University of California
Division of Agriculture and Natural Resources
Agricultural Experiment Station and Cooperative Extension

ANNUAL REPORT OF ACCOMPLISHMENTS AND RESULTS FY 2001

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University of California
FY 2001 Annual Report of Accomplishments and Results

SECTION A. PLANNED PROGRAMS

The University of California Division of Agriculture and Natural Resources (UC-DANR) 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-DANR 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 10 Research and Extension Centers and 33 sites of the Natural Reserve System.

The AES has about 650 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 140 specialists and 260 advisors.

UC-DANR'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 produces more than 350 crop or animal commodities. University of California Division of Agriculture and Natural Resources (DANR) researchers and extension specialists and advisors continued to develop and extend research-based knowledge to address the agricultural issues facing California producers. Changes in demographics, the emerging markets, global income growth, new production areas, losses in agricultural production, loss of wildlife habitat, new introduced invasive species, and regulatory issues cause a continuing requirement for increased and more efficient production and for development of new cultivars or breeds in plant and animal agriculture.

Last year, over 500 local extension programs were delivered in this area. In addition, 44 statewide collaborative workgroups composed of both AES and CE academics planned and conducted research and extension projects. California academics published 1,395 peer-reviewed articles and 450 extension publications to address Goal 1 and 17 patents were issued.

FY 2000-2001 Allocated Resources

Extension Federal Funds (Smith Lever 3 b&c)	Extension State Match	Research Federal Funds (Hatch)	Research State Match
$3,202,048	$22,164,262 [167.11 FTE]	$2,808,316	$58,496,017 [235.32 FTE]

UC-DANR's Agricultural Resources Programs Covering:

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

AGRICULTURAL PRODUCTIVITY AND EFFICIENCY

Dramatic changes in California agriculture's products, production and marketing are called for if agriculture is to remain a robust part of the state's economy. Overproduction, global oversupply, invasive species, competition for water and labor, and the pressure for urbanization of prime agricultural areas threaten the profitability of agriculture. The answers to these threats lie in the development of innovative marketing strategies, new crops and products, and new ways to produce them. In the future there may be 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, and maintain prices at a level adequate to ensure profitability and sustainability for California's farmers. In a global marketplace, this strategy will only be successful if California's agricultural products are clearly differentiated from those of other producers. Researchers may explore the development of premium-quality grade standards, seizing

the opportunity to speed the transition to organic agriculture, developing new ways of processing and packaging familiar products, and exploiting 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, UC research and extension 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.

The California AES faculty, Cooperative Extension specialists, and CE advisors working in fields related to the productivity and efficiency of agriculture reported their research and education efforts during 2001 in a total of 723 peer-reviewed publications, 241 extension publications, and 39 other educational vehicles. In addition, 293 Extension programs were delivered and 12 patents were issued and 32 statewide collaborative workgroups composed of both AES and CE academics planned and conducted research and extension projects From the numerous projects in which they are engaged, selected examples of projects, accomplishments, and impacts are displayed below in a range of key areas: aquaculture, genetic manipulation of animals, plant genomics and breeding, plant nutrition, marketing, tree crops, management of dairy wastes, and new crops.

Research and Extension Performance Goals:

- Enhanced management methods in agriculture by: developing management systems that integrate resistant cultivars and breeds; developing plant or animal germplasm with resistance to pests; developing monitoring systems and teams to detect and manage pest outbreaks; developing improved comprehensive management systems and methods for extending information on plant and animal health.
- Improved soil quality by developing improved agricultural systems based on long-term multidisciplinary studies of rotational or other management effects.

Outputs, outcomes and impacts:

Aquaculture

Globally, fish are an important food source, and wild capture of fish has historically been the largest component of this food source. The collapse of many important marine fisheries, due to a range of factors, including over-fishing, loss of habitat and other environmental changes has increased interest in aquaculture, the captive rearing of marine and freshwater species, to complement the wild catch. It has been suggested that the wholesale value of aquaculture in the U.S. might rise from the present $900 million to as much as $5 billion in the next decade. To achieve this unparalleled growth will require vigorous research and outreach programs, and DANR academics have been actively engaged in such activities for the past year.

Research and outreach objectives include:

- **Determining the environmental requirements of potential aquaculture fish species**: Fishes (especially threatened or endangered species) may be cultured for restorative stocking into their native habitats. The threatened delta smelt (Hypomesus transpacificus) is native to

California's Sacramento - San Joaquin 'Delta' estuary. To most efficiently culture delta smelt and to better understand its environmental limitations and those of the introduced exotic wakasagi (H. nipponensis), UC researchers measured the temperature, salinity, and water velocity (current) tolerance limits of these congeneric species in controlled laboratory experiments. These studies had special significance because the wakasagi has been proposed as a delta smelt surrogate in 'fish-friendly' pumps tests. Wakasagi had a higher mean critical thermal maximum (29.1, vs. 25.4 C for delta smelt), lower mean critical thermal minimum (2.3, vs. 7.5 C for delta smelt), higher upper salinity tolerance (26.8, vs. 19.1 ppt for delta smelt), and swam faster (for 6.0-6.9 cm standard length fish: 43.3 cm/s, vs. 28.2 cm/s for delta smelt) than delta smelt. Thus, the native delta smelt may be at a physiological disadvantage, particularly in habitats with suboptimal environmental conditions. The introduced wakasagi is more tolerant of temperature, salinity, and water current conditions, and may be more successful in shallow-water habitat restoration sites designed for delta smelt. Finally, the significant differences between these species' environmental tolerance limits argue against using the wakasagi as a delta smelt surrogate. Elucidation of environmental requirements and tolerance limits for important variables such as temperature, salinity, and water current will help delta smelt culturists create optimal conditions for delta smelt in their culture systems. Further, elucidation of the species-specific differences in these limits between the native delta smelt and the introduced wakasagi will allow environmental resource managers to better design restorative stocking and habitat management strategies to maximize the survival of the native delta smelt.

- **Genetics of fish for aquaculture and conservation**: The objectives of this project are to simultaneously develop a molecular genetic map of the genome and identify quantitative trait loci in salmon and tilapia; to apply standard breed improvement techniques for the improvement of tilapia and coho salmon; to extend the breed improvement methodology as genetic markers become available and to apply the genetic marker technology to studies of natural populations with reference to fishery management and conservation activities by local and national agencies. The one strain (4-way cross) from the Artificial Center of Origin (ACO) created from four species of tilapia was carried through a random mating generation (Gen 0) in preparation for the development of selection lines. The progeny of the Gen 0 were assigned randomly to three lines: control, growth in cold water, and growth in saline water. Several experiments were conducted to study the genetic basis of cold tolerance. Four genomic maps were completed using a 3WC family and a 4WC family. In addition, a 4WC family was used to assess the potential of identifying quantitative trait loci for cold tolerance and body size. Based on microsatellite loci, 442 markers were mapped to 24 composite linkage groups. Preliminary screening for loci associated with cold tolerance and body weight identified several potential markers clustered in a few linkage groups, suggesting they may be indicative of quantitative trait loci. The genetic material available in the recombined genome of the four species will allow the project to extract very unique strains with superior performance characteristics. In addition, the development of molecular technology for the species has provided material of value in studying the genetics of other fish species as well as identifyingantitative trait loci affecting performance characters important to farmed tilapia.

Tilapia culture in temperate regions is affected negatively by species' sensitivity to low temperature, so the identification of QTL for cold tolerance will enhance a breeding program designed to create cold tolerant strains. The project was successful in identifying a number of putative QTL. The results suggest that a breeding program for cold tolerance would be successful, and confirm that a new stock of tilapia can be developed using the composite cross approach and that there is potential for expanding the range of tilapia culture into more temperate regions.

- **Engineering systems for aquaculture:** The general objective of this project is to improve the scientific and engineering basis for aquaculture practices. Specific objectives include:

    1. developing technologies for improving the efficiency of water use in aquaculture systems and minimizing the negative environmental impacts from aquaculture;
    2. developing improved processes and equipment for unit operations carried out in aquaculture;
    3. developing instrumentation suitable for field use in aquaculture.

    Work continues on the development of methods to remove solids from aquaculture raceways. A device was developed for the continuous removal of solids from a raceway. The device is called the ASSIST and is installed in the quiescent zone of a raceway. The ASSIST creates a circular motion on the raceway effluent and partitions the flow into two fractions. One part carries over 90% of the water flow and under 10% to 50% of the solids in the effluent (depending on solids characteristics), and a second part with under 10% of the water flow carries the majority of the solids. The ASSIST was tested in 1/5 and 1/2 scale models using particles with settling characteristics analogous to those in a full scale aquaculture raceway. Water quality model development work has continued. The focus has been on models of solids removal through screening and sedimentation. A method to convert a settling velocity distribution to a particle size distribution, was developed for the screening model. This particle size distribution was used with newly proposed relationships to estimate particle removal as a function of particle and screen opening size. Empirical settling velocity distribution curves were used to estimate particle removal and settling velocity distribution changes in a sedimentation tank model. The model is configured to account for treatment costs in addition to the water quality impact calculations. Preliminary work toward the development of a hydrodynamic model of flow in an aquaculture raceway has started. The model will be used to study flow patterns and movement of particulates in raceways used for the intensive production of trout. The model will also be used to develop methods to improve solids and nutrient (phosphorus) removal from raceway effluents.

- **Enhancing reproduction of sturgeon**: There were two main objectives of this research. Objective 1 (final ovarian maturation of white sturgeon): The in vitro effects of commercial steroids on the maturation of ovarian follicles were investigated. The bioassay results revealed that several C21 steroids (progesterone and its metabolites) are potent maturation steroids in sturgeon inducing oocyte meiosis in the range of concentrations 4-32 ng/ml. All of these

steroids were previously found to be produced by ovarian follicles from gonadotropin-primed sturgeon females during oocyte maturation and ovulation. Objective 2 (reproduction of green sturgeon): There was continued development of artificial spawning techniques and collection of tissue samples from wild broodstock at the Klamath River, California. Pilot experiment was conducted to examine temperature range of green sturgeon embryos. Hatching occurred at temperatures 11-20^{o} C, with significantly higher rates at 14-17^{o} C and 100% mortality at 23^{o} C. The use of maturation-inducing steroid hormones will provide research and diagnostic tools for enhancing reproduction in domestic white sturgeon broodstocks utilized by the aquaculture industry. Temperature tolerance range of green sturgeon embryos indicates that its natural reproduction may be affected by rising river temperatures in spring, particularly during the years of low flow. Over one million pounds of sturgeon were produced annually by California farmers since 1992 (1.4 - 1.5 million pounds in 1995). The value of the fish and the potential in the future for a caviar industry to substitute for increasingly scarce and expensive Eastern European products indicate the potential impact of this work.

- **Genetic maps of aquaculture species - Pacific oyster**: The Pacific oyster, Crassostrea gigas, is the most farmed aquatic species in the world, according to FAO statistics. Farming of this species on the West Coast provides more than one-third of the annual U.S. oyster production but is based on the propagation of wild stock. Selection and crossbreeding could be used to improve growth of farmed oysters. To benefit ongoing commercial breeding programs for this oyster, the goal of this project is to develop a genetic linkage map, using at least 100 microsatellite markers. This project will construct a moderately dense linkage map of the Pacific oyster, tie linkage groups to specific chromosomes, map genes controlling hybrid vigor for growth, and test hypotheses about recently discovered lethal genes. At the Bodega Marine Laboratory (BML), four outbred families were produced, for linkage mapping, from parents and grandparents of known pedigree. To generate markers, researchers constructed four microsatellite-enriched libraries with CA, GA, TAG, and TAGA repeat motifs. So far, 103 clones have been sequenced and there are presently 27 markers on a consensus linkage map, comprising 9 (of 10 expected) linkage groups. A preliminary analysis of microsatellite markers in putative trisomic oysters showed that four separate linkage groups appeared to be associated on two different chromosomes. In November 2000, UC researchers established an active collaboration with a colleague's laboratory at Keio University, Tokyo, Japan. The researcher has a bacterial artificial chromosome (BAC) library of the Pacific oyster genome. Primers or clones for mapped microsatellite markers are being sent to Keio, so researchers there can determine which BAC clones contain mapped markers. BAC clones containing mapped markers will then be sent to another NE-186 participant at Rutgers University, who can locate them on specific chromosomes, using fluorescent in-situ hybridization (FISH). Researchers should then be able to align the linkage, physical, and cytological maps of the Pacific oyster. So far, the impact of this research has been on other participants, through communication of results at the annual meeting. Other investigators working on oyster genetics, genomics and breeding have adopted experimental protocols pioneered at BML. Primers for microsatellite markers have been exchanged among participants to facilitate coordination of gene-mapping efforts on three continents. It is too early for this project to have

benefited oyster farmers, but eventually it will be a key tool in improving productivity through directed breeding of oysters with better production and disease resistance characteristics.

