicompost analysis are C:N ratio, organic fractions, moisture holding capacity, growth promoting substances and total microbial count. The research data to evaluate are vermicompost quality, conversion rate and yield. 1999, 2000 and 2001 Vermicompost Field Days with a full 5 hr agenda including speakers, field displays and hands-on workshop on vermicompost harvesting. We conducted training sessions with Master Composters, BAREC staff, Master Gardeners, composters from the area, school kids, and general public. Partial reports have been posted at our sponsor's web site: www.urbancompost.com. We harvested three batches of vermicompost a year, yielding about half a ton each, of nice good quality vermicompost. Laboratory results supported our assumption about the excellent vermicompost quality, and the California Compost Council gave the highest grade to our annual samples.

Impact: We created a permanent educational and demonstrational small to medium scale vermicompost unit, where children K-6 age, high school and college (San Jose State University) students, Master Gardeners and Master Composters trainees, public agency representatives, and the

general public can get information and training on an exceptionally simplistic technology for food waste reduction. Two local restaurant chefs have adopted with slight modifications, our technology to dispose their restaurant's food waste appropriately. This is a project with obvious environmental enhancement potential.

Funding Source: Smith-Lever 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. The downturn in the economy has resulted in loss of jobs and reduced opportunities for individuals and families to improve their well-being. Economic pressures within California and the nation continue to impact the ability of families and individuals to maintain self-sufficiency.

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: emerging models for positive youth development, land use conflict at the ag-urban interface, supporting elders, out-of-school programming, healthy child development, and life-skills education.

Work during this past year has resulted in improvement in the quality of after-school programs, increased knowledge about the characteristics necessary to create supportive environments—places that are responsive to the emotional and social development of adolescents; improved academic achievement for students; improved attitudes about school achievement by children, parents, teachers and the community; increased amount of homework turned in on time; positive effects on youths' stewardship of the property and landscape where they live; identifying factors that influence adolescent suicide behaviors; having students consistently grow in their knowledge about the natural world; knowledge that agricultural workers suffer from higher rates of high serum cholesterol, high blood pressure and obesity than is found in the general population; increased knowledge about new welfare reform school attendance policies; the documentation of specific barriers within agencies that directly affect program implementation; community club leaders who are better able to deal with questions and conflicts that arise in the 4-H program; knowledge that children's development of conflict resolution strategies appear related to maternal employment factors of physical availability and children's sense of safety at home; lower costs to schools as more children are ready to learn; significant positive change in teens interview performance; improved wildland fire fighter protective clothing that will help them perform their jobs more efficiently and safely; a program that helped teen grow in their ability to work with younger children; improved public speaking and organizational skills for teens; knowledge that inquiry-based training improves teens daily lives by developing their questioning skills; and increases in teen interest in science.

CE advisors delivered 190 local extension programs in this area. In addition, 13 statewide collaborative workgroups composed of both AES and CE academics planned and conducted research and extension projects. California academics published 21 peer-reviewed articles and 5 extension publications to address Goal 5 last year.

FY 2001-2002 Allocated Resources

Extension Federal Funds (Smith Lever 3 b&c)	Extension State Match	Research Federal Funds (Hatch)	Research State Match
$1,111,844	$5,735,638 [50.49 FTE]	$133,415	$3,647,367 [13.95 FTE]

UC-ANR's Human Resources Programs Covering:

- **Human and Community Development**
- **Economically Viable Families and Communities**

HUMAN AND COMMUNITY DEVELOPMENT

UC-ANR focused its research and extension resources on the need to create supportive environments in which culturally diverse youth and adults can reach their fullest potential and to strengthen the capacities of families and individuals for self-sufficiency and well-being by improving life skills.

Research and Extension Performance Goals

- Improve the capacity of targeted communities to provide integrated approaches to support healthy youth development that involve youth, families, and community members, and provide training and technical assistance to family, youth, and community professionals.
- Develop and implement programs that teach and demonstrate collaboration building. Improve understanding of multicultural and diversity issues by providing youth and family service agencies with training and technical assistance in issues of diversity and promoting tolerance. Research the parenting practices of California's minority populations to develop and disseminate more culturally appropriate parent education materials.
- Developing and extending curricula on youth career decision making, workforce preparation and entrepreneurship experience to youth agencies in order to prepare youth for an employable future. Generate new knowledge about workforce preparation strategies by conducting comparative studies.

ECONOMICALLY VIABLE FAMILIES AND COMMUNITIES

UC-ANR focused its research and extension resources on the need to improve the capacity of consumers to efficiently use economic and personal resources and strengthen the capacity of communities, families and individuals to create and maintain sustainable economic growth.

Research and Extension Performance Goals

- Develop, test and institute effective educational programs on topics related to economic health: consumer choices, personal and family resources management, employment readiness and training, transition from welfare to work, etc.
- Develop, test, and institute effective economic education outreach models for building community coalitions with emphasis on economic self_sufficiency of individuals and economic development for communities.
- Conduct community level research on the effects of economic changes and decisions on communities and households.

- Perform evaluation research on economic programs that demonstrate effective results for potential creation of economic development models. Develop a "best practices" approach for replication of models that work.

Key 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. Our hypothesis 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. We are studying semantic memory in AD compared to normal aging, with five different experimental tasks (which vary in the degree to which attention- and/or strategy-based skills are required) and with eight different semantic domains (e.g., animals, tools). Thus far, we have data on all 40 combinations of task and domain for 21 AD, 30 elderly control, and 30 young control subjects. We also have partial data on an additional 30 AD subjects. Pathfinder network and multi-dimensional scaling analyses are employed. Our preliminary analyses indicate that all of the following effect the degree to which AD individuals show normal versus abnormal semantic memory organization: type of task, semantic domain (more coherent/structured domains are less likely to show group differences than less structured domains), and the presence of highly associated pairs or triplets within a domain. The general finding, however, is that semantic memory organization is far more preserved in AD than previously believed.

Impact: All cognitive abilities are dependent upon the access and utilization of world knowledge (semantic memory). Thus, a viable model of AD cognition must take semantic memory functioning into account. These findings are highly relevant to the assessment, treatment, and management of AD (which affects approximately 8% of all individuals over 65 years of age).

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

Key Theme: 5.01 Agricultural Financial Management
Title: Changes in Lending Criteria, Alternative Financial Institutions, and Farmers' Access To Credit

Description: The objectives of this project are to characterize changes in access to capital for agriculture from equity lending to lending on the basis of expected income, risk, and reputation (California) and joint liability and social collateral (Latin America); to identify the consequences of these changes for efficiency, equity, and farmers' welfare; and to propose alternative institutional technologies for enhanced lender, borrower, and social benefits. We have conducted with FINCA International, a major micro-finance lender to the poor, a pilot program of innovations in Uganda. The two innovations that were initiated by FINCA Uganda are a flexibility program which gives clients greater control over the terms and timing of their loans, and secondly a health insurance package which was bundled into the lending product. The program implementation has been designed as a

quasi experiment to allow for impact analysis. The database gave the opportunity for an analysis of the current situation of repayment in FINCA, a report that has been submitted to FINCA after the fieldwork. A second paper analysed the innovations. The second axis of research has been to develop an understanding of the problem of competition among micro-finance institutions. This is motivated by our observation in Uganda that the competition pressure hurt the social oriented micro-finances which are trying to reach the poorest segment of the population but need the less poor.

Impact: Regarding the FINCA program, we found that there generally is a tradeoff between the goals of achieving financial sustainability and the reaching of poor clients. Exceptions are women with numerous children and large numbers of non-working adults in the household. Large groups are surprisingly successful, and the average client is paying for the education of 13% more children than she herself has. Our analysis introduces a technique for conducting impact analysis in the presence of spatial shocks which occurred during the test and which were imperfectly observed. The Flexibility program is found to be effective, both in terms of decreasing dropout and in making lending more profitable, while the Health Insurance program attracts 'bad' clients and has perverse effects on the borrowing behavior of current clients. In our analysis of the competition, we show that, because of their unusual objectives, competition between lenders can have negative effects on the most vulnerable clients. In particular, decreased ability of MFIs to cross-subsidize poor lenders with profits from rich ones is likely to mean that the poorest clients are hurt by new entrants to the market. Also, the breakdown in the dynamic repayment incentives caused by multiple lenders under imperfect information means that impatient clients are likely to take larger risks with more lenders in the market, meaning that the most patient clients are left paying higher interest rates for the same loans.

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

Key Theme: 5.04 Child Care/Dependent Care
Title: 4-H Afterschool Child Care Programs in Placer and Nevada Counties

Description: Patterns of family life in the U.S. have changed dramatically. In more and more families with children in the elementary and middle schools, both parents (and single parents) participate in the workforce. Increasing numbers of children in kindergarten through eighth grade are unsupervised during non-school hours - often for three or more hours each day. Concerns continue over the lost opportunities and the risks (physical, mental health, safety) often experienced by unsupervised children. Quality after- school programs provide support to families and to children's positive youth development.

In 1983, work began on the needs of unsupervised children, then referred to as 'latchkey children.' What is believed to be the first 4-H operated school-age child care programs in the nation was established. These programs (18) continue to operate in Placer and Nevada counties as UC support group affiliates. The administrative offices are housed in our CE offices. CE provides program oversight and training to the board of directors and program administrators, but no longer provide day-to-day management to the programs.

A research article was written and published on work done during this project:

Junge, S., Johns P., George J., Conklin-Ginop E., and I. Valdez. (2000).The Effects of School-age Child Care in Northern California on Parents' Stress and Job Productivity. In M. Braverman, R. Carlos, and S. Stanley (Eds.) *Advances in Youth Development Programming*. 4-H Center for Youth Development. Division of Agriculture and Natural Resources. University of California, Davis.

Impact:

Program Demographics

Year	Hours of Care	Subsidized Care	Number of Children
1998/1999	300,058	310,635	1,171
1999/2000	303,198	346,966	1,722
2000/2001	336,472	300,813	1,263
Totals	*939,728 hrs*	*958,414 hrs*	*4,156 children*

As a result of the program, over 1.8 million hours of quality care were provided to over 4,000 youth in Placer and Nevada counties at 18 locations. The program also provides employment for over 65 staff and allows hundreds of parents to work more effectively knowing their children are well cared for in a quality-learning environment. Evaluations have shown that school principals report reduced vandalism on their campuses because of the 4-H ACCP. Classroom teachers report improved homework skills, as well as less fighting and improved conflict resolution skills. Parents indicate that they have less stress and that they perform better at work knowing their children are in quality care.

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

Key Theme: 5.04 Child Care/Dependent Care
Title: Community Agency Learning Series (Afterschool Programs) 1997 - current

Description: In 1997, a team of Youth Development Advisors formed a workgroup and agreed to share their expertise across county lines to offer an array of professional development workshops to staff and volunteers who work with youth in afterschool programs. This program offers 17 workshops related to youth development theory, youth development program management, and curricula for youth. The workshops are based on the latest research information in these areas and designed to improve the quality of afterschool programs.

Impact: The team has trained more than 800 youth development professionals. If they work, on an average with 10 children, our instruction has improved the quality of after-school programs for more than 8,000 children.

Each of the workshops was evaluated using a retrospective pre and post-test. For example, the results from a workshop on program evaluation indicated of the 28 participants, 27 (96%) indicated growth in at least one of the following areas.

	Pretty well	Very well	Improved
Understand the potential value of evaluating parent education programs.	21%	68%	68%
Understand the advantages and limitations of surveys, interviews, and observation for evaluating programs.	43%	57%	86%
Have ideas about when written surveys, interviews and observations are most appropriate.	46%	50%	85%
Have a rough plan for how I might evaluate my program	53%	47%	89%

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

Key Theme: 5.05 Children, Youth, and Families at Risk
Title: Risk and Protective Factors in Behavioral and Emotional Problems Among Rural Adolescents

Description: The objectives of this project are to: A. identify specific pubertal elements (e.g., pubertal status, maturational timing, maturational tempo, etc.) that adversely affect adolescent emotional problems; B. Examine the social contextual factors that may interact with pubertal transitions in leading to chronic behavioral and emotional problems and identify early pathogenic processes and familial and community conditions that either amplify or attenuate the potential for pathological continuities and changes; C. Test hypotheses regarding the processes whereby puberty, family processes, and community characteristics combine to exert influences on the occurrence of behavioral and emotional problems among rural adolescents; and D. Explore similarities and differences between Euro-American and Afro-American adolescents in risk factors that render them vulnerable to problem conditions and in protective factors that may buffer them against the adverse impact of these two developmental domains on their lives.

Since 2000, several projects have been completed. These include (1) a multi-ethnic, national study on the effect of pubertal transition on overweight perceptions and adolescent adjustment; (2) a large-scale study of the effect of pubertal transition on internalizing and externalizing behavior problems among African American children; and (3) a study on factors that predict persistent criminal offending among males who were incarcerated at CYA. In the first study with national data, we found that pubertal transition affects adolescents' perception of their weight changes which, in turn, influences their levels of depression, somatic problems, and self-esteem. The second study was based on data collected from approximately 900 African American children and their families. This study was the first to show that early physical maturation is related to every single categories of psychopathologies assessed among African American children. The third study showed that lower cognitive ability and early family environment are significantly associated with earlier onset of delinquency and criminal activities, which forecast the chronic criminal offending during the next 20 years of follow-up.

Impact: All papers listed are (will be) published by peer-reviewed journals. Social Psychology Quarterly is an official journal of American Sociological Association. Through widespread readership, these findings will have a very significant impact on our understanding of adolescent emotional and behavioral development and of the effect of adolescent biological changes.

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

Key Theme: 5.05 Children, Youth, and Families at Risk
Title: Building Youth Resiliency Through Environmental Design

Description: Project objectives were to : a.) determine the relationship of the physical environment to resiliency-inducing environments; b.) establish a typology of physical design characteristics which contribute to resiliency-producing environments; c). develop methods and policies for use by communities and designers for evaluating and improving the physical environments to produce more resiliency-inducing places. This report follows the 5th year of this project and the following comments summarize the accomplishments of the project over its duration. The project has focused on adolescents in the landscape and has included examination into three primary areas: the cultural context, the physical environment, and design processes. The following paragraphs briefly describe the project results in each of these areas. This examination included an analysis of the population demographics of the United States, particularly how population shifts (ethnicity and age) will effect the environments where adolescents live and where designers will work. The results were presented at several professional meetings and in an article published in American Society of Landscape Architects (ASLA) Annual Meeting Proceedings. A comparative study of two decades, 1950s and 1980s, examined popular press reporting of teen-related issues, design responses, and public policies. This article was published in Landscape and Urban Planning and was the start of a more in-depth study of the public policies affecting adolescents' use of places. It was found that several policies that restrict the use of public areas by adolescents have recently increased in popularity. The impact of these restrictions on adolescents' use of public places and on their emotional and social development was reported in several interim articles and in publication #2 listed below. Understanding adolescent preferences for particular environments was an important component of this project. The researcher conducted significant research prior to this project, but two additional studies were undertaken. The first, a study of teens in a rural community in West Virginia, included documenting the places important to these teens and also presented an in-depth comparison of other previous teen preference studies. The second, a study of community skateboard parks, examined the role these parks play in communities and with the skaters. This article was published in Urban Geography. Design Processes. An important component of the work of a design researcher is understanding how the information can be incorporated into design. This project included an examination of techniques to include youth in design decision-making. Through various community-based projects, several techniques for youth participation were identified. A review of these strategies was presented at conferences in Japan and Scotland. In addition, a workshop with teens was conducted to explore their desires for a community park and to evaluate the participation strategies. A video documenting this project was presented at a national professional conference and an international multi-disciplinary conference - the results were also published in the conference proceedings.

Impact: Designers will more fully understand the role the physical environment plays for adolescents and thereby understand the characteristics necessary to create a supportive environment - places that are responsive to the emotional and social development of adolescents. These changes are likely to have a long-term effect on the individuals and ultimately to the society in general.