- **Thermal resistance and stress proteins of artemia**: Encysted embryos (cysts) of the brine shrimp Artemia are used as an important food source in aquaculture. Researchers have shown that the stress protein/molecular chaperone called p26 is present in massive amounts in encysted embryos of the brine shrimp. The stress-induced inhibitory effects of p26 on the synthesis of RNA (transcription) in vitro result from protection of many nuclear components and are not due to p26 acting as a specific transcription factor. These biochemical studies correlated with detailed electron microscopical observations on stress-induced, major changes in nuclear ultrastructure. An unexpected outcome of this study was the finding that embryos containing p26 in the nuclei of their cells do not hatch under otherwise permissive conditions, and the researchers hypothesized that those embryos were somehow locked in diapause (a state of developmental and metabolic arrest). Further understanding of that result could prove to be of economic importance since the hatching percentage of cyst samples is a direct function of their value and, therefore, cost. Research has also continued into the analysis of heat resistance of artemia embryos from different thermal habitats around the world. The resistance of cysts to high temperature is closely correlated with their content of p26, and not with other stress protein families. That outcome is readily understandable since it is known that p26 is a molecular chaperone, protecting other embryonic proteins from irreversible damage. Studies in vitro have described interactions between p26 chaperone function and the sugar trehalose, also present in large concentrations in cysts. Interestingly, trehalose and p26 interact synergistically in model systems designed to evaluate chaperone function in vitro. By studying the basic biology of cysts, particularly the biochemical basis of their stress-resistance, there are hopes to optimize their use in the industry by improving cyst viability (hatch rate) and shelf-life (storage). Both are major economic considerations for many aquaculture operations world-wide

Genetic Manipulation of Animals

California's animal industries are among the most important contributors to the state's agriculture; production of milk and beef typically rank among California's top five agricultural industries. Future increases in productivity in animal industries will depend on strategic utilization of the information obtained by DANR researchers. In particular, UC researchers continue to examine the opportunities in genetic manipulation of animals. Three exemplars of projects in this area are provided.

- **Reproductive performance in domestic ruminants**: The objective of these studies is development and implementation of management techniques that will improve the well being of domestic and wild species. Researchers have focused on development of immunologic means of suppressing testicular development and function in domestic species. They call these immunology-based means of testicular suppression 'immunocastration'. The approach to immunocastration is centered on the development of a vaccine directed against a key hormone (gonadotropin-releasing hormone; GnRH) in the endocrine pathway leading to development

and function of gonadal tissue. In general, gonadal tissue in vaccinated animals remains infantile and non-functional and, thus, the animals are immunologically, but not physically, castrated. This technology has wide application as an effective alternative to surgical castration in the management of domestic and companion animals and is currently under investigation as a means of population control in feral animals. Recent studies demonstrate that this immunocastration procedure is effective in a variety of domestic ruminants, including beef cattle, sheep, pigs and fallow deer. Vaccination against GnRH markedly reduces testis size and serum concentrations of testosterone in intact bulls. Immunocastration also significantly reduces the aggressive behavior of bulls, while producing carcasses that are bull-like in size, but steer-like in marbling and quality grade. In addition, immunocastration does not require the equipment and labor costs associated with conventional castration and immunocastrated animals are not subject to the stress and decreased food consumption and growth that commonly follows physical castration. Recent studies indicate that immunocastration produces carcasses that weigh, on average, 50 lbs more than carcasses from animals subject to conventional castration. From an economic point of view, this translates into a $40 to $50 improvement in return for each animal. The same procedure can be used in heifer calves to increase the ease of calf management and reduce the incidence of inadvertent pregnancy in heifers destined for the feedlot. This is an important concern, particularly when feeding heifers to slaughter. Indeed, many feedlot managers report that the incidence of unintended pregnancy among heifers at feedlot entry is often as high as 25%. The resultant cost of abortion and decreased productivity is estimated to be as much as $100 per pregnant heifer. Immunocastration technology may be particularly useful in ensuring that feedlot heifers are open and reproductively inactive. This is likely to have a significant economic impact, not only due to improved feed efficiency, but also due to cost savings resulting from the absence of pregnancy.

Immunocastration technology also effectively suppresses testosterone secretion, aggressive behavior and antler growth in Fallow deer. This underscores the utility of immunocastration in non-traditional domestic species and suggests that active immunization against GnRH may prove useful in the control of feral populations of deer and other wild ruminants. The control of these populations is an increasing concern at the urban-rural interface where population control by predation or hunting may be limited, inappropriate and unsafe or unacceptable. Finally, current work examines the utility of active or passive immunization against GnRH for the swine producers of California. Intact male pigs (boars) grow more rapidly and produce a leaner and more healthful carcass than castrated males (barrows). However, the carcasses from boars are often impregnated with a metabolite of testosterone that imparts an objectionable odor and taste, called boar taint. To eliminate boar taint most male pigs are castrated before 1 week of age. Recent studies clearly demonstrate that testicular growth and maturation is arrested in male pigs actively immunized against GnRH 84 days before slaughter. In addition, testosterone production is markedly reduced in immunocastrated pigs and both objective and subjective measures of boar taint are significantly reduced as a result of the immunization procedure. Collectively these observations indicate that immunocastration

may be an effective, humane and non-invasive alternative to physical castration in the management of boars.

- **Germ cell and embryo development and manipulation for the improvement of livestock:** Research is being conducted on refinement methods for production of genetically modified animals to improve livestock production efficiency. An experiment is underway to determine the degree of effect of differentiation on the capacity of a somatic cell to be reprogrammed by nuclear transfer. Various cell types including skin fibroblasts, cumulus cells and mammary epithelium are being tested for their ability to produce nuclear-transfer blastocysts. In early experiments nuclear-transfer embryos are being cultured with blastocyst development the primary endpoint. Later nuclear-transfer blastocysts will be transferred to synchronized recipients and the pregnancies monitored to term. Approximately 10-20% of fused nuclear-transfer embryos from both fibroblasts and cumulus cells develop in culture to the blastocyst stage. This experiment is ongoing and data are preliminary. Somatic cloning procedures have been proposed as a new technique to 'genetically engineered' livestock species. Nuclear transfer allows genetic changes that are introduced in vitro into a somatic cell to be translated into a living animal. The large-offspring syndrome has been an unexpected consequence of in vitro manipulation of embryos in cattle and sheep. Understanding the mechanism behind this undesirable syndrome is the first step toward learning how to prevent it. Especially for cattle, in vitro fertilization procedures could benefit animal agriculture and is expected in the future to have an important impact on California's $6.3 billion livestock industry.

- **Genetic bases for resistance and immunity to avian diseases**: The objectives of this project are to identify and characterize genes and their relationships to disease resistance in poultry with an emphasis on the major histocompatibility complex as well as other genes encoding alloantigens, communication molecules and their receptors and other candidate systems. Research was completed on the topic of genetic variation within and among commercial broiler and layers lines. The locus studied was the ribosomal DNA complex encoding the 18S,5.8S,28S ribosomal RNA genes. This locus is of critical importance for ribosome production and it is linked to the major histocompatibility complex (MHC). The data indicated that commercial broiler populations show greater levels of diversity than egg-production stocks; the latter showing a high degree of similarity between individuals within lines and among foundation lines from different primary breeder firms. Difference in diversity may be related to the genetic base of the broiler populations (derived from several breeds) and layers (derived from a single breed) but also selection parameters used for broilers versus layers populations. New collaborative research is underway to establish the developmental profile for expression of major histocompatibility complex genes during embryonic development, which may affect cellular interactions prior to and during morphogenesis, impacting the success of several biotechnology efforts (culture of embryonic blastodermal cells, creation of germline chimeras from blastodermal cells). Several studies have now shown that commercial egg production (layer) foundation populations have reduced levels of genetic variation. This is cause for concern and consideration should a new or variant major disease emerge affecting

commercial populations. Thus this research provides important information that could be used to avoid significant losses in California's $238 million egg production industry.

Plant Genomics and Breeding

Division researchers are in the forefront, internationally, in research that is laying the groundwork for using plant genomics. The information that is being obtained in their research will provide tools that can be used in conventional breeding, or with plant biotechnology to improve plant productivity, reduce production costs, and improve output traits (quality, longevity, flavor).

- **Structure and function of the 60s ribosomal subunit P-protein complex in plants**: Crop yield is ultimately determined by the level and duration of synthesis of specific proteins. Ribosomes are responsible for protein synthesis in all organisms. An understanding of the structure and function of this complex organelle could greatly enhance manipulation of plant products and yield. Researchers have shown that heterogeneity exists in plant ribosomes. A complex of acidic phosphoproteins (the P-protein complex) of the 60S ribosomal subunit is a highly variable feature of the ribosome. This structure functional interacts with eukaryotic elongation factor(eEF)-2 and may play a role in the selection of mRNA translation and rate of ribosome translocation in plants. By use of antisera that specifically recognize the four types of P-protein in maize ribosomes, they documented significant heterogeneity in the levels of these proteins at specific stages of seedling and kernel development. Current studies are aimed at determining the significance of P2 heterogeneity in P-protein composition in the regulation of protein synthesis. This research provides significant new information on ribosome structure and function in plant cells and may have considerable impact on biotechnological approaches to engineering the crops that form the basis of California's $25 billion agricultural industry.

- **Disease and insect resistence of celery**: The traits of interest in this crop, valued at $309 million in 2000, are resistance to fusarium, late blight, leafminer and celery mosaic virus (CeMV, also known as Western Yellows). This year two new experimental fusarium resistant F1 hybrids were produced, which are now being field-tested. After identification of a wild celery accession resistant to celery mosaic virus (CeMV), also known as Western yellows, researchers followed the inheritance of this trait in an F2 and a backcross progeny. The study disclosed that the resistance to this disease is recessive. The resistance gene was named cmv. Additionally, they found two molecular markers closely linked to cmv, which will allow marker assisted selection for this trait. The main impact of this research has been the discovery of a source for resistance of an important disease, CeMV, and development of markers to facilitate breeding of resistant cultivars. The ability to breed disease and insect resistance into celery will have considerable economic and environmental impact, not only in reducing application of pesticides under conventional production, but also in increasing yield in sustainable and organic production systems.

- **Genetic improvement of beans (*Phaseolus vulgaris* L.) for yield, disease resistance and food value**: This research seeks to broaden the genetic base of common bean through: (a) use of wild bean populations; (b) increasing cross-pollination; (c) using and converting promising

tropical and sub-tropical germplasm; and (d) intra-racial and inter-racial gene pool hybridizations. In collaboration with North Dakota State and the University of Florida, genes for seed color or color patterns or markers linked to these genes have been mapped onto the common bean consensus linkage map. These genes include seed coat patterning (T, Z, L, J, Bip, Ana) and color (C, G, and V) genes. The P and B genes had been mapped already earlier. Results indicate that most color and color pattern genes are unlinked, which may account in part for the high level of diversity for seed coloration types in a common bean. Seed color characteristics are among the most important traits determining consumer acceptability. Locating the genes controlling these characteristics on the linkage map together with tagging markers will facilitate the work of breeders in recovering desired phenotypes in the progeny of crosses. These genetic studies, along with molecular mapping and genomic studies have an impact not only in California but also throughout the U.S. The production of snap and dried beans in California was valued, in 2000, at nearly $90 million. In the U.S., dry beans are produced on 1.7 million acres by nearly 11,000 farms. Nationwide, retail sales of dry beans total an estimated $1.8 billion. Although the dry bean industry has been in a period of recession in California, the ability to breed and market new cultivars with improved consumer acceptance could have substantial economic impact.

- **Conservation and utilization of germplasm at the C.M. Ricks' Tomato Genetics Resource Center**: The Center has a mandate to acquire, maintain, evaluate, document, and distribute genetic stocks and wild species. In the present year, the Center faculty acquired 16 new stocks, including accessions of the wild species Lycopersicon parviflorum and Solanum lycopersicoides from Ecuador, Peru, and Chile, as well as mutant stocks containing the high pigment genes hp-1 and hp-2, the Fusarium wilt resistance gene I-3, and other new alleles or mutant loci. A total of 3,595 accessions are currently available for distribution. From these accessions, 1,370 cultures were grown, of which 406 were for a seed increase, the remainder for observation. An additional 621 were grown for germination tests. 4,640 seed samples of 2,287 unique accessions were sent in response to 282 requests from 218 investigators; an additional 58 requests were for information only. The impact of TGRC activities is demonstrated by the ca. 100 journal articles published each year that mention use of TGRC stocks. Uses include the identification and transfer of resistances and tolerances of diseases, arthropods, and abiotic stresses from wild germplasm. In addition, TGRC stocks contributed to published reports of the cloning and sequencing of several genes underlying important agronomic traits, including fruit sugar content (Brix9-2-5), fruit size (fw2.2), and carotenoid composition (og and B). The California fresh and processing tomato industry generated wholesale sales of $617 million in 2000. The ability to improve fruit quality and reduce the need for pesticides by breeding with the germplasm housed at the TGRC has enormous present and future impact on the sustainability and profitability of this important industry.

- **Molecular genetic analysis of MI-mediated nematode resistance in tomatoes**: Researchers are using a genetic approach to identify the signal transduction components of MI-mediated resistance to nematodes. By screening 1,151 tomato M2 families, approximately 28,700 tomato plants, they have identified four confirmed mutants, showing different degrees of

infection and are using them to analyze the importance of different genes involved in nematode resistance. They have targeted a gene that is in the MI-1 resistance pathway, and is required by MI-1 to confer resistance to both root-knot nematodes and potato aphid. Transforming tobacco and pepper with the MI-1 gene does not result in nematode-resistant plants. This is an intriguing discovery and might answer some of the questions about the functionality of MI-1 in other crops. Although these plant species are close relatives of tomato, it is possible that they do not contain all the components of the MI-1 signal transduction pathway. It is possible that Rme-1 is one of the missing components in these crops. The impact of nematodes on solanaceous vegetable crops grown in California (wholesale value in 2000 of more than $1 billion) is difficult to assess, but with the loss of MeBr as a soil fumigant, and dramatic increases in the production of organic vegetables, the ability to use basic information to develop nematode resistant varieties by conventional or molecular breeding will have an important impact on the future sustainability of these enormous industries.

Plant Nutrition

The productivity of modern agriculture has depended on optimization of the nutrient status of agronomic and horticultural crop plants, primarily with the use of chemical fertilizers. In striving for improved sustainability of California's agricultural system, Division researchers and extension personnel are studying the basic biology of plant nutrition, and developing tools to target application of chemical fertilizers so as to maximize their benefit, and minimize their environmental impacts.

- **Analysis of the phosphate-starvation-response pathway in higher plants**: Plants have evolved elaborate metabolic and developmental adaptations to low phosphorus availability. Biochemical responses to phosphate (Pi) limitation include increased production and secretion of Pi-acquisition proteins such as nucleases, acid phosphatases, and high-affinity Pi-transporters. However, the signal transduction pathways that sense Pi-availability and integrate the Pi-starvation response in plants are unknown. To dissect signaling of Pi-limitation, researchers have devised a screen for conditional mutants in Arabidopsis thaliana. The genetic screen is based on the facultative ability of wild type Arabidopsis plants to metabolize exogenous DNA when Pi is limiting. After screening 50,000 M2 seedlings, they have isolated twenty-two confirmed mutant lines that show severely impaired growth on medium containing DNA as the only source of phosphorus, but which recover on medium containing Pi. Characterization of nine such mutant lines demonstrates inability to utilize either DNA or RNA. One mutant line, psr1 (phosphate starvation response), has significantly reduced activities of Pi-starvation-inducible isoforms of ribonuclease and acid phosphatase under Pi-limiting conditions. The data suggest that a subset of the selected mutations impair the expression of more than one Pi-starvation-inducible enzyme required for utilization of exogenous nucleic acids, and may thus affect regulatory components of a Pi-starvation response pathway in higher plants. Current research focuses on a detailed molecular and genetic characterization of the most interesting psr mutants, in particular of psr1. The psr1 mutation is a single recessive mutation that does not affect Pi transport but affects expression of several Pi-starvation-inducible genes, which further corroborates the hypothesis that psr1

impairs a regulatory gene important to the Pi-starvation response in plants. Phosphorus is one of the most important, yet least available mineral nutrients required by plants. Phosphorus deficiency results in reduced growth, and severe reductions in productivity for many plants. Supplemental phosphorus is provided by mining rock phosphate, an increasingly limited resource. Thus, understanding how plants sense and respond to phosphorus deficiency will provide the basic knowledge to develop strategies for more efficient phosphorus utilization by agronomically important plants.

- **Plant-based irrigation strategies to improve irrigation efficiency in orchards**:
  The objectives of this research are:

  1. To refine the use of plant-based water relations measurements, particularly midday stem water potential (SWP), as a practical irrigation management tool for orchards.
  2. To determine the effects of water stress on tree horticultural productivity and fruit quality.
  3. To recommend deficit irrigation strategies that allow significant savings of irrigation water while maintaining or improving horticultural productivity.

  Because of the increasing interest by growers and irrigation consultants, a number of separate studies were performed for prune, almond and walnut trees, resulting in a substantial practical improvement for the plant-based monitoring technique. Researchers showed that it was possible to use a shorter time between bagging and measurement of water potential, which allows for much more flexibility in scheduling orchard monitoring. Results have streamlined the protocol necessary to monitor plant water stress in orchards, and have lead to the commercialization of a simple hand operated device for this purpose (see http://www.pmsinstrument.com/pump-up.htm). Using plant water status to guide irrigation, many California prune growers have substantially reduced applied irrigation water (in most cases by about 40%) while maintaining dry fruit yield and improving fruit sugar concentration.

- **Nutrition of perennial tree crops**: The sustainable production of tree crops requires knowledge of the amounts of nutrients required by trees, the times during the year when these nutrients are attained from the soil and the management practices that can be used to supply the nutrients. Cropping status significantly influences nutrient uptake, the distribution of nutrients to fruits, storage organs and roots and the remobilization of nutrients out of leaves. Researchers have developed a nutrient budget approach that has resulted in dramatically altered N fertilization strategies and has indicated the need for supplemental potassium fertilization. They have now completed a computer based integration of these results and have produced an interactive Excel spreadsheet for distribution to growers. Application of the computer model for nutrient application has proceeded well and has significantly influenced fertilizer use. If implemented statewide, this program would result in an estimated reduction in N use of 10-20%, a predicted reduction in N leaching into groundwater of >35% and an increase in production of 5% .

- **Development of a leaf color chart for estimating rice leaf nitrogen content**: Estimating tissue N status at critical points of the plant's life cycle can greatly improve the economics of rice production. Adequate levels of nitrogen are particularly critical during the onset of the reproductive phase. Kernel size, as well as the number of kernels per head, are sensitive to N levels in the plant. Under California conditions, N levels in the most recently expanded leaf has been shown to be a reliable indicator of overall plant nutrient status.

  To be effective a grower must evaluate large acreage and make management decisions with in a short period of time. The objective of this project was to develop a color chart consisting of a series of calibrated color specific acrylic panels that describes leaf tissue nitrogen levels. Color panels had to accurately depict the actual spectral reflectance signature of rice leaves. Eight public rice varieties were grown under six pre-plant applied N levels in a hand sown replicated experiment. Thirty leaves from all varieties, N levels, and experimental replicates were sampled at panicle initiation and spectral reflectance of the individual leaves were determined with the spectrophotometer. Reflectance values for each variety were partitioned according to b+ values into 8 discrete ranges, which correspond to the individual color panels of the LCC. The L and a values associated with their respective b+ values of each leaf were retained in the data set. All leaf samples were analyzed for total N. Regression analyses relating color to N content revealed that medium and long grain varieties could be described by one equation and remain within the range of sampling error.

  The spectrophotometric data were transferred into color matching computer software where pigment formulations were developed utilizing light and heat stable colorants with the assistance of a fabrication firm. A high impact, high temperature plastic was chosen for production of the color panel. The color panel plastic is unaffected by direct light and temperatures up to 170 F. Ribbing was added to the individual color panels in order to reduce glare. The resulting color chart is durable and field ready. An adhesive label permits easy update of the calibration table. A mailing list of growers using the LCC is maintained and new calibration data can be sent via mail. The patent pending leaf color chart (LCC) has had state, national, and international impact. The LCC provides the grower a tool to evaluate nitrogen status of a rice crop in a cost-effective manner, avoiding leaf sampling and the preparation, laboratory analysis costs, and the associated time delays in receiving the required results. A more precise application of N fertilizer based on plant need and location in the field using the UC LCC is one means of improving fertilizer use efficiency. Improved efficiency helps reduce nitrogen runoff into surface and ground water. Finally, increasing energy costs have increased fertilizer prices emphasizing the importance of judicial use of this key input variable to improve farm profitability. The LCC is currently being field-tested in 6 Asian countries (Philippines, India, Bangladesh, Vietnam, China, and Indonesia) on an experimental basis. Researchers are collaborating with international scientists to investigate the production of an LCC suited to SE Asian rice varieties. The potential impact in Asia is substantial. Indonesia alone has requested 7,000 LCC's from IRRI. Additionally, rice specialists from three southern rice-producing states are considering a three-state collaboration to produce an LCC for

southern varieties. Locally, grower response has been enthusiastic and the technology is being extended to all California rice growers

Agricultural Marketing

Successful marketing is a fundamental component of a successful and sustainable agricultural operation. Global, national, and local marketing trends continue to have major impacts on California's farmers. In addition to research on the nature of these market trends, UC researchers and extension personnel are active in exploring new marketing tools, particularly for small growers and in local community settings.

- **Economic issues affecting the U.S. fruit and vegetable system**: The objectives of this research are:

    1. To assess the evolution of Supply-Chain Management in the fruit and vegetable sector, identifying strategic organizational and marketing implications for firms and specific commodity subsectors, and
    2. To analyze the relative competitiveness of fruit and vegetable subsectors, either regionally, nationally, and/or globally, using new and established analytical paradigms which incorporate theories from business schools and other fields.

    Among the findings: Current concern focuses on the potential for slotting fees to enter the commodity side of the $75 billion U.S. fresh produce industry. However, all types of fees can affect a firm's bottom line. This study showed that while commodity fresh produce firms did not pay slotting fees, they pay other fees, and they are increasing. In 1999, fees of all types averaged about 1-2 percent of sales for commodity shippers, but ranged from 1 - 8 percent for bagged salad shippers, largely due to the increase in slotting fees within the fresh-cut produce sector. Given low margins in the fresh produce shipping industry, fees paid by both commodity and fresh-cut produce shippers may be sufficient to determine whether a firm earns a profit or loses money over the course of a season. This research demonstrates that a focus on slotting fees is far too narrow when examining the incidence of fees on shippers. Another project used industrial organization theory to analyze changing relative competitive positions within the North American fresh produce industry. Porter's theories of clusters and the new economics of competition were a central part of the approach. The use by firms of strategic alliances and joint ventures as a strategy for improving competitiveness was examined. Both interviews with firms and an extensive literature review were conducted. Among the findings: strategic alliances and joint ventures play an increasingly important role in inter-organizational relationships, allowing firms to capture benefits from new markets more quickly and at lower risk than through horizontal or vertical integration strategies. The rapid rate of change in competitive markets means that companies may not have the time to develop necessary resources and capabilities internally. This is clearly the case among NAFTA participants, as a plethora of alliances were identified in the North American agri-food sector. Incentives to ally will remain and foreign direct investment (FDI) among the NAFTA partners in each other's agri-food systems will continue to grow, along with sales of affiliates in their neighbors'

markets. Firms' risk preferences and perceptions, strategic goals and resources will influence their choices of interaction, from spot market transactions to strategic alliances, joint ventures, and integration via mergers and acquisitions. This will in turn shape the future mix of FDI, sales via affiliates, and trade among the NAFTA partners. The information from the first study will be used in the current national policy debate on the impacts of retail consolidation on California fresh produce shippers. The study results are being considered by the FTC, DOJ, USDA, Congress and industry trade associations in the development of policies designed to improve system performance. The findings of the second project are being utilized by California agribusiness firms in developing their strategic positioning approaches within North America and beyond, improving competitiveness.

- **Market impacts of vertical coordination: the case of perishable commodities**: Coordinated exchange between the retailer and shipper is emerging as a key force affecting all participants in the produce marketing chain. This project is addressing the following specific questions:

    1. Do contractual arrangements between the shipper and retailer increase or decrease price instability and revenue instability at the farm gate level?
    2. Does growers' exposure to price risk in the spot market increase with more widespread use of contracts?
    3. Does the use of such contracts affect the average spot price and average price received for the crop as a whole?
    4. What are the likely impacts of the use of such contractual arrangements on the structure, performance and competitiveness of the shipping sector?

    The project aims to increase understanding of the implications of vertical coordination associated with the industrialization of agriculture by building a comprehensive theoretical and empirical model of the relationship between marketing contracts for perishables and commodity price levels and stability. Although the emphasis is on modeling the strawberry market, the work will also have implications for other perishable commodities. They are assessing the impact of pre-commitment agreements in strawberry markets on producer and consumer welfare. Pre-commitment agreements are a type of option in which the retail chains have the right to purchase a certain volume of strawberries at a pre-established ceiling price. If spot prices happen to fall, the retailers are not bound to pay the ceiling price. The researchers are conducting preliminary descriptive analyses using a subset of the data, in order to evaluate the qualitative information regarding pre-commitments. This project will increase understanding of the implications of vertical coordination associated with the industrialization of agriculture.

- **Calaveras Grown**: Calaveras Grown is a Calaveras county-wide education and marketing program to assist local agricultural producers market their products. The goal is to bring communities together for the support and growth of agriculture, agri-tourism, and preservation of open space in Calaveras County. During the past eighteen months, UC advisors have

worked to develop a vision, organizational structure, and marketing products. Last February, the first farm conference was held, bringing together more than 150 local producers and interested supporters The combined membership in the regular organization and the Farm Trails program is approximately 110. Impacts include an increased demand for information on specialty crops, increased interest in Williamson Act Agriculture Preserve zoning, exploration into development of a commercial kitchen to be shared by many local producers/processors, one new farmers market, research into the possibility of selling locally grown beef utilizing a USDA inspected mobile packaging plant, and a movement by the Planning Department and the Board of Supervisors to re-define commercial agriculture.

Tree Crops

Perennial tree crops are an important component of California's agriculture, providing an important portion of the fresh fruits and nuts for the nation, and, in some cases, the world.

- **Salinity tolerance of pistachio rootstocks**: Research demonstrated that all three currently commercial pistachio rootstocks are tolerant to salt levels as high as 8 dS/m. Above 8 dS/m, at >10 dS/m soil solution extract, the rootstocks ranked as follows; Pistacia integerrima, P. atlantica, P. atlantica, X P integerrima. There were no significant differences among the rootstocks. Despite the lack of effect on yield there were significant differences in water uptake by trees at different salinity levels. This suggests the effects of irrigating with saline water are long term and gradual. The tolerance of their rootstocks makes pistachios the most salt tolerant tree fruit crop grown in California, other than dates. This also means pistachios can be grown in areas with marginal quality water and irrigated with reclaimed water. The impact of this project will be seen over the long term. Based upon the data developed in this experiment, pistachios are now being planted on marginal ground with poor quality water in areas with no previous permanent tree crops. Additionally, poor quality drainage and well water, as opposed to more expensive aqueduct water, can be used for irrigation. The California pistachio crop was valued at $238 million in 2000; it is estimated that the increased plantings and reduced cost of land and water will generate $40 million in additional farm gate value within a decade.

- **Girdling for improvement of fig quality**: Research has demonstrated that trunk girdling Calimyrna figs significantly improves fruit size. However, after four sequential years of girdling the trees are displaying some signs of decline. This suggests girdling should be done on an alternate year basis. The improved fruit size means that a larger proportion of the crop can be sold as higher value dried figs as opposed to being processed into paste. California fig growers were able to direct an average of 17% more of their $51 million crop into higher paying dried figs sales as opposed to lower return fig paste.

Dairy Waste Management

California's dairy industry leads the nation in production and sophistication, but environmental issues, primarily related to waste disposal, are an increasing concern. Research and extension programs in the Division are addressing novel ways of utilizing dairy manure and lagoon water, and are providing tools for growers that will help reduce environmental contamination.