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

Key Theme: 5.05 Children, Youth, and Families at Risk
Title: E.R. Taylor School Healthy Start Collaborative and Research and Evaluation 1993- current

Description: Integrated health and support services to support low-income families living in high-risk environments involve bringing multiple social support services for children and their families to school sites. It is part of a national movement toward using schools as the hub to improve access and use of community support services. In California, integration of health and human services is supported by the Healthy Start Program, Senate Bill 620, that was enacted in 1992. Intuitively sensible, these programs are also grounded in ecological models of human development that suggest that support for children and families must include the multiple milieus of the human environment.

The objective of this research was to examine how the Healthy Start Program at E.R. Taylor School affected the low-income families who participated in the program. Also considered was the context of this program including the community, school, service providers, school personnel, and program staff. This study was supported by a $16,000 State Critical Applied Research grant. Qualitative research methods were used including extensive participant observations and informal interviews with various stakeholders, eighteen in-depth interviews with parents, and three focus group interviews with service providers and school personnel.

The findings from this research were disseminated by various professional venues including international venues such as the 1997 Independent Sector and the 1999 Qualitative Research Conference and national and state venues such as inclusion in the Harvard Family Resource Center and the 4-H Center book, Advances in Youth Development as well as regional conferences.

This research suggested that researchers and practitioners have focused too much on program theories and models. Too little attention has been paid to the context in which programs operate, specifically to the community and school, to the characteristics of the children and families that a program serves, and, probably most important, to the people who conduct the programs. The question of what kind of intervention is less relevant than who is conducting the intervention and for whom.

Impacts: The Healthy Start Collaborative led to significant additional resources for this E.R. Taylor School community. The Family Connections Family Resource Center, a community center offering additional support services, was founded through a $425,000 grant. After the initial grant, Family Connections is being sustained through City and County funds as well as other grants.

Funding Source: State Critical Applied Research grant, State, City and County funds, and Smith-Lever
Scope of Impact: County Specific

Key Theme: 5.05 Children, Youth, and Families at Risk
Title: College Bound

Description: The College Bound program is one of three community-based projects that were developed as part of California's statewide project, "Strengthening the Futures of California Families." This five-year project (1997-2002) was funded with a grant to the 4-H Center for Youth Development at UC Davis by USDA/CSREES through its Children, Youth, and Families at Risk (CYFAR) Initiative. Participating counties were Glenn, San Francisco, and Santa Barbara. Each county developed a unique project for high-risk youth and their families based on local partnerships and local needs. College Bound serves youth and their families in San Francisco's Portola district. ANR's major partners in implementing College Bound are the E.R. Taylor Elementary School and the Family Connections community resource center.

Program collaborators focus on helping families support their children in achieving academic skills and work to create a community with a shared vision of college as an aspiration for youth. The program conducts numerous activities for children and parents in the Portola community, including: (a) monthly parent education workshops that focus on the importance of early college readiness, educational standards, and academic expectations, (b) an annual college readiness fair at E.R. Taylor School, (c) "I'm Going to College" days for 4th and 5th graders that include visits to the campuses of UC Berkeley and San Francisco State University, (d) support groups for teens at the Family Connections Center which focus on life skills and career exploration, and (e) a Summer Family College program that provides summer classes at a local junior college and serves up to 50 parents and 80 children annually.

UC Cooperative Extension, E.R. Taylor School, and the Family Connections Center contribute staff time to College Bound. The program hired a College Bound Coordinator and a small number of parents to assist with liaison work for outreach, registration and classroom assistance, as well as providing child care so that parents could attend workshops.

Impact: Improved academic achievement for students. Improved attitudes about school achievement by children, parents, teaches and the community. Increased levels of positive parent/child interactions. Students, parents, and teachers gained a better understanding of college prerequisites.

Funding Source: State, Smith-Lever, CYFAR Initiative, the Richard and Rhoda Goldman Fund, the Louise and Claude Rosenberg Jr. Foundation, the Morris Stulsaft Foundation, the San Francisco Foundation, the Morrison and Forester Foundation, the San Francisco Unified School District, and San Francisco State University.
Scope of Impact: State Specific

Key Theme: 5.05 Children, Youth, and Families at Risk
Title: The Orland 4-H Afterschool Project

Description: The Orland 4-H Afterschool Project is one of three community-based projects that were developed as part of California's statewide project, "Strengthening the Futures of California Families." This five-year project (1997-2002) was funded with a grant to the 4-H Center for Youth Development at UC Davis by USDA/CSREES through its Children, Youth, and Families at Risk (CYFAR) Initiative. Participating counties were Glenn, San Francisco, and Santa Barbara. Each county developed a unique project for high-risk youth and their families based on local partnerships and local

needs. The Orland 4-H Afterschool Project serves students and parents in the communities of Orland and Hamilton City through providing educational opportunities and promoting supportive parent-child interactions. ANR's partners in the project include the Orland Unified School District, the North Valley 4-H Afterschool Child Care Program, the Glenn County 4-H Council, the City of Orland Parks and Recreation Dept., the Glenn County Migrant Education program, and other organizations.

The Homework Club is a homework assistance program offered at Fairview Elementary School for 3rd-5th graders four days per week. Students are referred by their teachers and their participation becomes part of students' individual student plans. Teachers provide feedback on the students' progress and take part in teacher-parent-staff conferences. Over 60 children have participated each year. Parents and siblings of the Homework Club participants are also invited to attend monthly family activities. The Thursday Club is an additional activity that provides enrichment later in the afternoon and/or in the evenings for all children in the community. The program has used curricula such as Animal Ambassadors, which deals with science inquiry skills, and the Mini Society program, which deals with business and entrepreneurship.

Impact: Students' classroom teachers reported that the program had a strong impact on the amount of homework participants turned in (e.g., a 33% increase in the number of students turning in homework all of the time) and was a contributing factor to improved performance and personal growth. Parents reported that their children's participation resulted in less arguing at home over homework and allowed for more quality time in the evening for the family. The project demonstrates that a homework assistance program can help level the academic playing field for disadvantaged children and can be a valuable intervention for children and families.

Funding Sources: State, Smith-Lever, CYFAR Initiative, the Orland Unified Elementary School District, the North Valley 4-H Afterschool Child Care Program, Glenn County 4-H Council, the Migrant Education program, the Glenn County Human Resources Agency, the Hamilton Unified School District, the Kaufmann Foundation and the Honda Foundation.
Scope of Impact: County Specific

Key Theme: 5.05 Children, Youth, and Families at Risk
Title: The Neighborhood GreenNet Project

Description: The Neighborhood GreenNet Project (or El Red Verde del Vecindad) is one of three community-based projects that were developed as part of California's statewide project, "Strengthening the Futures of California Families." This five-year project (1997-2002) was funded with a grant to the 4-H Center for Youth Development at UC Davis by USDA/CSREES through its Children, Youth, and Families at Risk (CYFAR) Initiative. Participating counties were Glenn, San Francisco, and Santa Barbara. Each county developed a unique project for high-risk youth and their families based on local partnerships and local needs. The Neighborhood GreenNet Project is a collaborative project aimed at engaging low-income families, especially their children, to participate in horticultural (green) education projects and horticulture-based small business startups. ANR's partners in the project include the Housing Authority of the City of Santa Barbara, Santa Barbara High School

and the Family Services Agency. The project serves families residing in public housing in the city of Santa Barbara.

The main components of the GreenNet program are computer education and gardening classes for the participating children. In keeping with CYFAR's technology emphasis, GreenNet has included the use of cutting-edge computer technology, providing participants access to Web-based sources of information, organizing and planning tools, and networking capabilities. GreenNet has also provided employment and mentoring opportunities to local teens who serve as paid project staff. The teen staff help mentor and teach the project's young participants, who range in age from 5 to 12. GreenNet participants develop community-based environmental projects including, for example, two native plant nurseries for local restoration projects. Since 1997 GreenNet has involved over 550 youth and 350 public housing resident families.

Impact: GreenNet participants reported increases in their work skills and self-confidence. Local agency contacts reported that GreenNet had an overall positive effect on inter-family communications. In addition, several of the teen participants have gone on to pursue college education and have chosen to major in business, technology, science, or science-related fields. The program also has had an unanticipated positive effect on youths' stewardship of the property and landscape where they lived.

Funding Source: State, Smith-Lever, CYFAR Initiative, the Housing Authority of the City of Santa Barbara (HACSB)
Scope of Impact: County Specific

Key Theme: 5.05 Children, Youth, and Families at Risk
Title: Our Kids Project: Key Findings Series and Public Policy

Description: This research project began with a meeting between representatives of the Interagency Child Policy Council and the University of California Cooperative Extension. Over the next 6 months, representatives from Oakland Unified School District (OUSD), a County Supervisor, Safe Passages, local school principals, and other public agencies were involved in the planning and the implementation of the project. A preliminary report was submitted in July 2000. Based on community feedback, data was analyzed and reports created that address local issues.

The planning meetings generated the following goals:

- To ascertain areas where County Services can link with schools in addressing the needs of school aged youth.

- To identify who the kids are that are "falling through the cracks" or "vulnerable". Further, for these groups, we plan to determine what their needs are and how we can better serve these groups of youth.

A research project focusing on the City of Oakland was designed to use both qualitative and quantitative methods and to use multiple sources of information (e.g., youth, parent, teachers). We also gathered information that would be comparable to national studies (e.g., youth risk behavior survey),

and useful to both the county and local schools. Therefore, the final research project was comprised of a youth survey, parent survey/interviews, teacher survey/interviews, and a community resource mapping.

Impact: The first of the key findings series, focusing on "Factors that Influence Adolescent Suicide Behaviors" was distributed to 58 local collaborators. This brief was motivated by the disturbing survey finding that about 21% or 256 out of 1232 students reported making a plan for suicide.

A major impact of this study was to help focus the Oakland "Safe Passages" initiative. During this period, the Robert Wood Johnson Foundation required "Safe Passages" to come up with a plan based on research data. This research provided the basis for the "Safe Passages" youth violence prevention plan. UCCE academic staff worked with a WestED contractor to create their plan and secure the 7 million dollar funding from Robert Wood Johnson foundation. In addition, the first key findings series was used to argue for increased mental health services in the 3 targeted Oakland middle schools. A presentation of the findings at the 2001 APA gathered local and national media attention (e.g., KPIX Ch. 5, San Jose Mercury News, PBS). Evidently, this is one of a few studies that ascertained factors influencing the mental health of minority youth.

Funding Source: State, Alameda County Health Care Services, and Smith-Lever
Scope of Impact: County Specific

Key Theme: 5.05 Children, Youth, and Families at Risk
Title: Knights Landing Youth Development Projects, 1998-present

Description: Knights Landing is a typical small town with one elementary school and no junior high or high school. Youth, primarily Latino, enjoy a supportive atmosphere in their early years of schooling but then experience alienation and other negative side effects of being bussed to a nearby city for junior high and high school. In 1998, there were no established youth programs to be found in this town where poverty, lack of health insurance, and lack of general services and transportation are all common problems. This project's objective is to address community needs for youth services. The work was supported by a California Communities Program grant for $4,000 and was conducted through collaboration with a UCCE Specialist in Community Development who is the Principal Investigator on related projects. A Healthy Start Coordinator was hired during the course of this project and became a collaborator, capitalizing on the community activity that had resulted from UCCE initiatives.

In 1999, a bilingual researcher was hired to develop a relationship with community members interested in supporting youth development programs and to research the impacts and side effects of university-community partnerships in the context of Knights Landing in order to inform our practice for the next phase of the project. Informal youth development programs were coordinated by the intern and a teacher at the school in 1999-2000. As we transitioned the intern out of the field, a 4-H club was chartered. Community members who were by then familiar with our work became leaders of the 4-H club. The new 4-H youth development volunteers are supported by 4-H youth and adult volunteers from other parts of the county.

Impact: Youth in Knights Landing are now provided opportunities to participate in youth development programs supported by the University of California that did not exist in previous years. Also, additional sources of funding for programs that support child welfare and community development have been acquired thanks to the capacity of community members to leverage resources that the University has brought into this community and because of our success at transferring ownership to the local population.

A 4-H club program was established in 2000 with 21 youth and 5 adults from the local community. All of the adult volunteers and most of the youth were Hispanic. A Healthy Start Grant was awarded to the local elementary school in 2001 with 4-H as a collaborating partner. A University-Schools Partnership Grant (from the UC Office of the President) including a section on youth development to build on the work discussed above was accepted for 2001-2003. In 2003, a 4-H after school program was started to serve 35 elementary school children who are not yet members of 4-H.

Founding Source: State, California Communities Program, and Smith-Lever
Scope of Impact: County Specific

Key Theme: 5.05 Children, Youth and Families At Risk
Title: On the Wild Side

Description: On the Wild Side is a collaborative project that brought community resources into after school programs to enhance environmental education and expose children to the natural world. Teen and adult volunteers worked in partnership to plan and deliver overnight camping experiences to children from low-income communities. The program goals included:

- Expanded knowledge of the natural world and systems within it.
- The development of an enthusiasm for nature and outdoor living experiences.
- An appreciation for the importance of conservation and environmental stewardship.
- A fun, positive experience with peers and staff in the outdoor setting.
- Teens increased awareness of the value and importance of civic engagement.
- Teens increased skills and confidence in program planning and delivery.

Impact: Having collected data for three years, including pre and post-test scores from young participants, we see that students participating in On the Wild Side consistently grow in their knowledge about the natural world. Participants score significantly higher on their tests after attending On the Wild Side events. The children's journal entries reinforce the quantitative data and speak to the rich learning that takes place. Over 90% of participants rated their experience very good or excellent. Seventy percent of teens who taught last year returned to serve again, and all nine adults that served on the 2001 planning committee returned to plan the 2002 events, evidence of strong program support.

A powerful part of On the Wild Side is the teens who volunteer their time and energy to plan and run the events. Teens attend an eight-hour curricula training, three evening planning sessions, and a weekend retreat to prepare for their roles as teachers and leaders.

When one looks at program impact, it is important to look beyond the empirical data. Children and teenagers are learning and growing as they explore the natural world and take on new roles and responsibilities, but it doesn't take journals or test scores to realize the magic of On the Wild Side. You hear it from after school program staff who tell of the bonding such an experience creates. You see it in the tireless effort of the teenagers who diligently prepare, teach, coach and play. You feel it around the campfire with voices lifted in song, or in quiet moments when children are gazing at the stars. Often in our effort to quantify our findings, we neglect to share what we seem to know intrinsically: that a program has heart; that it is filled not just with learning and new experiences, but also with love and commitment.

After three years of extensive program evaluation, On the Wild Side has proven itself effective in teaching children and empowering teens; the larger research question now is why. There are many reasons. The program is orchestrated through a team of knowledgeable, caring, and committed adults. Teenagers are trained, coached, and thoroughly empowered to create and deliver a high-quality experience; their energy and presence is an essential element to learning and fun. The program incorporates proven, time-tested curricula. After school site staff, parents and children who haven't had an outdoor living experience know what to expect through pre-trip orientations. Repeated experiences for staff and participants simplify the learning curve from year to year. Everyone-teenagers, after school staff, adult volunteers, and children-feel a connection with each other. This bonding is a result of learning wrapped in fun, of excitement (and risk) involved in trying new things, and of sharing meals and stories and the stars at night.

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

Key Theme: 5.07 Community Development
Title: Rural Economic Development: Alternatives in the New Competitive Environment

Description: Project objectives were to 1) identify and analyze the demographic and socioeconomic implications of economic restructuring in nonmetropolitan areas, with special emphasis on labor market implications and how various ethnic groups are affected by policy and market change and 2) identify changing public policy initiatives and relationships and their impacts on rural economies and governments and investigate the effectiveness of alternative policy instruments to affect rural economic and fiscal viability and structure.

PIA: This project examined the impact of the California Prison Industry Authority (PIA) on both the economic regions in which it operates and on the state of California as a whole. The economic impacts of PIA on California are $230.1 million in sales, $142.4 million in income, and 3,000 jobs (including PIA employees). Purchases of inputs to PIA industries contribute much more to the sales impacts ($86.3 million) compared to personal services ($78.3 million), and facility and general operating

($65.4 million). However, in terms of impacts on jobs, personal services account for the most impacts (871 jobs, excluding 692 PIA employees), followed by inputs to PIA industries (730 jobs), and facility and general operating (707 jobs).