- **Animal manure and waste utilization, treatment, and nuisance avoidance for a sustainable agriculture**: The objective of this project is to develop and refine physical, chemical, and biological treatment processes and engineering systems for management of manures and other wastes. Research is evaluating commercial mechanical and gravity flow solid-liquid separation equipment and the technical and economic feasibility of chemical flocculants to enhance separation of solids. Two dairy facilities with paired cement lined settling basins were evaluated during each of two summers and compared with mechanical separators evaluated previously. Producers loaded and dried each basin for approximately 30 days. Both facilities housed cows in freestalls. Depending on the method used to calculate TS efficiency of separation, values from 27% to 77% were obtained. Basins were more effective during the first weeks of work, and less effective during latter weeks of work. The paired basins were more effective than the mechanical separators evaluated previously. These basins could be operated more efficiently at their capacity, or should be more appropriately designed. Design and economic implications to dairy producers is important.

- **Dairy lagoon water monitoring and application**: This project seeks to determine optimum methods for use of lagoon water nutrients in crop production. Research has included a 3-year replicated field scale comparison of corn grown with conventional practices with corn grown using only lagoon water nutrients. The yield of corn grown using only lagoon water nutrients was comparable to yields obtained with commercial fertilizer. In addition researchers have been conducting a detailed evaluation of the application accuracy of a flow meter/valve/quick test methodology under both ideal and grower conditions. The system has proved to be effective in commercial practice, and is beginning to be adopted by non-project growers. Application accuracy of the entire system can be very good on a whole-field basis but N applied in individual irrigation checks can be quite different from what is measured by the flow meter at the pond outlet, mainly due to the travel time between the pond and the field. Project personnel have also analyzed a large data set of San Joaquin Valley dairy lagoon nutrient and salt concentrations to make generalizations about the composition of lagoon nutrients in the San Joaquin Valley. In most instances, the data indicate, dairy lagoon water can be used as a nutrient source without excessive build-up of phosphorus or salts, if applied at rates sufficient to meet the nitrogen needs of a corn crop. Nitrate concentrations in the shallow groundwater of the project farms have been steadily declining from a previous average of 96 mg/L NO3-N to their current levels of 20-40 mg/L. Reduction to the drinking water standard of 10 mg/L is challenging because accurate application of lagoon nutrients during the winter is difficult. Groundwater modeling of data collected indicates that 80% of the groundwater contamination associated with dairies comes from misapplication of dairy waste onto cropland. While it is too soon into this project for widespread adoption, it is anticipated that the techniques developed will result in significant reduction of groundwater contamination as these techniques begin to be put into practice. A number of producers have already begun using the recommended lagoon nutrient management techniques. The research findings are being referenced in the development of NRCS guidance, county ordinances and other guidelines and regulations that

will determine how the dairy industry manages land application of waste and the future sustainability of California's $3.7 billion dairy production.

- **Animal manure and waste utilization, treatment, and nuisance avoidance for a sustainable agriculture**: The objectives of this research project are to develop and demonstrate 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. These objectives are being addressed by the development and refining of physical, chemical and biological treatment processes and engineering systems for the management of manures and other wastes. An integrated anaerobic-aerobic treatment system were developed for dairy wastewater treatment. The system includes anaerobic sequencing batch reactor (ASBR) and aerobic sequencing batch reactor (SBR) to convert dairy manure into biogas and mineralize manure nutrients to make manure a better fertilizer. Alternatively manure nitrogen can be converted into nitrogen gas and returned to atmosphere without imposing adverse environmental impact. Laboratory test results showed that after anaerobic digestion, the reductions of the chemical oxygen demand (COD), total solids (TS), and volatile (VS) concentrations were 38.8%, 27.4%, and 30.4%, respectively. The biogas production rate was 0.32 L/g VS added. The methane content of the biogas was about 65%. With a comination of anaerobic digestion and aerobic treatment, the reductions of COD, TS, and VS in liquid effluent reached 90.4%, 70.3% and 79.7%. Manure management is a significant issue limiting expansion of California's $3.7 billion dairy industry. The equipment being developed in this project will provide effective tools for efficient utilization of dairy waste, reduction of nitrogen loading and emissions, and generation of biogas that can be used as a fuel for energy generation. Based on the biogas yield and energy generation potential of dairy manure, 1.5 million cows in California can generate 4.5 million kWh electricity per day, which is enough to power 150,000 households

- **Characterizing nitrogen mineralization and availability in crop systems to protect water resources**: Management of soil mineral nitrogen (N) is necessary to increase the profitability of a farming system and to minimize groundwater pollution by reducing N leaching. Nitrate enrichment of ground water and surface waters and their impacts on drinking water quality are important water quality issues. Nitrogen (N) use in cropping systems is one of the major sources of nitrate entering surface and subsurface waters. Concerns with nitrate enrichment of groundwater continue to grow and are a legitimate public health concern because many municipalities and rural residents depend on groundwater as their primary source of drinking water. The need to understand and elucidate the role of active carbon (C) and N pools in cropping systems continues to be critical for predicting N mineralization and availability in cropping systems. A better quantification of the N mineralization contribution in cropping systems would help minimize N losses to the environment and allow more accurate recommendations for crop production. Little information is available, however, on the effects of farming systems practices, such as organic farming, on soil mineral N and plant N availability. Organic and low-input cropping systems that use more C inputs are alternatives to conventional systems for sustaining long-term soil fertility. An understanding of the impacts of

these cropping systems on N balance (N applied minus N removed in harvested plant material), storage and loss is necessary to improve long-term soil fertility and minimize the risk of nitrate pollution. An evaluation of 4-year rotations of organic (N from legumes and composted manures), low-input (N from legumes and reduced amounts of synthetic fertilizers), and conventional (conv-4, N from synthetic fertilizers) and a conventional 2-year rotation (conv-2, N from synthetic fertilizers) on N balance, storage and loss was conducted from 1989 to 1998. Compared to the conv-2 system, the organic and conv-4 systems showed 119 and 8% greater cumulative N balances, respectively, over the duration of the study. However, N balance in the low-input system was 19% less than in conv-2 system. After 10 years of differential management, total N in the top 15 cm of soil was 1.46 g kg-1 in the organic, 1.26 g kg-1 in the low-input, 1.13 g kg-1 in the conv-4, and 1.1 g kg-1 in the conv-2 system. Compared to the conv-2 system, cumulative N losses for the organic, low-input and conv-4 systems were lower by 80, 92, and 10%, respectively. These findings suggest that cover crop-based organic and low-input cropping systems that add C to soil have the potential for storing N and making it available for future crop use, while minimizing the risk of nitrate pollution.

- **Improving water quality through watershed management in the Tomales Bay**: Both the dairy industry ($47 million/yr) and the aquaculture industry ($2.5 million/yr) are important employers in rural Marin County. The continued presence of these industries are important to the community economically, socially and culturally. A group of 18 dairy producers whose property runoff flows into Tomales Bay had formed a watershed group called the Tomales Bay Agricultural Group (TBAG). The purpose of this group is to combine industry information and efforts in reducing its contribution to the contamination of the bay and implement projects to improve conditions. Cooperative Extension and community members are collaborating in efforts to strengthen the viability of agriculture and aquaculture in Marin coastal areas by assisting land owners and the community to better understand the relationship between coliform levels in Tomales Bay and land use practices. This will include implementing management practices to reduce coliform levels and thereby enhance the natural resources in their watershed. The project implements recommendations from the final report of the Marin Coastal Watershed Enhancement Project.

  The specific objectives of the project are to:

  1. Provide a science based link between coliform inputs to the Bay and agricultural practices within the watershed.
  2. Evaluate animal waste management practices to reduce pollution.
  3. Develop resource management policies and a Hazard Analysis and Critical Control Points (HACCP) plan for waste management that would reduce coliform contamination of shellfish growing waters by tracking potential pathogens in the environment and identifying critical points where they can be eliminated or where management practices can be implemented to reduce exposure.

To assist with the water quality efforts, the CE team has implemented a systems approach study of animal agriculture facilities. Water quality data has been collected from land use practices at dairy, beef, and horse operations to identify and prioritize areas and practices that can reduce bacterial loading to the bay and its tributaries. Results from sampling and analysis are being used by the individual cooperators to make on-farm decisions regarding management of runoff and potential impacts to water quality. Results have been shared through newsletters and six group presentations.

Water quality sampling from the past two winters (1999-2000, 2000-01) 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 bay. Cooperators are implementing water quality management practices to improve water quality. The State Water Resources Control Board approved a Proposition 13 funding request to support management practice implementation based on project results.

New Crops

California farmers produce the widest range of crops and products of any state in the nation. UC researchers continue to serve as a resource for farmers seeking new crops and products, by testing a range of new germplasm, and providing the information that enables farmers to be successful in producing and bringing novel crops to market.

- **Potato cultivar selection, evaluation and development**: Fresh market potatoes are an important crop for California, valued at $202 million in 2000. Although ranked 10th nationally in acreage of potatoes, California ranks third in farm gate value. The objectives of this research are to:

    1. Provide the tools for continued profitability of this industry by the introduction and development of russet, white, red, chipping, and specialty potato cultivars of improved adaptability and quality.
    2. Evaluate and demonstrate, under the varying California environments, the characteristics of the many new cultivars and advanced selections being developed or tested in the U.S.
    3. Determine relative resistance/susceptibility of named cultivars and advanced selections to common biotic and abiotic diseases.
    4. Assess cultural requirements of advanced selections and new cultivars and select them on a basis of reduced input requirements.
    5. Conduct a seed potato increase program, as necessary.

    The potato clone A79543-4R was named and released as CalRed, jointly with USDA and University of Idaho. Other new clones jointly released by collaborating institutions and being grown in California are Cherry Red (DT6063-1R) and Silverton Russet (AC83064-6) by Colorado; Winema (NDO2686-4R), Mazama (NDO2438-6R) and Klamath

Russet(AO85165-1Ru) by Oregon; and Gem Russet (A8495-1) by Idaho. UC researchers 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 and specialty, 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. In addition to standard production, harvest and postharvest quality assessment on new and advanced clones, cultural adaptation of new cultivars was emphasized. A study to evaluate clones on the basis of nitrogen use efficiency was also begun. Thus nitrogen experiments were conducted in three locations, spacing trials in two locations and growth and nutrient uptake study at one location. Results of these multi-year experiments are preliminary. However, growers have already widely adopted the practice of applying 1/3 less nitrogen on a new Russet Norkotah clonal selection, CORN #3. This clonal selection has replaced more than 1/2 of the standard Russet Norkotah acreage. Thus, the resultant reduced fertilizer use, with higher yields, is significant.

Extensive trials were conducted in Kern County and Tulelake/Klamath Basin; numerous smaller trials were conducted in cooperation with local Cooperative Extension and growers. The final year of Russet Norkotah seed source, clonal selections and pre-plant environments were conducted. Best performing clones and new cultivars included A90467-1Chip, A91790-13Chip, AC87079-3Ru, ATX9202-3Ru, A8792-1Ru, TXNS102, TXNS112, CORN#3, Silverton Russset,CO89097-2R, NDC5281-2R, NDO4300-1, NDO4323-2R, NDO4588-5R, TX1673-2Yel, Amadeus, Fabula and Sante. No late blight was recorded in the resistance screening trial in 1999. The number and acreage of new varieties that were grown by California potato growers in 2000 is a record. All of these have been introduced to California potato growers through the UC-CPRAB program, in cooperation with the Southwest Region and Western Region. Of the 50,000 acres grown to potatoes, approximately 40,000 are grown with varieties introduced through this program. These changes allow the California potato industry to maintain their market share with higher quality, higher value varieties.

- **Citrus breeding and genetic analysis**: Citrus is one of California's major horticultural crops, with a value estimated at $1 billion in 2000. Although profitability of standard cultivars (Navel, Valencia) has been modest in recent years, there is a continuing interest in new cultivars, especially mandarins and their relatives. The citrus breeding program has developed a range of cultivars, and new cultivars are presently being readied for commercial release. Continued success in citrus breeding will depend on the development of new tools to improve the efficiency of breeding. One such tool is genetic maps of major parental lines which can be used to locate valuable genes and improve the efficiency of breeding programs.

  In a collaborative project with Texas A&M University, researchers are using positional-cloning to clone a trifoliate orange gene for resistance to citrus tristeza virus. Although trifoliate orange is resistant to this virus, its fruit are not edible and it has not been possible to develop virus resistant citrus cultivars by hybridization-selection methods.

Therefore, the researchers plan to isolate (clone) the resistance gene and transfer it to citrus cultivars using biotechnology. Sequencing of a 282 kb region that should contain the resistance gene was completed, the sequence was fully assembled, and sequence annotation completed. Sequence analysis 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 and transformation of candidate genes into CTV-susceptible cultivars 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.

To improve citrus rootstock breeding, UC researchers are studying inheritance of nucellar embryony (a type of apomixis used in citrus rootstock propagation). 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 the major gene for apomixis were identified and cloned. Analysis of AFLP markers to be used for linkage mapping and QTL analysis was completed.

Development of citrus cultivars with improved combinations of traits is a continuing project. Evaluation of yield and fruit quality of Gold Nugget (a seedless, late-maturing mandarin cultivar released in 1999) and several other mandarins continued. UC researchers expect to release three new mandarin 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. One novel grapefruit-type now in final testing is a pummelo x blood orange hybrid that combines sweet taste, red flecked flesh like that of blood oranges, and very few seeds per fruit.

Simple sequence repeat (SSR) markers were used to study genetic diversity in over 400 accessions from the University of California, Riverside Citrus Variety Collection. 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.

The likely impacts of this research include improved profitability of citrus production by reducing production costs and improving product quality and marketability. Identification of the gene for citrus tristeza virus resistance should enable its transfer into commercially important cultivars which will eventually protect the US citrus industry from this potentially damaging disease. Over 5,000 trees of Gold Nugget were sold during 2001, indicating fair market acceptance of this new cultivar. The development of new citrus rootstocks with better disease resistance and other traits may reduce environmental impacts of disease control chemicals. Research on citrus germplasm has improved our understanding of genetic diversity in citrus, allowed more efficient maintenance of citrus germplasm, and assists citrus breeders in choosing parents for hybridization.

HANDLING, STORAGE AND PROCESSING AGRICULTURAL PRODUCTS

A major part of the income of California's enormous horticultural industry derives from sales to other states and other countries. Long distance transport of highly perishable fruits, vegetables and cut flowers and other ornamentals requires the development and deployment of sophisticated postharvest systems. Researchers and extension personnel in the Division are active in working with the industry to develop improved methods for cooling, transportation and storage, as well as technologies for reducing postharvest losses due to diseases and insect pests.

The California AES faculty, Cooperative Extension specialists, and CE advisors working in this area reported their research and education efforts during 2001 in a total of 43 peer-reviewed publications. In addition, 6 Extension programs were delivered and four statewide collaborative workgroups composed of both AES and CE academics planned and conducted research and extension projects.

Research and Extension Performance Goals:

- Develop new technologies for storage, shipping, and distribution, including sanitation and disinfestation methods, to ensure that California products can be marketed nationally and internationally.
- Develop new methods for measuring and improving product quality characteristics and shelf-life.
- Develop technologies and practices to lengthen shelf-life of agricultural products and to improve storage and shipping characteristics.

Evaluation and Registration of Fungicides for Control of Post-harvest Decay in Stone Fruits: According to California Department of Agriculture statistics (Resource Directory 2000, CDFA), 1999 California bearing acreage of apricots, peaches, plums, dried plums, and nectarines was 19,000, 67,800, 41,500, 83,000, and 35,500 acres, respectively for a total of 246,800 acres and 1999 crop value was $30.7, 238.8, 82.0, 149.5, and 112.5 million for a total of $613.5 million. In 1992, the post-harvest fungicides Benlate and Funginex were withdrawn from registration, in 1996 Rovral was withdrawn, and in 1999 Topsin was withdrawn. This left these industries with no effective fungicides for post-harvest control of brown rot. Researchers stationed at UC Riverside,

UC Davis, and the Kearney Agricultural Research and Extension Center near Fresno evaluated new experimental fungicides, and worked with the federal western regional IR-4 program stationed at UC Davis to do residue research which led to a Section 18 registration for fludioxonil (Medallion or Scholar) for the 1997, 1998, and 1999 seasons. In 2000, full registration of this material was obtained. Two other materials, fenhexamide (Elevate) and BASF-516, are also being evaluated for future registration so that materials with different chemistry may be made available and rotated with fludioxonil to delay the development of resistance. Based on data from the 1950's prior to when fungicides were available for brown rot control, estimated crop loss from brown rot can vary from year to year from 20-50% based on how wet the season is close to harvest. Based on 3-year average crop value 1997-1999, a very simplistic analysis (unrealistically assuming no impact of such a massive reduction in crop yield on crop value), suggests this 20-50% reduction amounted to an annual impact of $118.4-$296.0 million per year over these 5 crops in total.

Development of Fungicides for Control of Post-harvest Decay in Pomegranates:
Pomegranate acreage in California totaled approximately 5,000 acres as of 2000. During overseas shipments of pomegranates, postharvest losses due to grey mold are typically ca. 50%. Based on current research suggesting that fludioxonil will be extremely effective in reducing grey mold on pomegranates, California growers planted over 4,000 new acres to pomegranate in 2001. Obviously, research showing fludioxonil is effective and work with industry to get this material registered coupled with the development of several overseas markets is having a big impact on growers and shippers (as expressed by their almost doubling acreage planted to pomegranates in California last year).

Source of Federal Funds: Hatch.
Scope of Impact: The post harvest program has international impacts, both in terms of the impact of its research and outreach and in terms of the effects of post harvest technologies developed in California on losses of perishables throughout the world.

PEST AND DISEASE MANAGEMENT
DANR focused its research and extension resources on promoting pest and disease management strategies that are safe, environmentally sound, and economically viable. Programs were delivered by individuals and collaborative groups including eight statewide workgroups composed of both AES and CE academics. To accomplish this, 182 Extension programs were delivered; 202 Extension and

Research and Extension Performance Goals:

- Provide cost-effective approaches for prevention and management of pests and diseases of plant and animals by developing and implementing: new vaccines; new pest-resistant and tolerant genotypes; new pesticide and disease management tactics; new biological control agents; economical threshold levels of pests and diseases in various production systems; new plant and animal breeding/management tactics; and cultural effects on plant production systems.
- Develop and introduce cost-effective detection and monitoring systems to: detect the presence and abundance of pest and disease organisms; facilitate efficient management

of pest and disease organisms in integrated management systems; determine economic-threshold levels of pests and diseases to provide more efficient timing for management practices.

- Develop and support pest and disease outbreak teams to anticipate and respond to pest and disease outbreaks by working with appropriate governmental and local agencies.
- Disseminate information by effective technology dealing with: recognition and identification of pests and diseases; economic thresholds for pests and diseases; and comprehensive and integrated management strategies for pests and diseases.

Outputs, Outcomes, and Impacts
Management of Insects and Mites Affecting Plants

- **Integrated Pest Management for Ornamental Crops**: Due to impending loss of pesticides commonly used to control Homopteran pests, and increased regulations on contaminants in water run-off, growers have shown increased interest in the use of cultural exclusion practices and resistant plants to manage pest problems. The results of UC studies suggest that the type of greenhouse plastic used in a structure can reduce insect population levels, and be useful in developing IPM programs for insect management in certain 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.

- ***Xylella* transmission studies**: Results of the *Xylella* transmission studies demonstrated that cultivars of oleander that are relatively tolerant of infection already exist, however, these varieties may still be infected by the pathogen, and may serve as sources of inoculum in the environment. Oleander bushes are widely used in California in highway medians and by the side of the road to buffer housing for road noise. In many areas, oleander plants are dead or dying. This research is leading towards the selection of tolerant oleander strains which might be used throughout California to replace dead plants.

- **Mechanism of Insecticidal Action of *Bacillus thuringiensis***: *Bacillus thuringiensis* (Bt) toxins are increasingly used for insect control through their expression in transgenic crops (cotton, corn). UC researchers have identified the key toxin-binding domain on one of the cadherin receptors. UC researchers are now in the process of expressing the receptor to identify its role in toxicity. This research will be important in understanding toxicity and in developing new Bt strains should resistance occur to currently used strains of Bt-corn or Bt-cotton as recent research and predictive models suggest is likely to happen. Many pest management systems in California and around the U.S. are now dependent on these transgenic crops and their loss due to resistance would be economically damaging and result in increased pesticide use and environmental contamination if growers were forced to shift back to the use of non-transgenic varieties.

- **Biological Control of Aphids on Alfalfa and Cereals**: **Importation and Evaluation of Natural Enemies**: *Allotropa matricarae* from Abu Kamal and *A. albipodus* from Khuzestan have provided significant results against the aphid wheat pests, *R. padi* and *S. graminum*, on

wheat in laboratory and field cage trials. They have potential for being more effective against these aphids than the native parasites presently found in wheat in California and Egypt. Based on the findings, *Allotropa* parasites have great potential against pink hibisicus mealybug (a major new pest in the southern desert valleys of California) in the hot regions of California.

- **Chemical Control Alternative: Mass-releasing Natural Enemies of Vine Mealybug**: The proposed program has a high potential for success based as there is strong support among Coachella Valley growers for this program. Ant control resulted in significant reduction in ant numbers closely associated with lower numbers of VMB. Significant reduction in ant numbers was obtained with no impact on parasites with chlorpyrifos applied with modified ground rig. Damage was dramatically lower in plots where parasites were released and which had ant control versus untreated and commercial plots in experiments, but especially compared with damage in surrounding vineyards near a UC experimental ranch (the treatments: 6-7% damage vs. > 65% in surrounding vineyards at the Sunworld Ranch). Yields were significantly higher in plots where parasites were released and in ant control plots compared with untreated and commercially treated plots in the experiment, and also when compared with yields on vineyards surrounding the plots on 2 ranches having high numbers of VMB. Results reduce the need for pesticide use and cost: they provide a viable alternative to pesticide use by enhancing more effective parasites with biocontrol potential through effective ant control. Development of economic threshold for VMB is feasible via the experimental design, which provides for data from 20 plots. This permits an analysis of seasonal numbers of VMB vs. damage, and VMB vs. yields from 20 data points.

- **Effects of Vineyard Conditions on Grape Phylloxera and Grapevine Damage**: Several years ago, a new strain of grape phylloxera appeared in northern California which caused extensive damage and appeared able to overcome resistance in then available rootstocks. Economic losses from grape phylloxera are currently prevented by use of new resistant rootstocks. However, no back-up methods for controlling damage are available should rootstocks fail again as they have in the past. The long-term goal is to develop back-up technologies for such a contingency. This project suggests that there should be an emphasis on work relating to soil management. The information being developed on the influence of compost on soil ecology and root pathology may have applications in other cropping systems.

- **Integrated Pest Management of San Joaquin Valley Citrus Arthropods**: The citrus industry has traded key pests. During the organophosphate and carbamate insecticide era, California red scale and citrus thrips were the key pests. During this new era of reduced risk pesticides (starting about 1995), citricola scale, cottony cushion scale, and katydids are the key pests. Over the past year, vedalia beetle research has provided pest control advisors with information on how to minimize the impact of the new insecticides on this natural enemy so that control of cottony cushion scale would not be severely disrupted. Recent registration of insecticides in the nicotinoid class have improved control of citricola scale but have increased disruption of vedalia beetle. A Kern County IPM demonstration trial and pesticide trials over the past year have demonstrated that suppression of the glassy-winged sharpshooter will

require broad-spectrum insecticides that will then disrupt the citrus IPM program. This will result in higher costs to the grower in terms of pesticide expenses and the loss of natural enemies, releasing secondary pests. A citrus entomology web site helped pest control advisors make timely sampling and pest management decisions. Greater information about insect pests and their natural enemies helps to reduce the cost of unneeded insecticide applications.

- **Biorational Methods for Insect Pest Management (IPM): Bioorganic and Molecular Approaches**: This technology has been developed to the point where it could be of great benefit in pest control in developing countries. However, with the current worries in Europe over genetically modified organisms, it is unlikely that further development will take place supported by large industry. UC researchers are looking for funding to develop altruistic technologies.

- **Tritrophic Interactions in Natural and Managed Ecosystems**: 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. This is basic research that is important in developing new plant varieties which are resistant or tolerant of insect attack and thus require minimal use of pesticides.

- **Low-toxicity Pest Management of Ants**: Currently, grape and citrus growers can use only contact insecticides, such as chlorpyrifos, for ant control. These products have only limited effectiveness, however, and chlorpyrifos may soon be taken off the market. Baits offer a more effective alternative and are less toxic than broadcast applications of contact insecticides. UC researchers have made significant progress in demonstrating the efficacy of baits in agricultural settings. This preliminary research is necessary to lay the groundwork for future registration of baits for use against ants in agriculture. These studies on boron are critical for understanding its mode-of-action and how to formulate this important toxicant that is used in so many pest control products.

- **Chemical Ecology and IPM Programs for Pest Insects**: A *Hemileuca maia* (the buck moth) 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 leaf-folder 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. UC researchers anticipate that the companies will have monitoring products available for grower use this year.

A 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.

The studies on the pheromone chemistry and substrate borne vibrational signals of stink bugs represent the first long-term, concerted effort to provide pheromone-based tools for sampling these widespread, polyphagous pests. In particular, the discovery that each species and sex utilizes substrate borne vibrational signals in addition to pheromones for mate location and recognition may explain why trap catches of almost all phytophagous stink bug species studied to date have been poor. Incorporation of vibrational signals and pheromone attractants into traps may solve this problem, and significantly increase the efficacy of the traps. This research is of critical interest to the California tomato industry (among others) which suffers significant economic annual losses due to sting bug feeding and fruit contamination.

Research has greatly improved the efficiency of mass rearing parasitoids of *Phoracantha* spp., at least doubling the numbers of parasitoids available for release for control of these pest species impact urban environments in southern California.

- **Molecular Genetics of Insects**: 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, Arizona. This is the first time a transgenic insect has been the subject of a field test, however confined, and this explains the large volume of media attention that has been ongoing for virtually the entire year, starting with a front page story in the Wall Street Journal, Jan 29, 2001 based on the pink bollworm work, and including an article in the October 2001 issue of Popular Science magazine, highlighting an ARS researcher's efforts to control pink bollworm from his USDA-APHIS methods development laboratories in Phoenix.

  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 which was first perfected by USDA.

- **Optimal Management Strategies for Arthropod Pests and Their Natural Enemies on Citrus and Avocados**: This research is designed mainly to help solve applied pest management problems facing the citrus and avocado industries in California. Research on avocado thrips has lessened 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. Informal discussion with pest control advisors and growers provide an estimated 50% reduction in crop loss due to avocado thrips damage in 2000 and 2001 over that seen in 1998. Part of this may be due to less thrips pressure during those years than was present in 1998, but a very large part of this is due to the Section 18 [based on the efficacy data, the California Avocado Commission submitted and received the Section 18 each year] allowing the use of abamectin and grower recommendations on how and when to use this material before thrips fruit scarring occurs. At a very minimum, one might estimate a $2 million/year reduction in crop damage over the past year as a result of the availability of this material and UC recommendations.