Waste Diversion: This project is the first attempt to estimate the economic impacts of the waste disposal and diversion system in California. The economic impacts from diversion and disposal at 1999 rates are 16-19% higher than the impacts if all the waste was disposed. The study also looked at the economic impacts in six regions of California. Waste diversion and disposal at 1999 rates have stimulated the regional economies more than if all the generation had gone to disposal-only in all regions but the Eastern California Region. The cost advantages for diverted materials come partly from the saving of landfill fees. The added positive impacts of diversion come from sales of the separated materials, their processing into feedstock, sales of energy for transformation and biomass products, and the value added in manufacturing that uses recycled feedstock. Typically, for every marginal ton of waste disposed in 1999, we estimate that $108 in total income impacts and $144 in value-added impacts would have been generated in the state economy. Whereas, for every marginal ton of waste diverted, $206 in total income impacts and $286 in value-added impacts would be generated.

Delta Project: The report estimates the impacts of recreational expenditures (boating and fishing) on the Delta region economy. The total boating expenditures of $247 million generate $445 million in total output, $183 million in income, $279 million in value added, and 8,058 jobs within the Delta region. For fishing, expenditures of $186 million generate $336 million in total output, $138 million in income, $209 in value-added, and 6,152 jobs. These values represent 1.7 percent of total Delta income and 3.2 percent of employment in the Delta for boating recreation. Fishing recreation impacts represent 1.3 percent of total Delta income and 2.5 percent of employment.

Impact: PIA: The PIA report demonstrates the positive economic impacts that this controversial program has upon the rest of the state. This should be useful to state policymakers and state agencies. Waste Disposal: this project demonstrated the positive economic impact in California, and the regions of California, of diversion, as opposed to disposal, of waste material. This has important policy implications for diversion and recycling activities as the state tries to reach the legislative goal of a 50% reduction in landfill. Delta Project: This project estimated the economic impacts of recreation in the Delta. This should be useful to the Delta Protection Commission, which requested the study, as well as regional and statewide policy makers.

Funding Source: Hatch Multistate Research and State
Scope of Impact: AZ, CA, DE, GA, IA, IN, KY, MN, MO, NV, NYC, NH, NC, OH, OR, PA, RI, SC, UT, TX, VA, WA, WI, USDA/ERS/ED, CO, ND, ID

Key Theme: 5.07 Community Development
Title: Toward a Modified Rural Focus For California Planning and Design

Description: Population increases in rural areas threaten to destroy the very amenities which attracted people in the first place. This project recommends design solutions to new rural social arrangements. The purpose of this study is to develop new policy for rural homelessness. The project objectives are

to identify and analyze the demographic and socioeconomic implications of economic restructuring in nonmetropolitan areas, with special emphasis on labor market implications and how various ethnic groups are affected by policy and market changes and to identify changing public policy initiatives and relationships and their impacts on rural economies and governments and investigate the effectiveness of alternative policy instruments to affect rural economic and fiscal viability and structure. In 2001, the new Rural Versus Urban Differences Project worked in all the areas named in the original proposal. We continue our applied studies of the impacts of tourism on rural and urban communities. In this work we have shifted our focus from impacts on the tourist destination to the motivations and behaviors of tourists. Our primary concern has been the question of what will motivate tourists to travel as destinations become increasingly homogeneous and provide experiences not much different to what the tourists can do at or near home? We have also continued our studies of the contributions of new and innovative landscape design practices to community quality of life. This work has resulted in ongoing consulting relations with the Museum of Modern Art, and Yerba Buena Center for the Arts, both in San Francisco, and the Center for Land Use Interpretation in Los Angeles. We have worked actively with these institutions to shape curatorial choices, funding and display strategies, and textual explanations accompanying their exhibits of new landscape thinking. We have found that the most innovative thought in landscape architecture is being applied to neglected, marginal, out of the way places, to brownfields and former landfills for example. Finally, we have deepened our work on the causes and consequences of rural poverty and homelessness. The PI co-wrote over four million dollars in successful grants to supplement homeless services in Yolo, Sacramento, and San Joaquin Counties. In partnership with the counties and with support from foundations, we continue our work in an experimental residential facility for the most difficult cases of family homelessness in the region. We have established a continuum of care ("Aftercare") for families graduating from drug, housing, and job programs. We are currently setting up parenting classes for Lao, Hmong, Cambodian, Vietnamese, and Ukrainian families in Sacramento. We have also just completed a mental health service needs assessment for the Hmong people in Stockton. All of these programs have a research component for which the New Rural Versus Urban Differences Project has primary responsibility.

Impact: The work on tourism benefits rural and urban planners who must factor tourism into their policy and planning recommendations. It eventually benefits the communities tourists visit and the tourists themselves. The work on new directions in landscape architecture benefits architects, landscape architects, urban designers, park administrators, and museums. It eventually benefits residents of communities where new projects are contemplated, and visitors. The work on rural poverty is having an immediate measurable and positive impact on the lives of the rural poor in Yolo and nearby counties.

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

Key Theme: 5.07 Community Development
Title: The California Endowment CEO Task Force on Agricultural Workers Health, 2000-2001

Description: California's agricultural worker population numbers more than one million and accounts for nearly $30 billion of California's economy. Despite such contributions, 70 percent of these workers lack any form of health insurance and government-funded insurance programs, such as Healthy

Families; Medi-Cal covers only 7 percent of these workers, recommendations lay a new foundation to once and for all improve the health and living conditions of this important and valuable sector of California. The findings of a previous landmark study, "Suffering in Silence: A Report on the Health of California's Agricultural Workers," reveal that the vast majority of these workers are at serious risk for life-threatening chronic diseases caused by inadequate nutrition, and have little or no access to medical or dental care. This report, which was conducted by the California Institute for Rural Studies (CIRS), provides the most comprehensive health survey of agricultural workers completed to date.

The California Endowment (TCE) brought together experts in the field of agricultural worker health and convened this Task Force to develop recommendations for improving the health status of this population. This mandate of the task force was to develop specific programmatic and policy-related recommendations for The Endowment and others to consider.

The project required an extensive effort beyond our borders. The intent was to establish a collaborative and binational focus and linkage with the appropriate government agencies and communities in the United States and Mexico to jointly address the health needs of migrant agricultural workers. This project highlighted the nutrition and health concerns relative to farmworkers and their families. The PowerPoint presentation developed for "Suffering in Silence" was adapted into Spanish with additional slides which addressed preventative aspects for the nutrition related issues. The Spanish version of the PowerPoint slides is now used throughout the state in presentations.

Impact: Publication, "The Bounty of Food: The Poverty of Health," 2001, available at http://www.calendow.org/news/NewsReleases/2001/special/press082101/press082101.htm

The study found that more than one-fifth of male respondents had at least two of three risk factors for chronic disease. Agricultural workers suffer from higher rates of high serum cholesterol, high blood pressure and obesity than is found in the general population. Many of these workers also suffer from acute dental and vision problems. A large number reported never having visited a doctor. These findings will be addressed with the $50 million TCE has committed as a result of the task force findings.

Funding Source: State, The California Endowment, and Smith-Lever
Scope of Impact: State Specific

Key Theme: 5.07 Community Development
Title: Merced County Attendance Project (MerCAP)

Description: The idea for the Merced County Attendance Project (MerCAP) originated in community concern over the perceived high absenteeism rates among students whose families received welfare cash assistance. Undertaken to improve the school attendance of students receiving Temporary Assistance to Needy Families (TANF), the program used attendance monitoring, communication with parents, Corrective Action Plans, and a financial sanction to discourage excessive absences.

MerCAP operated as a demonstration program for three years from June 1997 to June 2000 under a waiver from the California Department of Social Services (CDSS). CDSS also required an evaluation

to test the assumptions and efficacy of the program. Beginning in the 1997-98 school year, schools entered the program in one of three successive yearly MerCAP cohorts, until 71 schools were implementing MerCAP in 1999-2000. At the close of the demonstration period approximately 7,100 TANF students in grades 1-10 were covered by MerCAP. MerCAP included all TANF school children ages 6 through 15, and excluded teens 16 and older. MerCAP's attendance requirement was no more than 10 unexcused absences in any school year. The program relied primarily on the threat of sanctions and did not provide special case management services to families whose children did not attend regularly. By the end of the three-year demonstration period MerCAP involved all schools in this largely rural county rather than a specially selected subset of schools.

Impact: On average, TANF students had slightly lower attendance than their non-TANF peers during all three years or MerCAP. However, the largest average difference for any year is only eight-tenths of one percent (.008), less than 2 days absence per child. In some schools TANF student attendance is higher than non-TANF attendance. The data are consistent with school reports that relatively few TANF students reached the attendance triggers that prompt letters or conferences. School administrators were initially surprised at which students were or were not on their TANF lists. Overall, our data contradict the assumption that TANF students as a group have excessive absences.

Statistical tests on both aggregate and individual attendance data offer no conclusive evidence that MerCAP improves TANF student attendance. Even the few tests that find a statistically significant increase in attendance show very marginal substantive gains at best. This finding contradicts the expressed view of school administrators, many of whom believe that MerCAP improved TANF student attendance. The discrepancy may be explained by administrators focusing on the small subset of TANF students with excessive absences, some of whom improved their attendance as a result of MerCAP procedures. The ceiling effect caused by the good overall attendance of most TANF students means that the MerCAP "successes" that loom large in the eyes of administrators are marginal when looked at in the context of the entire TANF population.

In their first year in MerCAP, overall attendance in each of the three cohorts of schools entering the program increased significantly. From interviews with school administrators and attendance staff, this somewhat unexpected result seems to result from increased focus on attendance of all students as a result of their devoting time and attention to MerCAP procedures. To consider the alternative explanation that SB727 (school funding based on actual rather than apportioned attendance) was responsible for the increase, we examined the attendance pattern in Merced City Schools. Those schools, which did not enter MerCAP until Year 3, showed no change in attendance from 1997-98 to 1998-99, despite the implementation of SB727 in the 1998-99 school year. The following year, their first in MerCAP, overall school attendance rates increased significantly.

Our analysis provides one of the most thorough empirical tests to date of the assumptions underlying the new welfare reform school attendance policies that have been adopted in California and 39 other states. The MerCAP data suggest that these policies embody a popular idea but are likely to be, at best, only marginally effective in improving attendance. Our evaluation calls into question five basic assumptions guiding welfare policies for school attendance, and suggests alternative assumptions that may prove more fruitful for policy and program development.

Parents are often part of the reason children have school problems, but at the same time their cooperation and engagement can play a critical role in improving school attendance and achievement. The role of parents in MerCAP was limited to receiving information that many did not understand and/or take to heart. An alternative approach would bring parents into a partnership, drawing on their experience to identify underlying problems and potential solutions. The benefits of meaningfully involving parents have been cited in the experience of many successful school-community partnerships.

Taken as a whole, our analysis suggests that if the goal of the policy intervention is to improve attendance it makes sense to emphasize factors other than TANF status; and if the goal is to improve student achievement, it makes sense to emphasize factors other than attendance.

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

Key Theme: 5.11 Family Resource Management
Title: Life Skills/Work Skills

Description: The new federal and state welfare to work requirements for families receiving TANF requires that adult(s) from these families must be involved in work activities. These adults are entitled to 18 months of welfare to work services to prepare them for entering the workforce. As of October 2001, the CalWORKs population in San Joaquin County totaled 41,107, which was composed of 13,812 adults and 27,295 children. The number of adults in case-managed welfare to work programs was 12,923.

In order to assess the needs of this population, several focus groups were conducted in San Joaquin County by the Gateway to a Better Life Workgroup and UCCE staff. These focus groups indicated the educational needs of this population were related to their lack of life skills (conflict management, family relationships, parenting skills, goal setting, time management, dressing for the workplace, etc.). In addition, several meetings and focus groups were conducted with the Deputy Director of CalWORKs Employment Services and her Case Managers. Again, case managers were unanimous in their opinion that the major unmet need in their clients was life skills education. To quote one of the case managers, "I can get them a jobs but, without the life skills, the clients don't hold on to the jobs". Case managers shared that their clients were deficient in life skills such as how to overcome work barriers, time management, punctuality, attendance, relationship problems (i.e. husband/children don't want wife/mother to work), and stress management. Case managers stressed the following subject areas were needed: 1) budgeting; 2) nutrition, health; 3) balancing work and home; and 4) basic work skills.

The efforts were to: strengthen the capacities of families and individuals for self-sufficiency and well being by improving life skills; to continue the development, implementation, and evaluation of the UCCE Gateway to a Better Life curriculum; to increase the number of low-income state and county residents using life skills that lead to feelings of control, economic well-being, and self-sufficiency;

and to continue disseminating the Life Skills newsletter to agencies and organizations working with CalWORKs clientele.

Impact: This project included: 1) identifying agencies and organizations statewide and nationwide using the UCCE Gateway to a Better Life curriculum; 2) developing an agency survey and a trainer survey for conducting telephone interviews with these agencies and organizations; and 3) working with the Social Science Research Center out of Cal State Fullerton and the Gateway Workgroup to survey the agencies and trainers through telephone interviews.

Due to the small sample size, most of the findings from the telephone interviews were not statistically significant. However, some significant findings were: 1) Out of 10 agencies who received UCCE training, 70% used 23 to 24 of the Gateway lessons (the curriculum is comprised of 24 lessons) compared to 30% using less than 23 of the lessons and 2) Of those agencies using 23 of the 24 lessons, 60% self-reported their agency mission to be life skills education, 50% basic education, 50% workforce preparation, and 40% job retention. In addition, survey results documented specific barriers within agencies that directly affected program implementation and outcomes such as staff turnover, staff motivation, poorly trained staff, not enough time, agencies working in crisis mode, no training on using the curriculum, client attendance and motivation, life crisis nature of clientele, and clientele transportation.

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

Key Theme: 5.18 Leadership Training and Development
Title: 4-H Volunteer Leader Training

Description: Providing volunteer leaders with orientation, training and support is a responsibility of the 4-H Youth Development Program, both from an organizational perspective and project teaching perspective. Because volunteer leaders are the extenders of the program to youth, successful outcomes for youth and numbers of enrollment/re-enrollment are directly related to the quality of leaders guiding project and group learning experiences. San Mateo County has 250 volunteer leaders, 13 community clubs, and an individual youth project enrollment of over 1500 each year. While 50% of the leader's tenure is over 5 years, turnover of new volunteers is high. Recent surveys of local leaders indicate a need for and interest in training, not only in organization, but also in teaching methodology and curriculum/resources.

A training for leaders within the 4-H program was developed with the following objectives in mind:

- Improve effectiveness and operation of new leader orientation
- Provide volunteers with tools to effectively work with youth
- Improve community leader effectiveness in adhering to University and 4-H policies and procedures, including Affirmative Action
- Provide subject matter information and activities which are high quality and educationally and developmentally appropriate

Four new training workshops were developed:

New Volunteer Leader Orientation: Introduced a new delivery method and program content to reach volunteers in a timely manner with required orientation information. County 4-H Council purchased 20 copies of the California New Leader Orientation Videotape. All clubs were given their own copy and supplemental materials to use with new volunteers. The New Leader Resource Packet (one for each new volunteer) was revised and expanded to include information in a colorful format and answers a myriad of questions for new leaders. Over 50 new leaders participate in orientation each year.

Community Club Leader Training: Developed a 4-H Community Club Leader's Resource Binder and conducted a 2 1/2-hour training for 20 leaders, which included the nuts and bolts of CE and 4-H policies. The training included a SWOT analysis to further inform leadership of strengths and weaknesses in the program for subsequent training.

Project Leader Training: Organized an Animal Science Project Leader Training and Open House, where project outlines, curriculum, and resource materials were provided to 35 leaders.

State 4-H Leader's Forum: Wrote a proposal for the 4-H Assistant to present a workshop for Animal Science leaders at the 2000 State 4-H Leaders Forum.

Impacts: Fifty new volunteer leaders participated in new leader orientation. Evaluations show that having materials available at local community club sites increases the timeliness of the training and flexibility of meeting individual volunteer's schedules and needs. Twenty leaders attending the Community Club leader training said they valued the resource materials and felt more competent performing their organizational role.