- **Identification, Behavioral Ecology, Genetics and Management of African Honey Bees**: In collaboration with the USDA Bee Research Laboratory, the role of parasitic *Varroa* in activation and transmission of Kashmir bee virus was investigated. The detection of KBV virus was carried out by using (time step) RT-PRC. As KBV is detected in both healthy and infested bees, the data suggest that KBV may commonly spread in the bee population without causing disease symptoms until high infestations of *Varroa* mite are obtained. Nucleotide sequences of KBV virus isolated from both the honey bees of various geographical regions and *Varroa* mites were analyzed and compared. The pair-wise comparisons show the mean distance between Californian isolates varying from 0 to 3.2%. The mean distance between Californian isolates and other U.S. or Canadian isolates are equal or less than 3.2%. The Australian isolate is different from all North American isolates with mean differences of 11.5 to 12.3%. The present data suggest there is a significant difference between the Australian isolate and the North American isolates. The virulence of the North American isolates is currently under investigation. As the nucleotide sequence data reveal the significant difference between the Kashmir Bee Virus isolates of the North America and Australia, it may partially explain the severity of KBV infection in various geographical regions, and call for further investigation on the pathogenicity of KBV. Obviously, this research is important to commercial beekeepers and breeders in trying to develop strains of honey bees which are resistant to Kashmir bee virus.

- **Systemstics/bionomics of Trichogrammatidae (Hymenoptera) Emphasizing Trichogramma**: The *T. minutum* complex is perhaps the most frequently utilized group of *Trichogramma* in biological control in North America. Identification of the component species is critical for successful control and UC work has aimed at providing species separation. The entire family consists of parasitoids of minute insect eggs and are potentially important for biological control. The UC laboratory continues to provide identification of *Trichogramma* and other genera for biological control workers throughout the world.

Systematics work underway will help ensure that biological control projects can be provided with meaningful identifications in the future. Such research is critical to using natural control agents in multiple cropping systems, thus allowing a reduced use of chemical pesticides.

- **The Systematics and Biology of Blister Beetles (Coleoptera: Meloidae)**: Blister beetles (Meloidae) are of modest and sporadic significance to agricultural crops in North America. Their impact on agriculture in other areas characterized by small family farms (e.g., Africa) is greater and often critical. Also, meloids are of concern to domestic livestock producers. Adults are often ingested accidentally with feed by horses and, more recently, milk cows. Because of the presence of the poison cantharidin in their hemolymph, these beetles may cause illness and death. This year saw what was perhaps the first major kill of milk cows in California by Meloidae, after they fed on contaminated hay. Studies related to this project facilitate identification by non-specialists and help convey information on biological characteristics of these beetles. Also, identifications are provided at UC Riverside if requested.

- **Biological Control in Pest Management Systems of Plants**: Research results have shown that cotton growers cannot rely on releases of *Galendromus occidentalis* (a predaceous phytoseiid mite) for control of spider mites; this knowledge will reduce monetary losses in cotton, and enhance cotton productivity. UC researchers have also shown that papaya growers can use *Phytoseiulus macropilis* to control spider mites; this should reduce the use of acaricides significantly.

- **The Ecology of Herbivore-plant Interactions in Sustainable Vegetable Crop Production**: The work on novel antifeedant and insecticidal compounds from avocados may produce an alternative to current chemical use. The studies of plant allocation to defensive compounds in the levels of CO2 expected in the near future provide predictions of what can be expected in terms of insect-plant interactions. The resolution of Californian populations of *Liriomyza* leafminers sheds light on how competition might affect the development of new biotypes and species. The study of new chemistries is helping to provide better economic returns for growers while reducing potential for human health concerns and environmental damage.

- **Integrated Pest Management Strategies for California Horticultural Crops**: California's fruit and nut growers are especially impacted by the U.S. Food Quality Protection Act because there are relatively few proven options to the use of targeted pesticides for control of key insect pests that affect quality and yield. Results of this project are leading to the development of new options, and the preservation of the remaining options, through more efficient application and tools for monitoring pesticide resistance and pest abundance.

- **Labor Reducing Technologies and Cultural Practices**: UC CE advisors provided research-based information on labor reducing technologies and on several cultural practices to increase grower profitability and improve environmental sustainability. There are many cultural practices the grower has control of that determines their success in fruit and nut

production. Growers planting new orchards need new variety and rootstock information. Partially as a result of the project, 63% less Diazinon was used and total insecticide use decreased by half between 1997-1999 in Sutter and Yuba Counties. More environmentally safe alternatives were used. Increased worker safety resulted from reduced pesticide use and there was greater acceptance of agricultural practices by the public.

- **Viability of Family Farms:** The viability of local family farms is in constant jeopardy due to the falling commodity prices for cereal and oilseed crops in the southern Sacramento Valley region. Based on the 2000 County Agricultural Reports for Yolo, Solano, and Sacramento Counties, the commodities being studied are valued at $73.9 million. Corn is the principal crop in the delta region and supports the economic viability of the family farms in this region. It provides an important rotational crop in the rest of the region. With the increase in the production of silage corn in response to the increase in the dairy industry into this region, the county CE variety screening program is becoming more important. Reduced and more accurate monitoring for noctuid pests has reduced unnecessary pesticide applications. Accurate and timely weather data has reduced pesticide and other agricultural industry related particulate drift problems.

- **Reduced Insecticide Applications for Alfalfa**: Chlorpyrifos insecticide use in alfalfa in Yolo County has been reduced by nearly 50% as a result of a CE advisor's research/education program. This is important because TMDL's are currently being developed for this insecticide in many of California's waterways. Chlorpyrifos is highly toxic to aquatic life. Reduction in use in alfalfa will help reduce levels in waterways.

- **Varietal Less Susceptible to Whitefly**: Most cotton growers in southern California stopped planting Delta Pine 5461 (susceptible to whitefly infestation) and are now planting Delta Pine 5415 or NuCotn 33B (derived from Delta Pine 5415), which a CE advisor determined to be less susceptible to whitefly infestation. As a result there are 2 fewer whitefly insecticide applications per acre per year; a reduction in production costs of $64.50 per acre. Fewer insecticide applications to cotton results in less off target movement of pesticides into waterways.

- **Insect Growth Regulators:** The insect growth regulators Knack and Applaud are efficacious for 2 to 3 weeks compared to 7 to 10 days for organophosphate and pyrethroid insecticides. Insect growth regulators have replaced some of the organophosphate and pyrethroid insecticide applications in cotton. As a result there are fewer whitefly insecticide applications per acre per year; a reduction in production costs of $32.25 per acre.

- **Whitefly Control in Melons:** UC research on whitefly control in melons has resulted in and helped to retain a Section 18 label for Applaud®, and Capture® and a Section 3 federal label and California label for Admire® and Capture®. Without these insecticides, melons could not be produced in Southern California during the summer and fall. Fall harvested melons average value is $3,000,000 in Imperial County. Without melon production during the summer and fall

many non-skilled farm labor and skilled farm labor jobs would be lost. Loss of farm labor jobs is multiplied in local economies resulting in the loss of retail labor jobs.

- **Worm Control in Cole Crops**: UC research on worm control in cole crops and leafy vegetables has resulted in labels for Avaunt®, Confirm®, Proclaim® and Success®. These new insecticides are generally more efficacious than older organophosphate, carbamate, and pyrethroid insecticides. Avaunt®, Confirm®, Proclaim® and Success® are less harmful to beneficial insects and spiders as well as birds, mammals and fish; they are also safer for farm laborers and pesticide handlers compared with materials previously available.

- **Codling Moth Mating Disruption**: Implementation of area-wide mating disruption in pears resulted in an increased cost for control of codling moth but a reduction of secondary pest control costs yielding a slightly lower overall cost. Area-wide mating disruption has reduced the use of organophospates by 70% for the control of codling moth.

Management Plant Pathogens

- **Brown Rot of Stone Fruits**: **Pathogenicity Mechanisms and Host Resistance**: These findings are advancing the 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.

- **Biological Control of Late Blight on Tomatoes: Evaluation of Host-plant Resistance Strategies**: The late blight pathogen is now a major threat to tomato and potato production worldwide. The UC contribution to its control has included identifying new sources of resistance in a wild tomato species as well as careful monitoring of the population in 'hot spots' such as Russia. The global nature of its rapid spread has required international collaborative efforts. In California, late blight is a major threat to both the fresh market and processing tomato industries.

- **An Integrated Approach for the Management of Row Crop Diseases in Northern California**: Epidemics of soft rot of carrot and potato were caused by the bacterium *Erwinia* spp. Because soil temperatures were warmer than usual this year, growers applied excessive levels of irrigation water and created conditions favorable for disease development. UC researchers have demonstrated that the risk of serious losses to soft rot is enhanced when soils are saturated for 24 hours or more. These recommendations have been communicated to growers and should lead to less disease and economic loss.

- **Alternative Technology to Methyl Bromide for Control of Soilborne Diseases of Strawberries**: 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.

- **Interactions Between Closteroviruss and Their Plant Hosts**: This research showed that California CTV-infected citrus trees contain a mixture of virus-related sequences. In addition, the research demonstrated that there are some sequences that are highly conserved among the different isolates. This suggests that there may be opportunities for targeting the conserved sequences for controlling CTV.

- **Genetic Improvement of Beans (*Phaseolus vulgaris* L.) For Yield, Disease Resistance and Food Value:** Seed color characteristics are among the most important traits determining consumer acceptability. UC research locating the genes controlling these characteristics on the linkage map together with tagging markers will facilitate the work of breeders in recovering desired phenotypes in the progeny of crosses. Results also suggest that BDMV resistance in common bean may be conditioned by a single dominant gene. This may facilitate breeding for BDMV resistance, and may also make this gene a promising candidate for cloning and characterization. BDMV resistance is widely distributed within the Mesoamerican gene pool, which is consistent with it being a dominant trait.

- **Molecular Detection, Characterization and Control of Tomato and Pepper-infecting Geminiviruses**: 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.

- **Identification of the Molecular Determinants Responsible for Geminivirus Infection in *Phaseolus vulgaris*:** UC researchers have established that the hypersensitive response in the common bean cultivar Othello is not necessary for resistance to Bean dwarf mosaic virus and thus, that it is not a reliable marker for resistance screening. The results of these experiments also established that more than one viral factor contributes to the capacity of Bean golden yellow mosaic virus to overcome the resistance in cultivar Othello.

- **Genetic and Biological Mechanisms Regulating Disease in Crop Plants**: UC researchers report that induction of a programmed cell death pathway in plants by necrotrophic pathogens is critical for disease. Data suggests specific ways to block disease in plants using transgenes or new pharmaceuticals. The potential economic impact is great through novel genetic strategies and the discovery of new pharmaceuticals to block disease, resulting in reduced use of pesticides.

- **Molecular Genetic Dissection of Vegetative Incompatibility in Filamentous Fungi**: UC researchers are involved in the molecular and genetics dissection of genes required for programmed cell death in filamentous fungi. A number of these genes appear to be fungal specific and therefore are attractive targets for the development of drugs/fungicides that induce death in pathogenic fungi.

- **Etiology, Epidemiology, and Control of Virus Diseases of Horticultural Crops**: The role of latent viruses in vineyards in California is better understood as a result of UC research. 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, and sweet potato on a routine basis, increasing the availability of healthy stock to growers.

- **Regulation of Protein Interactions During Barley Strips Mosaic Virus Infection**: This research provides valuable information about the events involved in virus movement, and will help provide an understanding of the genetic and cellular associations of the TGB proteins that facilitate cell-to-cell and vascular movement. This information may also have utility for development of control strategies for protection against BSMV and other viruses.

- ***Xylella fastidiosa* Detection and Identification**: UC researchers elucidated the genetic relationships amongst various strains of *Xylella fastidiosa* (X.f.) (causing Pierce's disease in grapes) using several different techniques. For the most part, strains that were genetically different, also had different plant host ranges. UC researchers evaluated several plant micronutrients as potential X.f. bactericides and developed ways to introduce these compounds into grape. UC researchers developed methods to genetically manipulate and characterize X.f. genes. Such research is important in trying to develop a practical means of controlling Pierce's disease.

- **Elucidating Fitness Determinants in Epiphytic Bacteria**: By determining the chemical nature of leaves at the small scales that plant pathogenic bacteria experience, there can be a better understanding of the process that must occur for successful biological control of disease by antagonistic bacteria that compete with pathogens for nutrients. These studies thus improve the ability to develop alternatives to chemical pesticides for plant disease control.

- **An Integrated Approach to Management of Rice Residue and the Control of Rice Diseases**: Knowledge of *P. grisea* races that occur in California, allow breeders to proceed with confidence in attempts to produce rice blast resistant cultivars for California. Control of Aggregate Sheath Spot disease with a single application of fungicide is economical and results in an increase in both yield and quality. Development of potential seed treatments for control of Bakanae disease appears promising.

- **Walnut Blight**: UC research documented that walnut blight (WB) could be better controlled with the addition of Manex to Copper. Growers have been able to reduce the incidence of WB by as much as 50% by using this mixture of products without adding appreciably to cost.

- **Cucurbit Leaf Crumple Virus:** UC advisors have provided agricultural professionals with information on the diagnostics and economic impact of Cucurbit Leaf Crumple Virus that

enabled them to make management decisions when symptoms of this disease appeared in young cantaloupe plants. Data produced in the Cotton Leaf Crumple trial is being used by plant breeders. Monosporascus vine decline control techniques included metam sodium treatment immediately after harvest are successfully being used commercially in Imperial County.

- **Disease Evaluation Education**: UC CE education in disease evaluation improves a grower's ability to manage diseases to increase yield, quality and value. The conditional burn/rice disease project contributed to the development of regulations and procedures for evaluating rice diseases as a condition of obtaining a burn permit. Conditional burn work furthers the public desire to phase down burning while maintaining some burning as a tool for use disease management.

- **Blackmold:** Blackmold is a major disease impacting processing tomato production in the Sacramento Valley, especially in Sutter County, where the high density of flooded rice fields creates humid conditions in tomato fields. Since most fungicides are efficacious for seven to ten days, multiple applications are required to protect crops from disease. By targeting fungicides to the period when plants are most susceptible to disease, disease control may be attained using fewer fungicide sprays. The information developed in this CE county project has improved the efficacy and economics of fungicide applications for the control of blackmold in processing tomato. The forecast model has been useful for timing second applications of fungicide and for estimating the susceptibility of the maturing crop to blackmold.

- **Melon Powderly Mildew:** Pest Control Advisors use the results of a UC melon powdery mildew trial to help select fungicides; many PCAs commented that they use the registered material that preformed best in the study (Flint). When more than one application is required, they are using the best performing older material in rotation with Flint to prevent resistance development. Data from this trial was submitted to the EPA to help support registration of Procure on melons. Pest Control Advisors are using varietal susceptibility information when considering making preventative melon powdery mildew fungicide applications.

Management of Plant Parasitic Nematodes

- **Integrate Chemical-nonchemical Methods for Soilborne Pest Control**: **Mode of Action and Environmental Benefit**: This research has shown that when integrated with non-chemical control methods, lower rates of chemical fumigants may be adequate for controlling soil-borne pests. This will not only reduce the use and environmental input of chemical fumigants, but also facilitate the implementation of non-chemical practices. These efforts contribute to long-term reduction in pesticide use, and thus the sustainability of production agriculture.

- **Suppression of Plant Parasitic Nematodes and Root Pathogens by Beneficial Rhizosphere Organisms**: Any rational IPM program, to manage the sting nematode, will rely on information about its population dynamics and host range. This study has indicated two

critical times during the year when control strategies will be most effective and beneficial. The UC RAPD study provided evidence that it might be possible to determine the source of the original sting nematode infestation. The survival of *P. penetrans* for more than 2 decades in dry soil underscores its potential as a biocontrol agent.

- **The Transition from Conventional to Low-input or Organic Farming Systems**: **Soil Biology and Soil Fertility**: The UC Brassicaceae studies suggest candidates for use as green manure crops, as biofumigants, and for preparation of nematicidal flour or nematicidal extracts with potential in nematode management.

- **Genetic Variability in the Cyst and Root-knot Nematodes**: Development of grape rootstocks with broad and durable nematode resistance will provide powerful tools for the grapevine industry. It should be possible to establish productive vineyards in nematode-infested areas without resorting to the use of soil fumigants and other nematicides.

- **Genetic Variability in the Cyst and Root-knot Nematodes**: Understanding the co-evolution of mermithid parasites and their hosts have profound implications for predicting the efficacy of entomopathogenic nematodes (i.e. those that can be used to control insect pests). Moreover, elucidating relationships among the root-knot nematodes will ultimately suggest more efficient control strategies.

- **Population Biology of Nematophagous Fungi**: **Mortality, Efficacy, and Formulation**: Data indicate that the efficacy of some beneficial fungi (fungal control agents of pest nematodes) can be increased by changing how the fungi is added to the soil. The beneficial fungus *Hirsutella rhossiliensis* may require a protective covering to survive and grow in soil. Another beneficial fungus, *Arthrobotrys haptotyla*, did not require a protective covering.

- **Development of Cropping Systems for Preplant Methyl Bromide Alternatives for Perennial Crops**: Replacing methyl bromide will require knowledge of how it was influencing growth of replanted trees and vines. It will also require knowledge and field performance data on the attributes and limitations of each potential alternative. This work provides such guidance and shows that the performance of alternatives is not solely determined by reductions in soil pest populations.

Management of Weeds

- **The Biology and Physiology of Perennial Weed Control**: The UC work presents the first reported and documented case of glyphosate resistance in North America and has major implications to weed management programs especially with the wide spread emphasis on genetically engineered glyphosate resistant crops (i.e. “Roundup-Ready” crops that are in widespread use throughout the U.S.). This suggests that with the repeated use of only glyphosate for weed control in these crops, the development of resistance to glyphosate is a real possibility.

- **A Multidisciplinary Assessment of the Use of Cover Crops for Pest Control**: Orchard and vineyard growers are using herbicide treatments developed over many years and a few new herbicides are becoming available for use. Cover crop use has increased in vineyards and orchards. In many fields however, as water supply is reduced, the cover crops are the first practice to be changed or dropped because of increased water use and competition with trees and vines. With practices other than a strip herbicide treatment in the vine row and mowing or cultivation between the rows, there is an increased cost of operation and management levels for the grower. Some growers are not willing to accept these increases. The practices currently in use are economically and environmentally sound. In flower crops, there has been little impact except to make the growers more aware that there will be major changes in weed, nematode, and soil pathogen control when methyl bromide is no longer available. There currently is little that can replace methyl bromide without increasing rates of application of less effective alternative pesticides. There will be a period without registered pesticides that will control grower's soil pests. Growers are increasingly concerned about economically growing their crops.

- **Cultural Options for Integrated Weed Management in Rice, with Emphasis on Herbicide-resistant Watergrass**: Crop competition can be a safe tool for managing weeds in rice with less herbicides. Variability for rice competitiveness suggests opportunities for breeding. Early below-ground competition from rice could offset tolerance to rice shading in *Echinochloa* spp. Understanding of cross-resistance mechanisms to bispyribac and bensulfuron in rice weeds leads to guidelines on more rational bispyribac use.

- **Weed Biology, Ecology and Management in Agronomic Crops**: Increased grass weeds observed at the LTRAS (Long-term Sustainable Agriculture Program at Davis) project re-emphasizes that weed management programs must address all species present, even if their presence is low. Use of economic thresholds has permitted grass weeds to build up to damaging levels; weed seed production should be minimized when weed densities are still low. Sugarbeet growers were advised that using clopyralid may restrict their choice of rotational crops.

- **Weed Control:** Weeds have a significant impact on every acre of production of the more than 250 crops produced in Fresno County. Costs to control weeds can vary greatly, depending on several factors like impact on crop growth, infestation level, crop value, esthetics, etc. On tomatoes, UC research and extension efforts with rimsulfuron (Shadeout) has helped growers know how to use this new herbicide. Approximately 22% of the acreage of processing tomatoes in California were treated in 2000. Weed control (including hand weeding) costs have been reduced by about 35% compared to standard metham sodium treatments. This herbicide is used at a rate of 2 oz/acre, compared to metham sodium, which is applied at 50 to 75 gal/acre. Results from CE advisors' research with rimsulfuron were presented at an onion and garlic seminar in January 2001. More than 100 people attended the meeting and were exposed to this research. Additional information on the trial will be distributed in a newsletter to more than 500 people. With further investigation, transgenic sugar beet technology has the

potential of giving growers a versatile, cost-effective tool for fighting weeds in sugar beets. It is also evident that this type of technology will help reduce cultivation, hand weeding, and the amount of soil residual herbicides applied to the soil.

- **Nightshade Control in Cotton**: Since the 1996 cotton season, growers have been able to effectively control nightshade with Staple at a cost of $20 to $22 per acre including application. Hand hoeing costs have been considerably reduced and in many cases completely eliminated. If hand hoeing is necessary, costs are only $15 to $20 per acre. Nightshade control is now being achieved for $75 to $100 per acre less than the mid to late 1980's and yield losses due to nightshade have been reduced 50 to 75 percent, all resulting in millions of dollar savings to the California cotton industry.

- **Transgenic Herbicide Tolerant Cotton Varieties**: Beginning in 1997, a CE advisor's research program has focused mainly on transgenic, herbicide tolerant cotton varieties and the development and integration of this technology into the California cotton production system. The studies have indicated excellent control of nightshade and moderate control of other weeds such as annual morning glory and nutsedge when Roundup is applied to weed seedlings when Roundup Ready cotton is at no more than the 4-leaf stage. Studies continued to indicate the extreme importance of limiting over-the-top applications of Roundup to no later than the 4-leaf stage. Final plant mapping data indicated misshapened bolls and reductions of boll retention, especially at the 9 and 12-leaf stage of application. Cotton lint yields also showed a significant reduction at the 9 and 12-leaf stages.

- **Transgenic Tolerant Cotton:** A UC CE advisor tested BXN (bromoxynil) transgenic tolerant cotton on a limited basis in 1997 and 1998 with extensive testing in 1999. In 1999, due to the changes in "One Quality Law" governed by the San Joaquin Valley Cotton Board, several thousand acres of Stoneville BXN-47 cotton are now being commercially grown. Results of the trials, as well as grower experience, have indicated excellent control of most summer annual broadleaf weeds when Buctril is applied over-the-top of 2 to 4-leaf cotton to weeds no larger than the 4 to 6-leaf stage. Tank mixes of Buctril and MSMA have enhanced annual morning glory control but when tank mixed with grass herbicides (Fusilade, Poast and Prism) control of pigweed is considerably reduced. Buctril has no grass activity, so tank mixes with the selective grass herbicides are necessary to achieve grass control. There appears to be no loss of grass activity when mixed with grass herbicides. Buctril can be applied over-the-top and/or post directed up to 75 days from harvest without effect to cotton growth and development.

- **Alfalfa Studies:** Results of UC seedling alfalfa studies have given growers a variety of herbicides to prevent weed growth that results in considerably reduced quality and loss of revenue. Weedy hay has sold for $40 to $50 less than weed free hay that test 56 or greater TDN. The loss per acre can be up to $400 - $500, meaning the difference between staying in or going out of business.

- **Rice and Grain Production Systems:** The rice and grain industries compete in international markets, hence they have little control over prices, resulting in unstable incomes. Production costs continue upward. Successful producers manage price instability and rising costs by increasing their competitive ability. This includes more efficient management of production systems. Additionally, rice growers have significant environmental and resource competition issues, such as straw management and water supply and quality. The UC weed x yield interaction research provides a direct link between yield loss and level of weed infestation which improves a grower's ability to assess whether or not it is economic to treat a given problem. The combinations research contribute to a growing body of information on resistant weed management using multiple modes of action.

Animal Pests and Diseases

- **Behavioral Activity in Broiler Chickens and its Effect on the Incidence of Skeletal Problems**: A reliable and objective gait scoring system is needed for breeders and poultry producers to use in diagnosing and preventing leg problems, which are a source of welfare problems and economic loss. The UC system is a significant improvement over that currently in use. UC results also demonstrate that gait scoring is not a reliable method for assessing the incidence of tibial dyschondroplasia, and that other assessment methods (e.g., necropsy or x-ray) should be used for this purpose.

- **Animal Health Economics Including Cost-benefit Analysis of Control Issues**: This research demonstrated that when evaluating a vaccine applied to a population, in addition to the vaccine efficacy, one must also consider the vaccination rate, cost of the vaccine, potential disease transmission rate, and number and cost of cases avoided. Vaccine efficacy may underestimate its value because of the reduction of indirect cases typically avoided when vaccination is applied in a population.

- **Neural Mechanisms of Pain, Analgesia, Itch and Irritation**: The impact of this research is: (a) understanding neural mechanisms of pain, itch, and irritation to develop more effective treatments for humans and domestic animals, (b) understanding taste-irritation interactions with reference to hedonics of food consumption, and (c) understanding the neural mechanisms of general anesthesia with the aim of developing safer agents.

- **A New Potentially Zoonotic Tick-borne Infection**: ***Bartonella*** **Infection in Domestic Livestock:** UC work has clearly demonstrated the reproductive disorders generated by *Bartonella* infection in a mouse model, characterized by smaller litters, fetal resorption and bacteremia in live fetuses obtained by caesarean section from bacteremic mice. Similar observations have also been reported in experimentally infected cats. UC researchers were not able to demonstrate vertical transmission of the infection in calves born by cesarean section from bacteremic cows, therefore such reproductive disorders could be expected in other species, including cattle. UC leadership in *Bartonella* research has also led us to investigate infection not only in mammals, but also arthropod vectors. This project is quite original in that it investigates to determine a possible pathogenic role for a new bacterium, only recently

identified by a UC group. It is difficult at this point to quantify the impact of this infection on animal health, however, as a non- negligible part of reproductive disorders in cattle still have an unknown etiology. Thus, it is worthwhile to further investigate *Bartonella.*

- **Improved Diagnosis and Control of Bovine Protozoal Abortion Caused by Neospora Parasites**: 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 *Neospora* abortion, methods for increasing protective immune responses in naturally infected cattle must be investigated. UC researchers report here the first vaccine efficacy trial in naturally infected cattle.

- **Recombinant Moraxella Bovis Cytotoxin for Prevention of Infectious Bovine Keratoconjunctivitis**: Infectious Bovine Keratoconjunctivitis continues to have a severe negative impact on the U.S. cattle industry. UC recent research is uncovering novel ways to improve vaccines against this costly disease.

- **Sampling and Decision Support System for Northern Fowl Mites in Poultry**: Preliminary indications are that egg sampling may be practical for fowl mite detection, provided producers are interested in controlling moderate-to-high infestations. Such sampling is unlikely to detect low infestations as well as direct hen sampling does. The severity of mite resistance suggests a need to determine resistance mechanisms and to develop a testing system for mites prior to applications

- **Integrated Management of Arthropod Pests of Livestock and Poultry**: Effective poultry pest management necessitates understanding the pest, its biology and ecology. To enable poultry producers to suppress pests while minimizing worker exposure and environmental impact, demonstration projects were conducted with California's largest meat bird producers. Training the pest management supervisors in pest identification and optimal intervention timing allowed them to develop farm-customized programs that minimized pesticide risk while more effectively controlling target pests. Producers can reduce pesticide use, lower worker exposure, and minimize environmental impacts while providing improved food animal health and pest suppression.