Community club leaders have increased awareness of the policies and procedures in the 4-H program, are better able to deal with questions and conflicts that arise, and club financial books are better kept with less opportunity for fraud. Project leader training has resulted in increased numbers of youth participating in and demonstrating knowledge acquisition by passing animal science project proficiency tests (74%) and more requests for teaching resource materials, strengthening project learning experiences for youth.

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

Key Theme: 5.18 Leadership Training and Development
Title: Creating Welcoming Communities, 2001- 2002

Description: California's youth population is becoming increasingly diverse. By 2025, Latinos will account for 44% of the state's people. To address this issues of diversity including, knowledge and skills on how to recruit and work with youth and families representing the ethnic diversity of California, a workshop was designed. The objective of this effort were to improve understanding of multicultural and diversity issues by providing youth, 4-H volunteers, and 4-H staff with training and technical assistance in issues of diversity.

The design of this workshop was a team effort in collaboration with 4-H Youth Development Advisors. Staff and volunteers' learning styles and level of intercultural communication/adaptation based on our prior interactions with them were assessed using Kolb's learning style framework and Bennett's intercultural framework as guiding tools. The assessment was compared with a review of the intercultural communication literature. An interactive workshop was designed that incorporates simulated situations and small group discussion on recruiting and retaining families, specifically Latino families. The workshop concluded with an identification of strategies to create welcoming environments to support new families in 4-H.

Combined, the workshops engaged more than 200 youth development professionals and 17 youth. The workshop was taught to 54 staff and volunteers (3 Hispanics, 2 African-American, 5 Asian-American, 44 White) and to 17 youth and 5 adults (1 Hispanic, 16 White). Participants rated the workshop "excellent" and "good". Answers to requests for additional information from workshop participants and on-going technical assistance to Advisors on issues of multicultural understanding is being provided.

Impact: Workshop participants expressed an appreciation for the research component, and learned new ideas for recruiting and retaining new families. Several participants expressed that experiencing exclusion during the simulation game gave them insights on new approaches to include underserved populations. The workshop evaluations revealed that participants recognized that current recruitment activities do not target Latino families. Two youth that attended the workshop and are 4-H members in Santa Clara County taught this workshop at a youth conference in February 2002.

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

Key Theme: 5.20 Parenting
Title: Family and Work Identities During Times of Transition

Description: The project objectives are: 1. to determine the effects of work and family transitions on identity; 2. to examine the effects of work and family transitions on well-being; and 3. to examine the association between identity and well-being. In collaboration with the other stations working on the W-167 Multistate Research Project, we completed two '1-pagers' to give highlights of our findings. One of these papers focused on how parents' work impacts on children and the other focused on the need to coordinate domestic labor in families and to consider how parents' work impacts on marriages. A presentation on maternal employment in relation to child development was made at the California Statewide ANR conference, Oddysey 2001, Riverside, CA. Maternal availability as experienced by children was discussed. Other dissemination to the public was made through ANR radio broadcast. A general finding was that while mothers may work (for money) to increase their family's socio-economic status, when this is done at the expense of physical availability to children during out-of-school hours and children's sense of safety at home, children's response to conflict with peers appears influenced. Work on the new project has focused on refinement of instrument selection. Measures include: biographical data (e.g., education level, occupation, salary, marital status); vocational and personal identity; life orientation inventory; work environment scale; work satisfaction; marital

satisfaction. Learned optimism; boldness orientation; psychological distress; attitudes toward maternal employment will supplement the followup of children in the earlier project as they transition from childhood to adulthood in terms of family, work life, and well-being.

Impact: Children's development of conflict resolution strategies appear related to maternal employment factors of physical availability and children's sense of safety at home. As parents weigh the benefits of maternal employment, issues of physical availability and safety at home need special attention. Also of importance is to consider children's emotional well-being, particularly depression. Parents often think that elementary school age children are too young to have serious worries that characterize depression. This is not the case and is relevant for employed parents to consider as well.

Funding Source: Hatch Multistate Research and State
Scope of Impact: CA, ID, NM, OR, UT, WA, CO,; NON-SAES: PEI (Canada), IU (PA)

Key Theme: 5.20 Parenting
Title: Parenting Information for Low-Income Families in Tulare County

Description: The care and guidance children receive during their first few years determine, to a large extent, whether they will or will not become loving, confident young people and adults. To promote early development, parents need to know: how infants grow and change; the importance of responding warmly and consistently to their baby's need for comfort and support; to understand the value of encouraging their infants to explore; of promoting early language development; of disciplining consistently but without harsh punishment; of providing good nutrition; and of maintaining a child-safe environment.

Fortunately, most new parents want help and are eager to learn. Many of the most needy parents have little access to the kind of parenting information they want and can use. Parent Express has proven to be an effective, cost-effective, well-received means of providing basic parenting information. Parent Express is being distributed through the WIC Program to participants who are either pregnant or have an infant. The project objectives are to provide the newsletter to 9,000 low-income families over three years, evaluate the usefulness of Parent Express prenatal to 12 months and the need for a continuation of Parent Express from 13 to 36 months, and to evaluate the delivery method. It will be several months before we have evaluation results. Bilingual staff will interview a sample of 300 parents receiving the newsletter to provide data for evaluation. Radio Bilingue aired parenting PSA tips we provided this fall. We continue to work with the radio station to make parenting information available. Other CE offices have used the grant proposal to receive funding from Proposition 10 to distribute Parent Express.

Impact: An evaluation conducted by Radio Bilingue showed that 26% of the listeners surveyed remembered hearing the parenting tips we provided. Sixty percent of the respondents requested more parenting information about specific topics. The most requested topics were dealing with children's behavior. For Parent Express, our expectations are that: 75% or more of those who read the newsletter will report that the booklets caused them to become better parents in one or more of the major topic areas; and that 75% or more will feel more confident as parents. The ultimate impact is to have Parent

Express included in the California Children and Families Commission Kit for the New Parents. The kit is being distributed to new parents in every county in California and is funded by Proposition 10.

Funding Source: State, County Children and Family Commission, and Smith-Lever
Scope of Impact: State Specific

Key Theme: 5.20 Parenting
Title: Power of Play

Description: Children of low-income parents are often unprepared for kindergarten and their parents don't know how to help them. When children begin their formal education without the knowledge and skills possessed by the majority of children their age and expected by the system, they are at a great disadvantage. Many lose self-esteem and become discouraged with school at this early age. Many parents are equally unprepared to deal effectively with the requirements of the school system and remain helpless observers of their children's difficulties.

The overall goals of this effort are to: improve kindergarten readiness for low-income children through educational play; provide parents training and tools to assist their preschool children in becoming kindergarten ready through educational play; determine the usage of Power of Play educational materials by low-income parents and staff who work with these parents; provide training to low-income parents and preschool staff who serve low-income children in the Power of Play curriculum; instruct low-income parents on how to effectively assist their preschool age children in becoming school ready to help these children be more successful in their school careers; determine the extent to which low-income parents and preschool staff trained in Power of Play use the curriculum.

Impact: Countywide impacts for Power of Play shows that 91% of San Luis Obispo County low-income parents who participated in one or more trainings and participated in a follow-up interview used the Power of Play curriculum for educational play with their children at least one time per week and 82% of these parents used the curriculum at least two times per week with their children. All preschool staff members trained in Power of Play and who participated in a follow up survey indicated they use the curriculum with low-income parents and/or children. Power of Play training and curriculum are being offered to low-income parents and preschool staff who work with low-income children throughout San Luis Obispo County. Three hundred and two low-income parents from 25 agencies have been trained in the curriculum between January 2000--September 2002. During the same time period, 106 staff from 13 sites have been trained as train-the-trainers for Kindergarten Prep.

Focus group interviews with 33 parents at 13 sites indicate that 91% of the parents interviewed use the Power of Play program at least one time weekly with their children and 82% use it at least twice weekly. Personal follow up interviews with 12 staff members from five agencies indicated all staff trained in the Power of Play program were using the curriculum with parents and/or children.

Ultimately, this project can lower costs to schools as more children will be ready to learn with higher school success rates for children exposed to the Power of Play program.

Funding Source: State, County Children and Family Commission, and Smith-Lever
Scope of Impact: County Specific

Key Theme: 5.22 Promoting Housing Programs
Title: Farmworker and Low-income Rural Housing in California

Description: This project is a continuation of earlier research on creative design of low-income housing projects and furnishings through professional architectural participation in low-income housing projects, design development of manufactured housing prototypes, and affordable furnishings, and furtherance of low-income housing policy and funding.1) Work in Progress: Affordable Housing for Mentally Disabled located in Napa, CA. Skyline Apartments - 19 Dwelling Units and Community Building Work studies the ability to group mentally disabled in supportive group setting where each individual has a small, private apartment. Small site needs to include low-income people in existing neighborhood. 2) Galt concilio, Multi-Social Service Center for Low-Income Families located in Galt, CA. Project in construction document phase and construction to begin Spring 2001. Project explores use of manufactured buildings in low budget project with services offices, counseling and training facilities, clinic, and child care center. 3) Villa Almador - 96 Low-Income Multi-Family Dwellings and Community Center located in Brentwood, CA. Project explores skillful use of medium density housing in a single family residential area. Project in design development phase with construction anticipated to start Fall 2002.

Impact: Research explores design methods for housing low-income families in medium density settings that must be integrated with middle and upper income single family housing. Issues of efficient space use, energy conservation, and effective use of simple construction materials to create positive environmental impacts. Projects benefit low-income families (mostly farmworkers) in rural and suburban communities.

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

Key Theme: 5.26 Workforce Preparation
Title: 4-H Camp Academy: Teen Job Training

Description: Alameda 4-H Camp Academy has a history of providing leadership opportunities for teens by training them and allowing them to use their knowledge as camp staff. However, the program did not take this opportunity to provide teens with job training. The objective of the Teen Job Training project was to incorporate a job preparation component to the 4-H Camp Academy Program which links this experience to a real world experience. One of the Camp Academy training sessions is dedicated to teaching teens about job interviews and resume writing. We then require the teens to go through an application process for camp staff. This process includes submitting a resume and going through an interview. Based on their performance, we decide whether or not they can serve as a camp staff and in what capacity. The changes were the result of facilitation at meetings with 4-H leaders and

youth with the goal of making the program more professional. Part of this process was documenting the camp staff requirements, expectations, job descriptions, and activities.

Impact: Now in its third year, about 180 4-H teens have been involved in this program. The youth were interviewed during a camp staff retreat. At the end of 4-H Camp, we evaluated this program and made changes accordingly. The 180 teens involved in this project learned the skill of filling out a job application, creating a resume and interviewing for a job. Further, they learned about job evaluations and how this could affect their future. For many youths, this was the first time they experienced an interview process. For several teens whom we interviewed in a previous year, one can discern a significant positive change in their interview performance. Note, another unplanned impact was on the part of the 5 adult volunteers who served as interviewers. Three of them had never served as an interviewer. They noted that by serving as an interviewer, they gained a different perspective and personally learned how to better perform in an interview.

Funding Source: State, Alameda County 4-H Leader's Council, and Smith-Lever

Scope of Impact: County Specific

Key Theme: 5.27 Workforce Safety
Title: Occupational Safety and Health Through the Use of Protective Clothing

Description: Following development of a prototype thermal protective garment system for wildland fire fighters and physiological and thermal testing in the laboratory, prototypes were distributed to fire fighters for field testing. The fire fighters were asked to alternate wearing their standard protective clothing system with wearing the prototype system and to keep a weekly record of garment maintenance and problems. Following the fire season, they were asked to compare the two garment systems on 7 attributes, rate specific parts of the prototype as to mobility and give their opinions of 14 changes that differentiated the prototype from the standard system. Major findings were that the prototype system was rated better than the standard system on all 7 attributes with the two-way zipper on the jacket and reflective tape on the jacket sleeves being seen as particularly beneficial changes.

Impact: Recommended changes in the wildland fire fighter protective clothing system should reduce physiological stress while maintaining thermal protection so that fire fighters can perform their jobs more efficiently and safely.

Funding Source: Hatch Multistate Research and State
Scope of Impact: CA-D, CO, IA, IL, MD, MI, NE, NYG, OK; NON-SAES: TEX TECH. U., NYC

Key Theme: 5.28 Youth Development/4-H
Title: Enhancing Science Literacy

Description: At a time when academic test scores are scrutinized, science is a low priority in elementary schools, especially in low-income communities. After school programs are eager to

incorporate engaging, educational activities like the 4-H Youth Experiences in Science (YES) into their programs and provide an alternative venue for science education.

The overall goals of this effort are to: build enthusiasm for science in elementary school-aged children and to provide meaningful service learning experiences for teenagers involved in program delivery; understand and measure the impact of YES on its intended audience; stimulate scientific thinking and develop an enthusiasm for science in both elementary school students and teenagers living in low-income communities; to increase the diversity of the 4-H program base in Sacramento County; and to improve the quality of programming in after school settings.

Our objectives were to:

- Deliver the YES curriculum at Sacramento START after school program sites to 800 children with at least a three-month program; and

- Increase knowledge about nutrition and plant science through Garden Nutrition Program.

During the 2001-02 program year, 59 teenagers delivered YES to 805 children at 14 after school sites. In addition, 22 teenagers were trained in Project Learning Tree and Project WILD curricula and planned and delivered an environmental education outdoor living experience to 140 elementary-aged students in June, 2002. Almost 400 children attended plant science and nutrition programs through the UCCE/Grant High School collaboration.

Program evaluation was completed and published for the YES project. The YES evaluation team was comprised of program stakeholders including Sacramento START staff, administrator, and teen teachers. It was both a formative and summative evaluation, and it examined the impact of YES on teen teachers who delivered the curriculum, START students who participated in activities, and YES' impact on the START program overall.

Impact: Findings of the YES evaluation included skill development in public speaking and other areas for teen teachers, engagement in inquiry and exposure to scientific facts for young participants, and that the program is fun and well-received by all stakeholders. Specific recommendations for program improvement were also noted.

The YES program served completely different populations than our 4-H Club program, extending important services to low-income and multi-ethnic populations. Of elementary-aged participants in Sacramento County Science Literacy Project, 31% are African American, 21% Hispanic, 16% Caucasian, 30% Asian Americans. Focus group interviews with adults involved verified YES' positive impact on the after school program.

The Youth Experience in Science Project Evaluation examined the program's impact on teen teachers who delivered the curriculum and the elementary-aged children who received the program. It also explored the implementation and effect of YES in after school programs. The evaluation found that teens grew in their ability to work with younger children, in public speaking, and their organizational skills. Children were engaged in the process of inquiry and were exposed to scientific facts and concepts. The program was seen as an asset in the after school setting.

Our project backers-Intel and Sierra Club-have been pleased with our efforts in the science literacy area and continue their support of UCCE efforts. The "Science Literacy Project" works hand-in-hand with effort by schools and after school programs to increase academic performance, especially in communities where test scores are lowest.

Funding Source: State, Intel and Sierra Club, and Smith-Lever
Scope of Impact: State Specific

Key Theme: 5.28 Youth Development/4-H
Title: Animal Ambassadors - A Science Education Outreach Model

Description: Animal Ambassadors is an innovative, new youth science program that uses the world of animals as a "bridge" to help youth develop an interest in science while emphasizing critical thinking and life skills. It uses a cross-age teaching method in which teens are trained to guide younger children through hands-on science activities. The American Honda Foundation supported the project with $125,000 over a two-year period. The first year project involved youth from 5 to 8 years of age. Based on the success of the first Animal Ambassadors project, the project was expanded to four pilot counties in California in different geographic locations to test the positive outcomes in the development of hands-on, inquiry-based activities for the 9 to 11 age group. This program was a cooperative effort between an Extension administrator and specialist at the UC Davis, School of Veterinary Medicine, Veterinary Medicine Extension (the developer of the Animal Ambassadors Program), and four California 4-H Youth Development Advisors. The objectives of the program are 1) to engage children in the scientific thinking process and improve their critical thinking skills, 2) to enhance children's views of their relationships with animals, 3) to develop a progressive and sustained training model (i.e., step-up incremental training) for teen facilitators and adult trainers, 4) to increase the competence of teen leaders with respect to inquiry-based teaching methods, and 5) to increase teen leaders' workforce skills.

In both years of the project, the project team conducted three training-of-trainers at UC Davis for 4-H Advisors/Program Reps and adult volunteers from the four counties. The trained leaders and staff then held three "step-up" incremental trainings for teens in the counties over a several month period. After receiving training, the teens delivered the experiential science and technology program to youth in various venues, including standard 4-H project meetings, after-school program sites, homework clubs, and YMCA sites. Research methodology included pre/post comparisons on: 1) direct participant observation on whether or not children were involved in the science processes, 2) object description assessment, 3) "draw yourself with an animal" assessment tool, 4) questionnaires to determine family involvement, and 5) surveys and post intervention focus group interviews with teen trainers. In the first year, the research was conducted over a seven-month period with 14 teens and 60 children (ages 5-8). Three 4-H clubs and one YMCA after-school site served as the four research sites. In the second year, approximately 20 teens and over 100 children (ages 9-11) were involved in the program.

Impact: The results were extremely positive and significant. All objectives had some positive outcomes, and both children and teens showed increases in desired behaviors. An article on the first year of the program was included in the 2001 4-H Programs of Excellence publication; the peer-reviewers judged it the best write-up in science/technology. Also, an article on the project and its

results was published in the December 2002 issue of the Journal of Extension. New knowledge was created on using scoring rubrics to access and quantify drawings.

The success of the project led to the American Honda Foundation funding a second project, involving three additional counties. New curriculum for 5-8 and 9-11 year olds is now available; Indiana CE has already adopted the curriculum as one of its 4-H science/tech projects. The training model has implications for 4-H trainings, CE and science-teacher trainings. Also, the teens have reported the inquiry-based trainings have impacted their daily lives in school by having developed their questioning skills. In addition, for approximately 60% of the teens involved in the project, their participation affected their future education and career plans positively, and that they gained skills (problem solving, teamwork, communication, and the ability to organize and complete tasks) that will aid them in their endeavors.

Funding Source: State, American Honda Foundation, and Smith-Lever
Scope of Impact: National

Key Theme: 5.28 Youth Development/4-H
Title: Teens as Teachers (TAT), 1998-2001

Description: In 1997 the David and Lucile Hewlett Foundation awarded the 4-H Youth Development Program in Santa Clara county a $50,000 grant to implement cross-age science teaching programs in high schools in San Jose. In 1998-99, this project was implemented with the East Side Unified School District in San Jose. In 1999-2001 the project was implemented with the San Jose Unified School District at Pioneer High School, Almaden and Los Alamitos Elementary Schools. The objectives of this project were:

- To expand teen educational experiences through authentic cross-age science teaching.
- To increase teen planning, cooperation, and implementation skills.
- To stimulate teens' and elementary children's science critical thinking skills.

A 4-H Youth Development Advisor supervised the program coordinator, trained teens, developed and cultivated relationships with youth, school administrators, teachers, and business partners. A total of 16 2-hour sessions were taught to teens from Pioneer High School on teambuilding, processes of science, teaching methods, and rocket science units emphasizing experiential learning. Teens spent 8 hours teaching in each elementary school classroom. Teaching teams consisted of three youth. Each team planned and delivered unit science lessons to two 5th grade classrooms. The Program Coordinator oversaw day-to-day operation of the program. 4-H academic staff revised the rocket science curriculum after each pilot session and coached teens while they served as teachers of elementary school aged children.

Fourteen Mexican American males, and two White teens (one male, one female) participated in all sessions. Youth were grouped into teams of three. Together they planned and delivered unit science

lessons to two 5th grade classrooms reaching 66 children who were 45% Mexican American, 35% Asian American, and 20% White.

Impact: A pre/post questionnaire and focus group interview probed teen attitudes and thoughts on science and service-learning. The pre-post survey indicated attitudinal changes and the focus groups helped identify program operational issues. Survey results indicated that teens interest in science increased by 70%. Throughout the project teens expressed that they had never learned science in a "fun way" and that it was great to learn concepts such as Newton's Laws and then apply them. A significant positive change in terms of school-work was in response to whether teens "have to be encouraged to do homework," which decreased from 80% to 50%. Responses advocating that service learning be required "for all high school students" increased from 50% to 70%. The program provided authentic work experiences offering teens new insights into teaching, peer cooperation, learning and science careers. This project continued six months beyond grant requirements. The Rocket Science curriculum that was piloted has been used by two 4-H leaders in Santa Clara County and by staff in Monterey County. A description of this program was submitted to National 4-H and was selected as a 2001 Program of Excellence through a peer reviewed process.

Funding Source: State, David and Lucile Hewlett Foundation, and Smith-Lever

Scope of Impact: State Specific

Key Theme: 5.28 Youth Development/4-H and Soil Erosion
Title: 4-H Watershed Environment Model Project

Description: Two major problems face a prominent estuary in San Luis Obispo (SLO) County: soil erosion and the rapid in-filling of the estuary, and pollution associated with urban runoff. Changes in citizens' behavior come about only after a thorough understanding of the direct consequences of one's actions. The 4-H Watershed models were designed to demonstrate those consequences graphically in a way that both youth and adults can understand. The models were designed in such a way to be easily replicated in any watershed area in the world. Each model is a permanent sculpture that people can walk on, that shows local geography, and that can be used to teach individuals how to keep creeks and other bodies of water clean. The objective of the 4-H Watershed Environment Model Project is to develop a reasonably priced, large-scale working model of a watershed to be used for educational purposes, that could be replicated in any watershed in the world.

Project activities have included facilitating the building of models in SLO County, and providing statewide and national leadership for the project. A Watershed Model Construction Manual, has been published and is both available in hard copy and on-line at the SLO County 4-H website. All stages of the From Ridges to Rivers: Watershed Explorations curricula have also been placed on the web. These are companion pieces to the construction manual. 4-H staff members have also talked to individuals about the models who have then published their own articles about the models, which then brings more attention to the project and the construction manual. Consultations with dozens of individuals throughout the country about the watershed models have taken place, usually after they have either reviewed information on the website or read about the model in a publication.

Impact: A report on the 4-H Watershed Environment Model Project, was published in the 2000 4-H Youth Development Programs of Excellence. A second model of the Morro Bay Watershed was built largely by students and 4-H SLO Scientists, and is housed at an elementary school where it is used by teachers to teach watershed concepts and sources of water pollution; to teach local history and map reading skills; and, to help children understand the water cycle. It is also available for community groups to use; youth trained in the use of the model present the demonstrations to the groups. High school students built the third model in SLO County, of a different watershed. Students demonstrate the effects of runoff pollution to middle school students and community groups to help them understand how to prevent pollution of the rivers and streams. The original 12X12 ft. model of the watershed, built by 4-H youth and adults, is permanently housed at the county schools' Environmental Camp. The EPA detailed the model for two weeks on the their national website as an "environmental highlight" project and the Nonpoint Source National Monitoring Program Successes and Recommendations report highlighted the original model with a photograph and a caption about "4-H Modelers."

El Dorado County in California, replicated an even larger (24' x 24') model, which is housed at the El Dorado County Fairgrounds. Individuals from 17 states have contacted San Luis Obispo County UCCE to discuss plans for building large-scale plans using the manual. The San Luis Obispo County UCCE office has received photos of a model built by a teacher and students in Alabama, and of two models built in Washington through the efforts of water quality and 4-H Washington State CE personnel. Requests come in every week for more information on constructing a watershed model and utilizing the From Ridges to Rivers: Watershed Explorations curriculum. To date, over 38 states have utilized the curriculum, which was developed in San Luis Obispo, California.

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

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.

Program Planning Advisory Committees (PPACs)
These committees are comprised of forty-five Division members representative of the diversity of UC ANR disciplines and program areas, from all Division-affiliated campuses and from county offices throughout the state. Fifteen individuals serve on each of three subject area committees, Agricultural Resources, Human Resources and Natural Resources. During FY 2002, the PPACs initiated a new planning process as a result of a review of the initial five years of PPAC planning. The PPAC are now charged with recommending Division-wide program priorities by identifying Critical Issues facing California that the Division can address and Target Issues, those Critical Issues where additional Division resources are most needed to address the problem. The planning process has been changed from an annual process to a three year process. In addition the PPAC charge has been expanded to include an "environmental scan" of stakeholders to determine the Critical Issues; assessment of current Division capabilities and resource commitments to the Critical Issues, and program evaluation to determine how effectively the Division has been able to address the Critical Issues.

During the fall of 2002, PPAC members began the "environmental scan" by surveying external and internal stakeholders through personal contact, written surveys, and web-based surveys. The input collected on current and emerging issues along with the current assessment of Division resources will be used in the PPACs identification of Critical Issues and Target Issues during FY 2003. Division administrators will use the final PPAC report on Critical and Target Issues in making programmatic decisions, including resource allocation decision.

UC ANR Workgroups
Division program workgroups are a primary mechanism for accomplishing ANR's high priority research and extension goals through grassroots leadership. They bring together Agricultural Experiment Station (AES) and Cooperative Extension (CE) personnel along with non-ANR partners to work on emerging and continuing priority issues in Division program areas.
Non-ANR participants are identified by the scientists, advisors and specialists working in the specific program area and invited to participate in workgroup activities, including needs assessment and issue identification and evaluation and reporting of program results. The involvement of external stakeholders in the workgroups ensures that real world needs are brought to the attention of University scientists and extension specialists and advisors as programs are planned and implemented. There were over 90 Divisionwide workgroups with a total membership of over 3,700. These workgroups involved nearly 600 external stakeholders in their program planning process and workgroup activities and projects. External stakeholders on the workgroups include individual producers, representatives from local community groups, state and federal agencies, industry groups, consumer groups, and colleagues from other higher education institutions.

Workgroups request funding for high priority research and extension projects identified by the internal and external workgroup members Funds are then allocated for specific research and extension projects collaboratively planned by the workgroup and conducted by workgroup members. Where appropriate, ANR workgroup funding is used as "seed money" to leverage or match other sources of support.

An example of the use of stakeholder input is the Prune Workgroup. The Workgroup held its annual meeting, attended by 17 Division members and 18 prune industry members and identified a need for the development of an environmentally sound production system as a priority research and extension project. AES and CE personnel developed a "reduced environmental risk" system, in which cultural inputs such as pesticide sprays, irrigation, and fertilization are minimized because they are based on monitoring rather than standard recommendation applications. The demonstration plots are already seeing reductions in specific pesticide sprays and applied irrigation as a result of this project. Once refined and more widely implemented throughout the state, the approach should have a substantial positive influence on the environment around prune orchards in California.

Another example of the use of stakeholder input is the Alfalfa Workgroup. Members working on the Alternative Forage Crops project conducted informal interviews with growers in different areas of the Central Valley to determine the main forages of interest. Based on the responses, projects were implemented, focused on those needs, specific to the region. Field trials were established and data was collected in the spring/summer of 2002. Information on the results have been disseminated at industry meetings and through publications. One publication provided a review of alternative annual forage crops that could be grown in California. With over 800,000 acres in annual forage production in California, these types of alternative forage crops may incrase in important in the future due to their hight yeilds, ability to help recycle various waste products and high degree of flexibility in rorations and the potential to adjust rapidly to water supply and market fluctations.

In response to requests from the lettuce industry, UC researchers sought a better way of utilizing biological controls in lettuce for the lettuce aphid. Growers had been using the green lacewing as the best candidate organism as eggs of this insect are readily available for purchase and are relatively inexpensive. A series of field trials was conducted working with grower-cooperators to test the mechanical applicator. The final observations indicated that a key problem was in a poor fit of the natural enemy, the green lacewing, to the environmental conditions of the Salinas Valley (cool and windy) and also, a very low tolerance for the pest made timing the application of the eggs difficult. A survey of lettuce growers who represented over 50% of the lettuce production in the Salinas area, showed 100% of the growers who had previously tried release of lacewing eggs have stopped the practice, in response to this work and their own experiences. This is expected to save the growers $200 to $300 dollars per acre, which they can use toward more appropriate biological or cultural controls.

Formal advisory groups

The President of the University chairs the President's Advisory Commission on Agriculture and Natural Resources to identify the education needs of California's agricultural, natural and human resources interests and advise him on how the University can best meet these needs through its science-based research, classroom instruction and educational outreach. The members represent 28 business, consumer, youth and government leaders from throughout California and meet twice a year to provide input. The Vice President - Agriculture and Natural Resources participates as a member of

this Commission and brings the Commission's advice to the Executive Council, the Division's administrative group charged with Divisionwide strategic planning.

Each of the three colleges at Berkeley, Davis and Riverside and the School of Veterinary Medicine at Davis, have external stakeholder advisory councils that meet at least annually to provide feedback on their research, extension, and teaching programs. Members of these councils represent the spectrum of clientele who use the Division's programs and who have expressed interest in providing input to the college/school planning efforts.

Several of the Statewide Special Projects and Programs have external Advisory Councils that meet at least annually to review progress and offer recommendations for future program direction.

Commodity Organizations/Marketing Order Boards
Members of these organizations provide annual input on research and extension needs for their commodities to UC ANR members through regular meetings and discussion of funding for research projects. These individual groups also come together on an annual basis to form the California Commodity Commission. This Commission meets with the Vice President and offers specific recommendations on program planning and funding issues.

SECTION C. PROGRAM REVIEW PROCESS

There has been no significant changes to the California program review processes since the UC Plan of Work Update, submitted in July 2000.

SECTION D. EVALUATION OF SUCCESS OF MULTI AND JOINT ACTIVITIES

(*1) Did the planned programs address the critical issues of strategic importance, including those identified by the stakeholders?*

California's research and extension professionals planned and delivered programs that addressed the critical issues facing the state in the areas of agriculture, natural resources and human resources by pooling the expertise of California AES and CE academics, by collaborating with colleagues in other institutions, agencies, and states, and by consulting 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 issues identified by California stakeholders:

Key Theme: 1.06 Animal Production Efficiency
Title: Cow-Calf Quality Assurance Program
Scope of Impact: State
Source of Funding: Smith Lever and State
This program was developed in response to consumer concerns on the safety of beef production practices. Through cooperative efforts of California Cooperative Extension and organizations representing industry organizations, efforts were initiated in 1992 to develop and deliver educational programs that would effectively and efficiently provide information to producers so they would understand and adopt practices that would assure consumers that beef is safe, wholesome and produced using practices and acceptable techniques with concern for the animal when used during the handling and transportation. This program has evolved into a series of educational programs that that are offered to producers in traditional meeting format where producers receive basic information and are tested for certification. As a major statewide effort by both Cooperative Extension and industry, the programs are delivered throughout the state. In an effort to accommodate all potential participant, the program has Spanish versions of the written test materials necessary for certification.

Key Theme: 1.24 Ornamental/Green Agriculture
Title: Pest and Disease Persistence in Commercial Mulch Piles
Scope of Impact: State
Source of Funding: Smith Lever and State
While it has been demonstrated that avocado and citrus derive significant benefits from the use of mulch derived from urban yard waste, reducing water use by as much as 25%, herbicide use and nutrient inputs, the question of the fate of introduced pests and diseases was unresolved. Concern about the introduction of pests through use of the yard waste led to the possibility of an ordinance on the use of yard waste in orchards. This study assessed the survival of several noxious weeds, pests and diseases in a typical mulching operation with results indicating that there is little survival beyond three days in the piles constructed of freshly chipped material. This was an important study to the growers because it has been instrumental in providing them with information on the consequences of using urban-derived mulches and now guidelines have been developed to ensure that these mulches do not spread disease and pests. Currently in Southern California, nearly all new avocado orchards are

planted using a mulch and perhaps as much as 10% of the mature citrus orchards are using mulch, resulting in reduction of materials sent to landfills and also reductions in fertilizer, water, herbicide and fungicide use.

Key Theme: 1.25 Plant Genomics
Title: Genetics and Varietal Improvement of Strawberries
Scope of Impact: State
Source of Funding: Hatch and State
California strawberry growers faced the combined challenge of competitive markets, increasing labor cost, and growing regulatory obstacles to use of their most effective cultural tools. Responding to their concerns, this project resulted in the release of two short-day strawberry cultivars to the industry for commercial propagation and fruit production. Together the two cultivars with improved production and harvest efficiency, better fruit quality and broad tolerance to environmental stresses are expected to replace the Camarosa cultivar worldwide. The benefits conferred by these two cultivars will thus affect approximately 50% of the fruit production around the world.

Key Theme: 1.26 Plant Germplasm
Title: An Integrated Approach To Management of Rice Residue and the Control of Rice Diseases
Scope of Impact: State
Source of Funding: Hatch and State
Rice growers have used open-field burning to effectivly manage rice diseases in the past; however new legislation has passed to phase out burning of rice straw so they need alternatives to burning while maintaining disease control. The continuing spread of blast in California indicates the continuing need for caution in using pathogen free seed sources and to avoid spread through transport of and use of contaminated equipment. This project responded to the growers' needs and provided the knowledge of P. grisea races that occur in California allowing breeders to proceed with confidence in attempts to produce blast resistant cultivars for California. Control of Aggregate Sheath Spot disease with a single application of fungicide is economical and results in an increase both yield and quality. Development of potential seed treatments for control of Bakanae disease appears promising.

Key Theme: 1.31 Risk Management
Title: Pesticide Applicator Safety Training Seminars in Spanish and English
Scope of Impact: State
Source of Funding: Smith Lever and State
To ensure the safety of pesticide applicators and the general public in the application of agricultural pesticides, UC advisors developed hands-on demonstrations for pesticide applicator safety training in Spanish and English. Workshops were offered two to four times a year for the past 10 years, with audience size ranging from 25 to 125 for each event. Providing the workshop in Spanish has been important since there are many applicators who do not speak English and need this type of training. Spanish speaking clientele ranged from one-third to two-thirds of the attendance. The workshops have received very high evaluations by both the participants and growers who send their applicators. The participants comment that they have a greater understanding of how to do their job and how to do it safely. Growers report an increased awareness in pesticide safety by the applicators and improved compliance with pesticide regulations by the applicators. They have also reported significant improvements in applicator technique and care of equipment as a result of these workshops. One

grower indicated that he believed that the money spent for the training workshops was recovered very rapidly due to reduced pesticide waste and improved coverage. After an instructor has assisted in a training workshop, he/she receives a complete set of curriculum in both English and Spanish. This allows the trained instructors to conduct their own training sessions, further extending this information. This has expanded the scope of the program, allowing wider dissemination of this important training.

Key Theme: 2.06 Food Safety
Title: Teaching Youth FSNEP About Food Safety
Scope of Impact: State
Source of Funding: Smith Lever and State
Cconsumers have indicated confusion regarding correct information on nutritional and food safety practices and often do not practice good health behaviors in these areas. Health professionals are considered to be a credible source of food safety and nutrition information for consumers. Health professionals need to remain current in their knowledge in order to best assist consumers in achieving healthier lifestyles. Also, teachers can provide students this information. CE advisors offered in-service training sessions for these two groups, including educational information in Spanish. During FY 01-02, 88 trained teachers extended Youth FSNEP information to more than 2,500 students and 6 professional seminars were offered and attended by 189 health and family service professionals; and 5 educational brochures in English and Spanish were finalized and distributed to 980 parents through 16 preschools to assist parents in packing healthy brown bag lunches for their preschool children. This resulted in more than 85% of teachers trained incorporating nutrition training in their teaching curriculum; l00% of participants attending professional nutrition and food safety seminars indicated they gained useful and meaningful knowledge. Eighty-nine percent of participants responding to a 6-month follow-up survey regarding their attendance at a Cooperative Extension nutrition or food safety conference indicated they made at least one positive behavior change based on the information presented during the conference. The long term impact of improved nutrition and food safety practices will reduce medical costs and decrease lost work time due to health problems.

Key Theme: 4.12 Integrated Pest Management
Title: Investigation of the Strawberry Bronzing Problem
Funding Source: Smith-Lever and State
Scope of Impact: State Specific
Bronzing is a fruit disorder that causes fruit to turn brown and dry out. Such fruit are completely unmarketable. During severe bronzing episodes, 100% of the fruit in a particular field may be unmarketable for a few to many weeks, creating tremendous economic loss. While bronzing has occurred at varying levels for many years, the cause of bronzing remained unidentified. California advisors collaborated with growers to identify the casue and to form management options for growers. Extensive field plots were established to test the hypothesis that bronzing is a result of plant stress. Promising results were obtained that temperature and solar radiation may be important factors in bronzing. Treatments that reduced plant stress (such as supplemental irrigation) significantly reduced bronzing. Interestingly, some UV-light blocking compounds in the trials, normally used as additives in pesticides, prevented bronzing. Outreach efforts were made to small acreage, limited resource Hispanic strawberry growers. These growers were surveyed to determine the extent of bronzing in their fields and research findings were relayed to them. Bronzing information was included in a newsletter and three general non-peer-reviewed publications targeted for clientele, including a Spanish

language publication that discussed bronzing. A Spanish language field day was organized that extended our information on bronzing. This outreach allowed us to establish field plots with under-served, Hispanic speaking clients.

Key Theme: 4.13 Land Use
Title: Vineyard Expansion into Oak Woodlands
Scope of Impact: State
Source of Funding: Smith Lever and State
Impacts of the intensification of agriculture on the oak woodlands in a southern California county prompted a broad based community interest and concern about the conversion hardwood range by an expanding vineyard industry. This conflict between agriculture and non-agricultural interests prompted a collaborative effort by Cooperative Extension to develop and deliver an objective educational program to address these issues. This was the beginning of a collaborative educational effort between Cooperative Extension and an industry that previously had not participated in the local CE natural resource programs. Initially, there was a lack of trust on both sides of the issue. A series of educational meetings were held, including people who owned the resource, the vineyard industry, the environmental community, county planning staff, and the general public. The CE efforts brought people of differing views together and provided factual information to consider regarding the issues associated with their concerns. The vineyard industry is more aware and utilizes information learned from attending these meetings.

Key Theme: 4.23 Water Quality
Title: Non-point Source Pollution Best Management Practices – "The Clean Water Program"
Scope of Impact: State
Source of Funding: Smith Lever and State
The 1987 Clean Water Act requires municipalities to eliminate the discharge of pollutants into their storm water conveyance systems through the development of a comprehensive storm water management system. Although the horticulture industry is not singled out in these regulations, no water other than storm runoff will be allowed to leave properties and enter gutters or storm drains. In order to assist the horticulture growers comply with the Act, CE advisors conducted numerous workshops and tours in FY 2002 to learn how to eliminate/reduce runoff. Approximately 90% of the horticulture growers in the initial pilot site enrolled in the Clean Water Program, and adopted the best management practices recommended. As a result, growers have significantly reduced or eliminated runoff leaving their properties. Through voluntary adoption of BMPs, these participants have successfully avoided more onerous regulatory 'fixes' to the runoff situation. This will allow growers to stay in business by working with the jurisdictions and agencies to reduce pollution and improve water quality in the region.

Key Theme: 5.20 Parenting
Title: Power of Play
Scope of Impact: State
Source of Funding: Smith Lever and State
Children of low-income parents are often unprepared for kindergarten and often their parents do not know how to help them. When children begin school without the knowledge and skills possessed by the majority of children their age, they are at a great disadvantage and can self-esteem and become discouraged with school at this early age. Many parents are equally unprepared to deal effectively with

the requirements of the school system and remain helpless observers of their children's difficulties. California advisors developed the Power of Play curriculum to respond to the need to improve kindergarten readiness for low-income children and provide parents training and tools to assist their preschool children in becoming kindergarten ready through educational play. Countywide impacts for Power of Play shows that 91% of San Luis Obispo County low-income parents who participated in one or more trainings and participated in a follow-up interview used the Power of Play curriculum for educational play with their children at least one time per week and 82% of these parents used the curriculum at least two times per week with their children. Focus group interviews indicated that 91% of the parents interviewed use the Power of Play program at least one time weekly with their children and 82% use it at least twice weekly. Ultimately, this project can lower costs to schools as more children will be ready to learn with higher school success rates for children exposed to the Power of Play program.

(*2) Did the planned programs address the needs of under-served and under-represented populations of the State(s)?*

Listed below are several examples of California efforts to address the needs of under-served and under-represented populations in the state.

Key Theme: 1.20 Managing Change in Agriculture
Title: CE Programs Offered in Spanish
Scope of Impact: State
Source of Funding: Smith Lever and State
Offering UC Cooperative Extension programs in Spanish is as much about building relationships as extending information. There is, perhaps, no closer tie than a shared language. UC Cooperative Extension has ensured that the easy connection and improved transfer of information possible in Spanish is a part of its work with California Latinos. The Latino population in California - expected to become the largest plurality, surpassing white non-Hispanics, within 20 years - is holding fast to its culture, one that values the basic institutions of work, family and citizenship. An important way the culture is preserved is the use of the Spanish language. The majority of Latinos who speak Spanish also speak English. But, there are widely varying levels of proficiency in English. In 1997 ANR personnel conducted field interviews with 167 farmers in 10 counties. More than half of the respondents were Latino and spoke Spanish primarily. Virtually all respondents indicated wanting more information available to them in their own language. In response to this feedback, advisors hold conferences in Spanish for farmers and farm managers on a variety of agricultural topics. One advisor has written books on agricultural personnel management and offered them in both English and Spanish in paper form and on the Web. One advisor provides weekly radio spots in Spanish for the Hispanic radio stations. These 190 spots reach audiences in a five county area. An Advisor coordinated a 3-day Dairy Herdsman Short course held in two Central Valley locations and purchased equipment to provide simultaneous translation for those Hispanic attendees who had difficulty understanding English. Approximately 8 -10 Hispanics attended at each location. In all, the UC Division of Agriculture and Natural Resources employs more than 40 academics who speak Spanish and provides nearly 100 publications in Spanish in the ANR online publication library. The UC Small Farm Center also offers extensive materials in Spanish. In addition, the Division’s web site offers much of its information in Spanish.

Key Theme: 1.32 Small Farm Viability
Title: Agri-tourism
Scope of Impact: State
Source of Funding: Smith Lever and State
Quaint lifestyles, a rural getaway and a connection with history are commodities that can be offered to people who live in urban settings, long for a simpler life, and have money to spend. The Division's Small Farm Center has been promoting agri-tourism as one way for small-scale farms to stay in business when large-scale, vertically integrated agricultural operations keep commodity prices low and competition fierce. On one small farm, a scale-model steam engine pulls hand-made railroad cars around the five-acre Christmas tree plantation with a tree house, a nature trail, swing, hanging bridge and two miniature homes on a hillside to enhance the visitor's experience. One small producer transformed a traditional 50-acre farm on the outskirts of Watsonville into a thriving agri-tourism business. "We would never have survived just by growing berries and apples," the owner stated. She and her staff now serve fresh apple juice and apple pie, apple-themed gifts and antiques to suburbanites who visit the farm for a day in the country picking apples or berries. The Small Farm Center Director is leading a diverse group of UC staff, farmers, farm industry representatives, tour operators, educators and many others in an informal agri-tourism working group. One of its first accomplishments was the development of www.calagtour.org, an online database designed to connect tourists with genuine California farm experiences. Nearly 400 farms throughout California are in the database. Web site visitors will find excursions to pumpkin patches, corn mazes, farm-animal petting zoos, wineries, agricultural heritage museums, festivals, fairs, on-farm bed and breakfasts, and dude ranches. Those interested in purchasing farm-fresh or organic produce can also use the database for locations of roadside stands, U-pick operations and farmers' markets. Wildlife viewing, nature hikes and other environmentally based opportunities are included for people looking for the increasingly popular eco- and nature-tourism experience. All the farms are categorized and searchable by region, county and type of operation. "Agri-tourism gives people a chance to build relationships with those who produce our food and steward the land while having a chance for a fun, educational experience," said the owner of a guest ranch "It also opens a new door of opportunity for producers."

Key Theme: 3.03 Human Nutrition
Title: "Dining with Diabetes"
Scope of Impact: State
Source of Funding: Smith Lever and State
The Health Promotion and Disease Prevention Workgroup developed materials for a visual campaign to increase awareness of risk factors for diabetes and adapting a model for teaching the principles of a healthy diet to people with diabetes and their families. Both programs targeted the African American community, who, according to the needs assessment conducted last year, expressed interest in receiving more diabetes information through community-based channels. The workgroup developed a California version of the "Dining with Diabetes" (DWD) curriculum, adapted for the African American community. The workgroup chose 12 different recipes to format and test with the target group. The workgroup also provided input on additional hands-on activities to include in the unit and guidance on how to deliver the program in California. In February, a target group pilot-tested the recipes. Initial feedback from the target group was very good, but apparently two of the twelve recipes were not acceptable. Wrkgroup members reviewed progress to date and made suggestions for additional changes in the two recipes.

Key Theme: 4.14 Natural Resources Management
Title: CE Programs with Native Americans
Scope of Impact: State
Source of Funding: Smith Lever and State
Advisors throughout the state have increased efforts to work with local Native American Tribes, particularly on natural resource management topics.

One Northern California advisor had several opportunities to work with Hoopa Valley Tribal Forestry staff and several of the tribal members, some of whom are involved with forestry activities. She brought the Forestry Institute for Teachers to the reservation for exposure of their forestry program and some of their cultural values. It was a very enriching and mutually beneficial day. She also helped to host the National Network of Forest Practitioners annual meeting which was held at Hoopa. She also been worked closely with Wiyot Tribe and involved them into the Humboldt Bay and Watershed Symposium held in February 2002. The Wiyot tribal Chair opened the symposium and several members participated throughout the two days. Additionally, the Symposium poster featured a traditional Wiyot home. These combined activities allowed us to broadly highlight their history and presence in the watershed.

The program of a Central Valley advisor was directed towards understanding the relationship of natural resource management to the lives, culture and heritage of American Indians. He provided educational programs about Native American uses and management of blue oak woodlands in collaboration with the North Fork Mono Indian Reservation, Sierra Mono Museum, Picayune Rancheria of the Chuckchansi Tribe, Chuckchansi Tribal Government, Tule Indian Reservation, USDA Natural Resource Conservation Service, Coarsegold Resource Conservation Service, Central Sierra Watershed Committee and the Yosemite-Sequoia RC&D. Currently a booklet illustrating plants used by Native Americans in the foothills of Madera and Fresno Counties is being distributed to improve understanding about the uses of native plants in the lives of American Indians. He also worked with representatives of the Chuckchansi Tribal Government to develop a wild pig control strategy in wetlands used to cultivate sedges for construction of water-tight baskets and involved members of the tribe in presentations at the annual Agriculture and Natural Resources Youth Workshop.

A southern California advisor has extended his pesticide safety trainings to tribal members from various small tribes in the San Diego area. He has also involved them in research trials, establishing a litchi varietal trial and Valencia strain trial at the Pauman Band of Mission Indians reservations. This activity greatly increased the contacts with the Native Americans and they now regularly attend the Extension meetings and field tours.

Key Theme: 5.05 Children, Youth and Families At Risk
Title: 4-H "Walk on the Wild Side"
Scope of Impact: State
Source of Funding: Smith Lever and State
A California Youth Development advisor developed a 4-H environmental education camping experience for 200 fourth and fifth graders from low-income areas. More than half (54%) were African American, 25% Latino, and 15% Caucasian. For many of the students who were primarily from an urban setting, it was their first outdoor camping experience. Pre and post_test scores indicate

that On the Wild Side participants increased their vocabulary, grew in their knowledge of habitat and ecosystems, and became familiar with plants and animals of the Sierra foothills. Seventy-one percent of the participants rated their experience as excellent and 23 % rated it good. A longer range potential impact is the "On the Wild Side" will plant the seed for environmental stewardship in children who have had little or no exposure to natural settings. The program was equally enriching for the teenagers who served as teachers. One of the teen teachers commented, “"I know that we accomplished much more than to entertain our campers. Just looking at them and comparing the depth of their observations and questions about nature before and after camp was enough to prove they really learned something. And for me personally, that silent praise is the best praise anyone can ever receive."

Key Theme: 5.18 Leadership Development
Title: Teens Outreach Efforts
Scope of Impact: State
Source of Funding: Smith Lever and State
A group of 4-H county All Stars decided to create their action plan of action around involving more minorities in the 4-H program. They met with school adminstrators and identified a bi_lingual elementary school as the best location to center their efforts. They organized a Family Cultural Extravaganza to highlight potential 4-H activities for the youth with bi-lingual interpreters assisting. Approximately 150 people attended, most of them families. People signed up to become involved in the 4-H program. Families planted container vegetable gardens to take home and learned a wide variety of information. The All Stars created a 4-H Survey Questionnaire that they helped the 4th and 5th grade students complete. Based on the results of this questionnaire, they were able to identify the projects the youth would like to do in 4-H and the fact that the meeting place must be within walking distance of their homes as they must be able to walk to the activity. Another concern was money to pay the insurance fee and for materials. The All Star team contacted local agencies, banks and other funding sources to get a fund started to pay these expenses. Since this is an intercity club the projects will be those the youth would like to do that can be done within their surroundings. The All Stars recruited leaders from interested parents, school staff, a nearby retirement village and others who speak the language since this is a bi-lingual 4-H club which helped to create an atmosphere for the minority youth to feel comfortable. The impact of this project was to develop leadership skills and community outreach capabilities of the All-Star youth as well as establishing a 4-H program designed to meet the needs of the youth involved.

(3) Did the planned programs describe the expected outcomes and impacts?
The planned programs achieved many of the performance goals as described by the case study examples in Section A.

(4) *Did the planned programs result in improved program effectiveness and/or efficiency?*
Collaboration with other institutions results in efficient programs delivered to the citizens of California. Collaborative work with other instituions builds on the comparative advantage of each institution and leverages the expertise within the region/area. This results in less duplicative efforts or “reinventing the wheel” in each state. The collaborations bring about improved program efficiency, making the most effective use of the resources in each institution. This is particularly important in the current economic environment of limited or declining resources. This is illustrated, for example, in the continuing multistate activities in the Northern California/Southern

Oregon intermountain efforts and the livestock collaborations among California, Oregon, Idaho, and Nevada.

The strong integration of California's AES and CE research and extension programs ensured effective and efficient programs addressing the needs of California citizens in agriculture, human and natural resources. The strong linkages between the local county CE programs and the campus research base guaranteed that there is a research base for the county programs to draw upon as the local clientele identify the problems and issues affecting them. Through the program planning processes described in Section B., AES faculty, CE specialists and CE advisors interacted through the workgroups and Program Planning Advisory Committees throughout the year, keeping communication from the field to the laboratory constant. An example of the effectiveness of the California integrated programs was the rapid mobilization of the University researchers, CE specialists, and CE advisors to work on the Pierce's disease threat to California grapevines. When it became apparent that there was a new pest, the glassy winged sharpshooter, that could spread the disease more rapidly and threaten the statewide industry, UC researchers and extension academics were able to respond quickly due to the integrated infrastructures already in place, calling on the academics at the three Colleges at Berkeley, Davis and Riverside, and the entire statewide network of advisors to address this issue. Over 50 research projects were initiated with colleagues from state and federal agencies and industry groups.

SECTION E. MULTISTATE EXTENSION ACTIVITIES

California Cooperative Extension advisors and specialists collaborated with colleagues in other states on the following activities. By collaborating with their extension colleagues in other states, California CE professionals are able to improve their program effectiveness and efficiency by pooling their expertise on critical issues. An example of this is the C.O.I.N. collaboration. Examples of activities conducted in response to stakeholder input are: the Potato Production and Marketing programs; the Multistate Study of Epizootic Bovine Abortion in Cattle; and Impact Assessment of the Klamath Basin Water Crisis. The Rural Low Income Families: Tracking Their Well Being and Function in the Context of Welfare Reform is an example of multistate extension activities targeting an under represented population.

NATIONAL GOAL 1

Key Theme: 1.03 Agricultural Profitability
Title: Intermountain Winter Seminars
Cooperating States: CA, OR
Source of Funding: Smith Lever and State
Annual winter seminars are conducted jointly by UC and Oregon State University in the Klamath Basin. In 2002, an all-day pest management seminar was conducted as was a full-day seminar on agricultural marketing.

Key Theme: 1.03 Agricultural Profitability
Title: Harvest Aid Performance and Fiber Quality Evaluations
Cooperating States: CA, OK, TX, TN, NC, AL
Source of Funding: Smith Lever and State
California advisors continued their collaboration with researchers at University of Oklahoma, Texas A&M University, Auburn University, University of Tennessee, and the University of North Carolina to develop effective harvest aid recommendations that contribute to harvest efficiency and high fiber cotton and the evaluation of the interactions of environmental conditions on harvest aid material efficacy and effects of defoliation on fiber grade and quality. A final objective is to assist with the registration of new cotton defoliants. The research report for FY 2002 will be available in early 2003.

Key Theme: 1.05 Animal Health
Title: Multistate Study of Epizootic Bovine Abortion (EBA) or Foothill Abortion in Cattle
Cooperating States: CA OR, NV
Source of Funding: Smith Lever, Hatch, State, California Cattleman's Association
EBA is an extremely costly disease in California alone and it is probable that those costs are similar in other affected regions. EBA costs California producers about 7 million dollars per year in out-of-pocket costs. EBA is listed as a top priority problem for the California Cattlemen's Association (one of only five problems so listed). Also, pregnant cattle from unaffected areas of the U.S. simply cannot be imported into many areas of California because of the losses that would occur due to EBA. The University of California has been working on this disease problem for more than 50 years and most of the progress has been made in the last 5 years.

This project focused on the multi-state collection of specimens for further study of the tick vector (Ornithodorus coriaceus) and the detection in these ticks of the bacterium that causes EBA in cattle.

Also, further characterization of the bacterial agent of EBA was possible from the tick specimens and from tissues of calves that were aborted either in transmission experiments or naturally. One of the reasons for this progress has been the cooperative effort and the CE component of that has been substantial. The results to date would strongly suggest that we have identified genetic sequences that are unique to the EBA pathogen as we demonstrated 100% specificity and 87% sensitivity. This last year, ticks were collected from California (11 sites), Nevada (3 sites), and Oregon (3 sites). Several other sites in each state were sampled but no ticks were collected. Tick specimens collected from south central Oregon, southeastern Oregon, and central and northern Nevada helped to demonstrate that the vector and the EBA agent are common outside of California. Depending on the geographic area and the individual collection site, this test found that 5% to 30% of the ticks appear to be infected with or carrying the EBA agent. This level of prevalence helps to explain some of the variation seen in abortion rates from natural outbreaks of EBA. Preliminary identification of the etiologic agent of EBA as a member of the delta-proteobacter, and cloning of a ribosomal gene, have permitted us to develop the first diagnostic tool for EBA that does not rely solely on the pathologic examination of the fetus. An EBA- specific polymerase chain reaction (PCR) technique for sensitive and specific identification of the bacterium in both necropsy specimens and the tick vector as mentioned above has been accomplished. The data generated in the past two years has provided sufficient information on EBA to submit a competitive grant to the USDA NRI program entitled "Host-Vector-Environmental interactions in Epizootic Bovine Abortion".

Key Theme: 1.06 Animal Production Efficiency
Title: National Pork Board Extension Educators Advisory Committee
Cooperating States: CA, SC, IA, MI, MS, WA, TN, MT, VT, UT, IL, MN, GA, OK, WI, PA, OH, KS, KY, OR, NE, MO, NC, IN, ND, SD, AR, TX, AL
Source of Funding: Smith Lever and State
The National Pork Board (NPB, formerly the National Pork Producers Council) established the extension Educators Advisor Committee approximately six years ago as an advisory committee to guide the NPB staff in the development of swine specialists throughout the United States. These advisors are also responsible for the development of the Educators Conference held annually in September in Des Moines, IA. The Committee typically meets three times a year, including one meeting that involves an educational tour. California hosted the 2002 educational tour. Proceedings of the Educators Conference were distributed on a CD.

Key Theme: 1.06 Animal Production Efficiency
Title: California, Oregon, Idaho, Nevada (C.O.I.N.)
Cooperating States: CA, OR, ID, NV
Source of Funding: Smith Lever and State
The mission of this multistate project is collaborative efforts on research and education in the area of Livestock Production in the Western States. To achieve this mission a problem solving question and answer exchange has been accomplished by an email list-serve covering personnel in all participating states (California, Oregon, Idaho and Nevada). This is used on an almost daily basis by agents and advisors to coordinate joint projects, problem solve, and share research data. In addition, an annual conference/tour is hosted by a different state to increase information exchange. The 2002 meeting was held in the Imperial Valley, California on April 22-25, 2002. The meeting involved more than 35 participants from five different land grant universities. The meeting offered 15 hours of in-service

trianing and tours of local agricultural enterprisees focuing on interactions between animal agriculature and an increasingly urbanized desert environment. The COIN group activities during FY 2002 included planning the revisions to the Western States Cooperative Extension Cow-Calf Management Guide, the 1800 page publication that is also available on CD ROM. The 50 attendees at this meeting were from AZ, CO, ID, MT, NV, NM, OR, UT, WA and WY.

Key Theme: 1.27 Plant Health
Title: Spinch Downy Mildew
Cooperating States: CA, AK
Source of Funding: Smith Lever and State
A California advisor continued his collaborated with his counterpart at the University of Arkansas to identify new strains of the spinach downy mildew in California.

Key Theme: 1.28 Plant Production Efficiency
Title: Potato Production and Marketing
Cooperating States: CA, OR
Source of Funding: Smith Lever and State
The most significant threats to economically sustainable agriculture in the Klamath Basin are continuing low market prices, particularly for potatoes and the uncertainty of future water supplies for irrigation. Low market prices for potatoes the past five years have placed great economic strain on potato producers forcing some farms unto bankruptcies. The unexpected cut off of irrigation water in 2001 by the U.S. Bureau of Reclamation caused tremendous losses in farm income and placed Basin growers in even deeper financial difficulties. The following collaborative projects are helping to provide improved profitability for California and Oregon producers in the Klamath Basin.

A: Potato Seed Conditioning Trial: A California advisor and specialist and Oregon State researchers conducted field experiments at Intermountain Research and Extension Center and the OSU Klamath Experiment Station to determine whether seed conditioning (physiological aging of seed) could be used to overcome slow initial emergence after the planting of two promising new potato varieties. Reports were published in the Klamath Experiment Station Annual Report and the Annual Report to the California Potato Research Advisory Board.

B. Planting Methodology for the Production of New Potatoes: A California advisor performed trials at the Intermountain Research and Extension Center and at the Klamath Experiment Station to establish optimum planting and harvest times for the production of "new potatoes." The research resulted in the development of planting guidelines for "new potato" production and for the production of two new russet-skinned potato varieties.

C. "New Potato" Investigation: A California Advisor and an Oregon State researcher investigated "new potato" production and marketing methods and techniques in the European markets.

D. Value Added Marketing Group: A California advisor instigated and facilitated the formation of a local grower operated collective marketing group whose primary function is to establish new strategies for marketing potatoes, with particular emphasis on value added marketing. The new group is in the process of developing a strategy for the marketing of "new potatoes." The group has been successful

in striking close working relationships with the Oregon State Food Innovation Center and the UC Potato Work Group.

Key Theme: 1.28 Plant Production Efficiency
Title: Joint Cotton Projects
Cooperating States: CA, AZ
Source of Funding: Smith Lever and State
A. Variety Trial: A California advisor continued his collaborative efforts with researchers from the University of Arizona Cooperative Extension to determine which varietals would yield the best quality and quantity of cotton for a particular region. Nine cotton varieties were planted in March 2001 on three fields located near Cibola, AZ. Varieties were selected and supplied by the University of Arizona as part of the UA statewide cotton variety trial tests. Each vareity was replicated 5x, with plots being field length (approximately 1,550 ft long) x 12 rows wide. Plots were visited several times during 2001, and were picked Jan.11-14, 2002. Data were obtained and means analyzed for each variety in regards to seed cotton yields, lint, and cotton quality by using both at field measurements and ginning data. Growers and PCAs highly interested in results. Growers used results for cotton varietal choices for 2002 growing season as results reflected both yield and quality aspects for the nine varieties tested

B. Effects of twin line planting with a Monsem planter on cotton yields and micronaire: Three cotton growers in the Palo Verde Valley of California were selected to participate in the study that encompassed much of Arizona. Experimental designs were worked out with grower involvement. Cotton was planted in March, with two of the growers comparing multiple seeding rates via the twin line technique (Monosem planter) to their standard growing methods. Plots to be harvested in fall 2002.

Key Theme: 1.28 Plant Production Efficiency
Title: Cotton Production
Cooperating States: CA, LA, MS ,TX, OK, AL,TN, NC
Source of Funding: Smith Lever and State
Beltwide Root Health Study: California Extension advisors continued to work with their colleagues at Mississippi State University, Louisiana State University, and Texas A&M to quantify and demonstrate the impact of a healthy root system on yield, earliness and fiber quality and to develop cost-effective recommendations for healthy stand establishment that will enhance grow-off and performance of a cotton crop. As a result, there was an increased grower awareness of cultural practices that effect pre-harvest preparation. Updates on the study were published in the Beltwide Cotton Production Proceedings.

Key Theme: 1.28 Plant Production Efficiency
Title: N Best Management Practices for Sweet Corn
Cooperating States: CA, AZ
Source of Funding: Smith Lever and State
A California advisor worked with his Arizona colleauges on this project to identify and demonstrate N best management practices (BMPs) for sweet corn. Large amounts of fertilizer are typically used to produce high quality sweet corn. Rates of N applied to sweet corn in the desert often exceed 300 kg

N/ha. This project seeks In 2001-2002, they initiated N studies aimed at evaluating several diagnostic tools for efficient N management of sweet corn (*Zea mays*). Diagnostic tools evaluated included the traditional dry stalk nitrate-N test, the traditional soil nitrate-N test, and a quick soil test. Studies conducted in the spring and fall of 2001-2002 on sites in the Coachella Valley were designed to evaluate the response of sweet corn to side dress N fertilizer applications and test the effectiveness of various diagnostic plant and soil tests as predictive tools. Typically sweet corn planted in the spring is following lettuce, broccoli or cauliflower. Sweet corn planted in the fall generally follows leaching of the fields with large amounts of irrigation water. The interpretive summary is published in the proceedings of the Fertilizer Research Education Program.

Key Theme: 1.28 Plant Producting Efficiency
Title: Vegetable Production
Cooperating States: CA, AZ
Source of Funding: Smith Lever and State
A. Dehydrator onions: Dehydrator onion yields as affected by pre-harvest timing application intervals of AuxiGro WP: Dehydrator onions are a crop of interest to both the Parker Valley of western Arizona and the Palo Verde Valley. Two treatment timings (7 weeks, 3.5 weeks prior to harvest and both) made by commercial applications were compared in a commerical field of onions grown for dehydration. Plots were field length (~1,200 ft x 12 beds wide) and replicated three times. Plots were harvested in July ? 2001. Data indicated that eight application timing resulted in an approximately 3.5% increase, and utilziing both resulted in just under a 7% yield increase. Data were analyzed and a report write-up was submitted June 2002 to University of Arizona College of Agriculture Vegetable Report. A poster was also constructed on this subject for the joint University of Arizona/University of California Desert Crops Conference held in Yuma, AZ.

B. Vegetable diseases: A number of diseases were noted affecting area vegetable production. Pepper samples were sent to both AGDIA and the University of Arizona Plant Pathology department for diagnosis. Peppers were found to be positive for alfalfa mosic virus. Carrot samples were also sent to various plant pathologists for disease identification. Results were somewhat inconclusive due to inconsistancies/contradictions of laboratory analyses. Growers and PCAs were satisfied with most findings, as this allowed them to make management decisions based on fact.

NATIONAL GOAL 4

Key Theme: 4.12 Integrated Pest Management
Title: Alfalfa Report
Cooperating States: CA, AZ
Source of Funding: Smith Lever and State
The Alfalfa Report is a bi-monthly newsletter published by the University of Arizona Cooperative Extension Office in Yuma County. A California advisor continued to contribute insect pest management articles published in each issue.

Key Theme: 4.12 Integrated Pest Management
Title: Alfalfa
Cooperating States: CA, AZ
Source of Funding: Smith Lever and State

A. National Insecticide Bio-assay on Beet Armyworms: In collaboration with researchers at the University of Arizona Cooperative Extension, a California advisor collected beet armyworms for a national insecticide bio-assay during August 2001. The efficacy of certain pesticides were tested on beet armyworms from Parker Valley. Data indicated that beet armyworms from this area continue to have a high tolerance to the insecticide against which they were screened, although this insecticide has not been used inthe area, indicating that high temperatures are selecting out weaker inidviduals and stronger, more difficult to kill populations result. Two presentations on alfalfa insect control were organzied and given at educational meetings organized by University of Arizona Cooperative Extension for Mohave and La Paz County alfalfa producers in Feb. 2002. An educational meeting for alfalfa and forages was organized and held in Sept. 2001 in Blythe for local growers. Speakers included those from both University of Arizona and University of California Coperative Extension. Reports of previous (prior to July 1, 2001) alfalfa projects were finalized and submitted and published in University of Arizona College of Agriculture Forage and Grain Report, as well as one article for Entomological Society of America Arthropod Management Tests.

B. Cowpea aphid is a fairly new pest of low desert alfalfa in California and across southern Arizona. A previously secured grant allowed for evaluation of 29 insecticide treatments for cowpea aphid management in low desert alfalfa when this insect as well as beneficial wasps were present, as well as effects of treatments on other alfalfa pests present. Treatments were made in Feb. 2002, utilizing small plots and a replicated experimental design. Insects were sampled several times in the 15 days after application. Data were analyzed and reports published in fall 2002 in University of Arizona College of Agriculture report, as well as local extension newsletter (Palo Verde Valley Update). A poster presentation of the report was also accepted and presented at the 2002 Western State Alfalfa and Forage Symposium in Sparks, NV (Dec. 2002). Data indicated that best control was achieved by Furadan and organophosphate insecticides (especially low rates of Lorsban) when cowpea aphids are low on the stems and parasitic wasps are present. Pyrethroid insecticides were much more effective in controlling blue alfalfa aphids than were the organophosphate insecticides. PCAs and growers are currently utilizing the results in their management for cowpea aphid in area alfalfa.

Key Theme: 4.12 Integrated Pest Management
Title: Western IPM Coordination
Cooperating States: Western States
Source of Funding: Smith Lever and State

A California IPM advisor is the IPM Coordinator for the IPM Program at CSREES. He attended the Western IPM Coordinators meeting in April with his western states counterparts and developed the Plan of Work (2000-2004) for the IPM Program (Smith-Lever 3(d) IPM Extension funds) and reported the activities through the Program Performance and Results System (PPRS). The Western IPM Coordinators met in San Diego from in April, 2002. IPM coordinators from the western region were present including Hawaii, Guam, American Samoa, AK, OR, WA, UT, MT, CO, and WY. In addition to a tour arranged by local Farm Advisors, the Coordinators discussed national and region issues

including the National IPM Symposium, development of regional workshops, and funding opportunities. I

Key Theme: 4.12 Integrated Pest Management
Title: Cotton Pest Management Activities
Cooperating States: CA, AZ, MS
Source of Funding: Smith Lever and State
A California advisor interacted with CE colleagues in Arizona to develop outreach programs for whitefly in cotton and attended the Cotton Entomology Pest Management Seminar in Georgia in October 2001, at which pest updates are provided, cooperative research is planned, and useful publications exchanged.

Key Theme: 4.14 Natural Resources Management
Title: Impact Assessment of the Klamath Basin Water Crisis
Cooperating States: CA, OR
Source of Funding: Smith Lever and State
In response to the expressed desire of local stakeholders for complete and reliable information presented in one place with extensive references, a team of more than a dozen faculty from the University of California and Oregon State University worked on a report to chronicle the impacts and potential impacts of the irrigation water cut off that occurred in the Klamath Basin in 2001. The chapters are organized to cover impacts in four general areas, social, environmental, natural resources and public policy. The report was prepared in a very short time frame so that it may be used to make more fully informed decisions regarding future water policies in the Basin. The report is available on line at: http//eesc.orst.edu/klamath

Key Theme: 4.14 Natural Resources Management
Title: Tri-State Intermountain Workgroup
Cooperating States: CA, OR, NV
Source of Funding: Smith Lever and State
This workgroup is composed of faculty, specialists, agents, and administrators from Oregon, Nevada, and California Cooperative Extension Services. The group meets each January for three days to share program information, applied research results, and discuss issues of regional importance. The group met in Reno, Nevada in January 2002 to identify the priority projects for the region. Three priorities were identified: Sage Grouse Conservation Strategies, Water Quality and Stream Temperature Monitoring, and Invasive Species Spread of Noxious Weeds on Rangeland.

A. Experiment to Control Medusahead and Revegetate Medusahead Infested Lands: The experiment examines herbicide, burning and/or cultivation combinations to determine the best integrated control strategy for medusahead in the intermountain area. Different plots were reseeded with competitive, introduced and native grasses to evaluate revegetation success after control. Several of the experimental treatments were successful at controlling medusahead. The impacts of the project include 1) BASF is using the results to support registration of Plateau (herbicide used in the experiment) in California and 2) Bureau of Land Management personnel are considering adopting medusahead management protocols developed in the experiment. Hopefully in 2003, the project will have results on re-vegetation techniques for medusahead management to help BLM and private

landowners manage medusahead on their property. Cooperating States: CA, OR

B. Sage Grouse Conservation Strategies: California advisors worked with Nevada and Oregon Agents to develop and conduct workshops for clientele to bring them up to speed on the Conservation Strategy development process for California and Oregon Sage Grouse populations. Workshops were held in California and Oregon in March 2002.

C. Water Quality and Stream Monitoring: This was identified as a high priority issue, particularly in SE Oregon and NE California. California advisors and their Oregon counterparts have been monitoring streams in the Goose Lake Basin which stretches across the California/ Oregon border for the past 10 years. This was the first comprehensive monitoring program in Oregon and California, and the advisors are developing two peer-reviewed papers to publish our results. They also collaborated with an OSU Range Science faculty member and conducted a Watershed and Environmental Sustainability Techniques Workshop in Oregon in September 2002.

Key theme: 4.23 Water Quality
Title: An Evaluation of the Effectiveness of Livestock Distribution Practices in Grazed Watersheds
Cooperating States: CA, OR, ID, MT
Source of Funding: Smith Lever and State
Nonpoint source pollution, 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. However, policy makers, regulators and land managers 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. In response to this need, identified jointly with ranchers, UC academics worked with their colleauges in Oregon, Idaho and Montana to bring together basic research on behavioral mechanisms that regulate herbivore distribution patterns and the emerging field of landscape ecology to develop strategies and practices for attracting cattle away from riparian zones or other environmentally critical areas. The results of the project will be applicable to range livestock operations throughout the west.

This three state project worked on field livestock distribution studies and on modeling/data analysis components of the project. Modeling: Project participants met to develop a conceptual model of an animal distribution model and collected data on landscape temperature data in study pastures in Montana, California, Idaho and Oregon. Equations are being developed that relate the landscape temperature data to solar isolation. Montana Herding Study: A study was initiated to quantify the effectiveness of herding to protect riparian areas and an additional 2-year study was initiated to evaluate the effectiveness of supplement placement without herding on cattle grazing. Effectiveness of treatments in this study cannot be estimated until the end of the field season next year. Cow tracking

studies were completed in four pastures during four seasons this year. The vegetation data, forage quality data and the cow position data is currently being analyzing from this study. Preliminary observations indicate that the supplement was an effective attractant. However while the supplement sites were strong attractants cattle often moved to other locations to graze. These data require extensive analysis and we will run similar studies at other ranches during 2003. The potential impact of these studes will be improved application of livestock distribution practices so that livestock can be attracted away from environmentally critical areas and attracted into areas where grazing is being used as a tool to manipulate vegetation.

Key Theme: 4.23 Water Quality
Title: Optimization of Water and N Application Efficiency for Surface Irrigated Production Systems
Cooperating States: CA, AZ
Source of Funding: Smith Lever and State
The low deserts soils are commonly used for the production of high value vegetable crops. Water scarcity in the arid southwestern United States is a major impetus for improving water use efficiency in agriculture. Nitrate contamination of surface and groundwater is often associated with excessive irrigation and fertigation practices. A California advisor and his Arizona colleagues are conducting a study to develop new design and management approaches and guidelines for N-fertigation system in surface irrigation settings through field experiments and modeling simulation studies. The objective is to conduct field experiments to develop database for the calibration and validation of surface hydraulics and chemical transport models. Such models will be used to develop improved management guidelines for the N-fertigation practices in the desert southwest. The research project is underway at two locations, one in Arizona and one in California. Results in 2002 were presented at the American Society of Agricultural Engineers Annual meeting (July 2002), Irrigation and Salinity Management meeting at the USDA Service Center (April 2002); Irrigation Practices for Nutrient Management in the Imperial Valley and an abstract and poster was presented at CAPCA's 28th Annual Pest Management and Nutrient Conference and Agri-Expo, Anaheim, CA. October 2002: and a Vegetable Crop meeting in Yuma, AZ in December 2002. Our growers are under continuous pressure to save water and reduce the amount of nitrogen and fertilizers in surface and subsurface drainage. Results from our work will develop guidelines for new fertigation practices under varying soil and irrigation management practices.

NATIONAL GOAL 5

Key Theme: 5.16 Impact of Change on Rural Communities
Title: Rural Low Income Families: Tracking Their Well Being and Function in the Context of Welfare Reform plan (Multistate Project NC-223)
Cooperating States: CA, CO, ID, IN, KT, LA, MN, MS, MA, MI, NE, NH, OH, OR, UT, WY
Source of Funding: Smith Lever and State
A California Nutrition, Family and Consumer Sciences Advisor worked with colleagues in Colorado, Idaho, Indiana, Kentucky, Louisiana, Minnesota, Missouri, Massachusetts, Michigan, Nebraska, New Hampshire, Ohio, Oregon, Utah, and Wyoming ject documenting welfare reform impacts from the perspective of rural family members to provide insights to agencies and policy makers as they adjust welfare reform to enhance and change rural family functioning within their rural communities. A

group of low income families are being tracked in each state to determine the impact of welfare reform in rural America. In California, 40 mostly Latino low income families from two Central Valley counties are being tracked. As part of the study, participants were surveyed annually about income, work status, money management, health care, nutriton, food security and transportation. Results of the first year indicated that 75% of the families eligible for Food Stamps were not enrolled and just 19% of the eligible familes used food stamps. The second year's data is being analyzed and final interviews are being conducted

Key Theme: 5.18 Leadership Training and Development
Title: 4-H Cooperative Curriculum System, Leadership Curriculum
Cooperating States: CA, SC, OR, MD, AZ, ID, OR, ND, WI, ID
Source of Funding: Smith Lever and State
A California advisor re-wrote and edited the eight activities curriculum geared towards developing leadership skills amongst adolescents in grades K-12 developed by the group earlier. She also recruited 4-H volunteers and community partners to pilot the new curriculums.

Key Theme: 5.18 Leadership Training and Development
Title: National Junior Horticultural Association (NJHA)
Cooperating States: CA, OH, MI, NC, KY, PA
Source of Funding: Smith Lever and State
A California advisor served as the national program chairman for NJHA; his responsibilities included a large diversity of activities, ranging from working with the national officers team (youth from Ohio, Michigan, North Carolina, Kentucky, Pennsylvania) and their advisor, keeping state leaders across the nation informed about upcoming events, developing new projects for the national level, and helping to organize the national convention as well as securing new national project leaders and state leaders as necessary, while also promoitng NJHA in California. He initiated a new project, Horticultural Connections, that was officially begun as a national event at the convention in fall 2001. Through his efforts with the other officers, youth officers gained great experiences in their leadership abilities, and youth attending the convention greatly expanded their horticultural knowledge in their preparations for the various contests at the convention (speech, demonstration, expeimental horticulture, etc.). Approximately 200 youth attended the convention, with 12 states entering teams in the 4-H division of the Horticulture Identification and Judging contest. Many people commented that the convention was very good.

Key Theme: 5.28 Youth Development
Title: National CREES/NREM CES-YES Website
Cooperating States: CA, WI, CT. WY, VT, GA, IL, FL, IN
Source of Funding: Smith Lever and State
A California advisor involved with the National CREES/NREM CES-YES Design Team produced a website that was launched at the North American Association for Environmental Education Conference in October 2001. The website provides tools and resources for 4-H leaders, County Agents/Advisors and Specials on "how-to-do" environmental education and how to partner with members of the national natural resources agencies: USFS, USGS, USFWS, BLM, NRCS and others.

The website also makes connections to Department of Education standards and service learning opportunities that utilize the environment as the back drop for that learning.

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 Univesity 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.

Strong examples f how this occurs are the coordinating conferences that bring together department Agricultural Experiment Station (AES) faculty and Cooperative Extension (CE) specialists, CE advisors, and selected clientele into a Divisionwide forum. These annual conferences promote effective communication and interaction among the members and promote statewide programmatic coordination of research and outreach activities relating to a major subject matter or commodity area. The objectives of a coordinating conference are to: 1) foster interactions, communication, and collaboration across traditional intercampus, interdisciplinary and interdepartmental boundaries, and among campus and county-based academic staff; 2) create a more visible and active focal point - both within and outside the University - for research and outreach activities; and 3) facilitate the formation

and activities of appropriate workgroups addressing targeted areas within the overall programmatic area. Below are two examples of areas where the integration of AES and CE work well.

Natural Resource Coordinating Conference (NRCC): This is held annually, and involves Range, livestock, forest, marine, wildlife, fisheries, environmental policy, youth education, and general natural resource advisors, specialists and faculty members participate in the NRCC. The objective of the Coordinating Conference is to bring together the workgroups, special projects, and AES and CE academics working in the broad area of natural resources to identify current priorities in natural resources; provide training on current high priority topics (past topics have included biodiversity, riparian restoration, fire ecology, natural resources in agriculture, marine and terrestrial interface, salmon ecology and management); present successful examples of effective natural resource programming; build teams of advisors, specialists, and faculty to develop responses to issues; and become aware of emerging natural resource policy issues. THE NRCC was held in April 2002 with the focus on current and emerging research and extension programs within ANR in restoration ecology and conservation biology. Thergroup discussed where ANR programs should be heading, given the current base of interest in these important areas. All participants learned about the accomplishments and future plans of the Natural Resource workgroups The program also allowed for special breakout sessions of the various workgroups and statewide special projects and five special workgroup meetings coordinated with the NRCC. Post- conference field tours of restoration and conservation biology programs in the Sacramento Valley area.. The field trip provided opportunity for ANR staff and natural resource clientele with the various agencies to become familiar with each others' programs and needs such as wetland, fisheries restoration, threatened and endangered species management, and water management interface issues

Nutrition Coordinating Conference: The annual Nutrition Coordinating Conference serves as the "umbrella" group to bring together professionals from the nutrition and health community to provide continual input on current critical nutrition and health issues facing California's population. It provides the forum for active, effective communication and action among its members.focuses on providing a cohesive, coordinated food and nutrition program for California which includes food and nutrition issues that in some cases, may be addressed in greater detail by other workgroups. In order for an effective food and nutrition program, based on sound science-based nutrition information to be delivered to California consumers, it is critical that members of the professional community remain up-to-date on current nutrition and health issues. In turn, it is imperative that those performing the basic and applied research are aware of the nutrition and health-related problems facing the diverse subgroups of California's population. The February 2002 Coordinating Conference highlighted nutrition research updates by representatives from advisors, specialists, faculty, and non-ANR partnersand provided the opportunity for identification and discussion of the critical nutrition issues facing Californians. It also provided additional coordination and communication between the special research and outreach activities of the related food and nutrition workgroups, including LIFE (Linking Individuals, Families, and Economics), Maternal and Infant Nutrition, Building Food Security, Body Weight and health, Anemia Prevention for High Risk Groups and Health Promotion and Chronic Disease Risk. This ““umbrella”” workgroup has strengthened the collaborations among specialists, faculty, scientists from the WHNRC (USDA-Human Nutrition Research Center), advisors, and non-ANR/UC nutrition and health professionals. These interactions have strengthened the already existing

partnerships among the professional community and ignited further interest in working together to develop research-based cohesive nutrition education programs.