- **Targeting Small Poultry Producers for Health and Management Programs**: A comprehensive survey of farm and management variables and microbiologic testing for *Salmonella* and *Campylobacter* was completed on 13 game-bird farms throughout California and from this it can be concluded that this group is not a high risk for food safety.

- **Genetic Probes for the Diagnosis of Leptospire Infection in North American Cattle**: Babesiosis is emerging as a disease of public health significance in the U.S., with increased reports of clinical, even fatal, cases in areas where the risk of infection with Babesia was not recognized previously. Studies on granulocytic ehrlichia indicate that the agent of HGE is

distinct from other previously identified agents of human ehrlichiosis, yet it is similar or identical to *E. equi*. Thus, the comparative ecology and pathogenesis of EGE relates directly to HGE and human health.

- **Host-virus Interactions in Blue Tongue Virus-infected (BTV) Cattle**: The fact that the duration of viremia is finite in BTV-infected ruminants has considerable relevance to international trade codes pertaining to blue tongue, the only OIE List A disease that is endemic in the U.S. UC studies with primary ECs indicate that these cells provide a very convenient and relevant system for the characterization of the pathogenesis of bluetongue disease. UC molecular characterization of the neutralizing determinants of BTV is central to efforts to develop improved vaccines to prevent BTV infection and bluetongue disease.

- **Reproductive Performance in Domestic Ruminants**: In this study, the efficacy of 2 salmonella vaccines was evaluated. No effect was observed following salmonella bacterin vaccination. Salmonella bacterins are the most commonly used salmonella vaccines on the market. Vaccination of cattle with a commercially modified live salmonella cholerasuis vaccine (licensed for poultry) reduced shedding of group C1 salmonella by 25%, but had no effect on the shedding of salmonella from other serogroups. The high prevalence of salmonella shedding by dairy cows on this commercial dairy and the limited efficacy of the vaccines used indicates the ongoing need to develop better prophylactic strategies to reduce the prevalence of salmonella in dairy cattle.

- **Epizootic Bovine Abortion**: **Geographic Distribution of the Tick Vector and Causative Agent**: This research has demonstrated that the tick vector of epizootic bovine abortion (EBA) is present in both Nevada and Oregon and that the etiologic agent of EBA is present. Thus, EBA should be considered a potential cause of reproductive loss in both Oregon and Nevada cattle.

- **Epidemiology of Bovine Viral Diarrhea Virus Infection in Dairy Cows**: These findings provide information necessary in characterizing the waning calf herd immunity resulting from decay of cloistral bovine viral diarrhea virus (BVD) antibodies and give estimates of ages when calves might respond favorably to BVD vaccination. The model will permit development of vaccination strategies tailored to the specific needs and practices of a herd.

- **Avian Lung Fluid Balance**: The basic physiology and pathophysiology of lung fluid balance in *Gallus* is relevant to the poultry breeding industry in that respiratory diseases are a leading cause of flock mortality. This is particularly true of broiler husbandry. The underlying mechanisms of many avian respiratory diseases, and hence their prevention, may involve pathophysiological mechanisms which alter normal lung fluid balance.

Vectors of Human Diseases and Impacts on Human Health

- **Molecular Genetics of Californian Arboviral Vector Mosquitoes**: The presence of significant organophosphate and low-level pyrethroid tolerance in medically important

mosquitoes such as *Culex tarsalis* and *C. quinquefasciatus* has significant impact in the operational use of insecticides in California. Attempts to prevent further increase in insecticide tolerance by judicial use of resistance management protocols must be initiated. UC research will be of substantial benefit in improving this situation.

- **Mosquitoes and Arbovirus Transmission**: UC results indicate that the virulence of eastern equine encephalitis (EEE) for its North American mosquito vector does not depend on dose. Instead, virulence characteristics are associated with growth properties of this virus in infected mosquitoes. This research is important in understanding how different mosquito species will vector this disease.

- **Molecular Genetic Analysis of *Drosophila* Paralytic Mutants**: The *Drosophila* mutants that have two dramatic phenotypes. They are seizure-susceptible which may ultimately provide basic information in developing new anti-convulsant drugs for human seizure disorders. They also suffer from paralysis that may provide a basis for designing new types of pesticides to fight insects.

- **Mosquito and Agricultural Pest Management in Riceland Ecosystems**: 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 multi-agency 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.

- **Animal, Cell and Enzyme Models for the Detection of Exposure to Pesticides and Other Toxicities**: A UC project standardizing clinical laboratory cholinesterase assays has attracted California and national agency attention hopefully resulting in an improvement in how laboratories screen for exposure to organophosphate pesticides. The evidence that piperonyl butoxide crosses the blood-brain barrier under the conditions of The UC study is important in assessing the therapeutic value of this drug.

- **Mechanisms and Mitigation of Agrochemical Impacts on Human and Environmental Health**: Reducing runoff of pesticides from orchards and farms is important to maintain the food and fiber production of California. The results of the CALFED project are an important component of California's Integrated Pest Management efforts. Improving the performance of clinical laboratories in detecting exposures to pesticides help protect people and wildlife from pesticide related illnesses.

NATIONAL GOAL 2

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

UC-DANR's Human Resources Programs Covering:

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

According to estimates from the Centers for Disease Control, approximately 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.

Twelve local extension programs were delivered in this area. In addition, one statewide collaborative workgroup composed of both AES and CE academics planned and conducted research and extension projects. California academics published 94 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 2000-2001 Allocated Resources

Extension Federal Funds (Smith Lever 3 b&c)	Extension State Match	Research Federal Funds (Hatch)	Research State Match

$10,416	$1,580,969 [8.66 FTE]	$182,745	$4,351,243 [18.72 FTE]

- **Outputs, impacts and outcomes**:Research findings indicate that some organophosphate pesticides exhibit the property to activate in human prostate cancer cells, prot oncogen, c-Neu, which is known to play a pivotal role in pathogenesis of prostate cancer. Such a finding raises the possibility that their residues in human tissues are acting as androgen mimics in promoting the development of prostate cancer. Understanding the effects of organophosphate pesticides on human prostate cancer cells and the role that it plays in promoting prostate cancer, will provide new approaches to preventative treatment.

- Persistent pain frequently indicates that cumulative injury will follow as a result of poor ergonomics. A UC study on farm workers indicated a reduction in pain and discomfort experienced as a result of improved ergonomics in the work environment directly benefits the workers. This has also resulted in a benefit to management and society. Work on a bench top propagation cutter for ornamental nurseries has now resulted in commercialization of the unit. At one nursery alone, four workers are still productively employed who would have had to accept disability retirement or change of profession if an alternative shear had not been available. This study indicated a reduction in the number of workers reporting persistent pain by over 50%.

- Bacterial stress responses contribute to food-borne illness directly by influencing bacterial pathogenicity and indirectly by promoting bacterial survival in foods. The general stress response strongly contributes to bacterial survival in the natural environment, in foods, and in the human body during infection. UC faculty are doing research on bacterial stress response systems in order to regulate or control the bacterial growth in foods. Understanding the function of this response will allow control of bacterial growth in foods, and understanding its regulation will allow treatment of bacterial infections by new approaches that do not rely on conventional antibiotics.

- Food borne illness due to pathogenic Gam-negative bacteria is a constant public health threat. Pathogenicity of many Gam-negative bacteria involves secretion of virulence factors. UC research demonstrated that flagellar-dependent motility plays a critical role in the ability of the bacterium to invade human cells. The project also examined the regulation of the yplA gene which encodes a virulence factor secreted by the flagellar type III secretion system. Results from these studies established that yplA belongs to the flagellar regulon (Schmiel et al.). Furthermore, transcription of yplA is controlled by the flagellar transcriptional regulator FlhDC and the flagellar specific sigma factor, sigma 22. These results provide knowledge that can lead to the development of methods for treatment or the prevention of food-borne illness by Gram-negative bacterial pathogens.

- Ecologic assessment of Salmonella enteritidis var Typhimurium in a dairy milk shed: The objective of this research is to specifically determine the subsets of S. Typhimurium in a

geographic community with a high concentration of dairy cattle and describe the medical ecology of the bacteria relative to the subsets.

1. Determine the genetic and phenotypic diversity of S. Typhimurium isolates from human and bovine sources in a region with a concentrated population of dairy cattle.
2. Determine the spatial and temporal dynamics of S. Typhimurium isolates from human and bovine sources in a region with a concentrated population of dairy cattle
3. Determine the risk factors for the persistence of S. Typhimurium on large dry lot and free stall dairies.

The system for routinely collecting ST isolates is in place. The three county health departments are providing the researchers with isolates and epidemiological data from reported clinical cases. The animal diagnostic laboratory is providing them with isolates from bovine (adult and calf) clinical cases. In addition, they are working closely with the milk receivers in the region and have assayed more than 400 bulk tanks (representing 85% of the dairies in the region) for the presence of ST. They have commenced collecting environmental samples, primarily water sources. All the microbiologic assays have been optimized and detection limits determined. The objective of these assays is to develop tools to facilitate epidemiological studies where large numbers of microbiologic samples need to be processed in a short period of time. Their data suggest that as the sample is refrigerated there is spatial clumping of the bacteria rather than uniform distribution in the milk sample. They have assessed the antibiotic phenotypes of current banked isolates and have a spectrum of resistant phenotypes from resistant to sensitive. They have also begun genetic characterization of all isolates and have completed a map of the three-county region that includes dairy and other animal enterprise locations, streams, industry, other agricultural enterprises, and biosolid and effluent discharge/storage sites. They have linked this map to their ST isolates and have begun preliminary spatial assessments. The construction of the maps was a collaborative effort between local government, industry, and the university. It appears that only a portion of the known S.Typhimurium is associated with dairy cattle and can be identified in milk or on cull animals and some of these may be associated with food borne and human disease. In addition, there are specific inputs, reservoirs, and animal management practices that are responsible for the persistence, spread, and expression of this subset of S. Typhimurium on California dairies. This study will not only provide information to rapidly address the source of any ST outbreaks in California, but also will enable the development of strategies to reduce the risk of such outbreaks, thereby safeguarding the future of California's $3.7 billion dairy industry.

- Systemwide improvements in quality and microbial food safety during the production and distribution pipeline from seed to food service or retail consumer are extremely important to the agricultural sector involved in perishable produce management. The objectives of this research are to develop and evaluate novel approaches for assuring the quality and safety of fresh-cut vegetables and fruits. 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. Detectable populations of nonpathogenic E. coli, potential

indicators of direct or indirect fecal contamination were found on preharvest fruits and vegetables, primarily in association with close proximity to concentrated animal production facilities or if over-head irrigated with source water containing these indicators. Populations ranged from undetectable (less than 10) to greater than 100,000 viable bacteria per sample by membrane filtration and selective/differential enumeration. Ambient summer air temperature above 39^{o}C and ambient relative humidity less than 25% were not sufficiently restrictive to survival on the surface of diverse tree and row crops.

Researchers have developed and validated standard methods for inoculation and recovery of pathogens from a variety of produce items including tomatoes, apples, strawberries, melons, and broccoli. This has enabled them to evaluate growth and survival of Salmonella, Listeria monocytogenes, and E. coli O157:H7 at refrigerated, frozen and ambient temperatures. 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. Generic E. coli, pathogenic E. coli O157:H7, various Salmonella serovars, and Listeria monocytogenes were found to persist in commonly used pre and postharvest fungicides and postharvest fruit and vegetable waxes and oils, at labeled use rates. Multiplication on a few fungicide formulations was observed. Survival of E. coli O157:H7 in frozen apple juice and strawberries was found to be strain dependent. Survival was significantly greater when 20% sucrose was added to the strawberries. A survey of California grown cantaloupes has been conducted during 1999-2001. Over 990 melons have been assayed and no positive detection of naturally-contaminating Salmonella were found. In contrast, all artificially contaminated melons from the same fields were positive for the applied strain of Salmonella.

Research targeted at improving the effectiveness of ozone, a chlorine alternative that produces comparatively few disinfection by-products and no known carcinogens, is being conducted in collaboration with commercial packers and shippers.Wash treatments are currently being evaluated for both intact and cut products. Treatments include chlorinated and unchlorinated water, vinegar, and use of a consumer antimicrobial spray. The research data are helping to define parameters for both design and implementation of Good Agricultural Practices and future research needs to improve microbial food safety programs. The findings have the potential for enormous impact on the continued profitability of California's $13.9 billion horticultural industry, since identifying novel approaches to ensuring food safety is critical to maintaining consumer confidence in these products.

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.

Over 40 local extension programs were delivered in this area. In addition, eight statewide collaborative workgroups composed of both AES and CE academics planned and conducted research and extension projects. Last year, California academics published 119 peer-reviewed articles and four extension publications to address Goal 3.

UC-DANR's Human Resources Programs Covering:

- **Human Health and Nutrition**

Research and Extension Performance Goals:

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

FY 2000-2001 Allocated Resources

Extension Federal Funds (Smith Lever 3 b&c)	Extension State Match	Research Federal Funds (Hatch)	Research State Match
$467,213	$3,407,047 [26.16 FTE]	$298,826	$4,538,940 [18.59 FTE]

Outputs, impacts and outcomes:

- The EFNEP and FSNEP projects assist California low-income families make the best use of their resources for food and help them in achieving a safe, healthy and adequate diet by using locally delivered educational programs. Of 452 Tulare County families participating in EFNEP and FSNEP, 68% of the families graduating improved one or more food resources management practices, while 33% improved 2 or more practices. 80% of the families graduating improved one or more nutrition practices, while 46% improved 2 or more practices. 54% of the families graduating improved one or more food safety practices. In San Luis Obispo County, 75% of California teachers trained in Youth FSNEP have incorporated nutrition training in their teaching curriculum.

- Hosting nutritional and food safety seminars and programs have provided health professionals and consumers with current and accurate information. A six-month follow-up survey to participants at a Bone Health conference indicated that 83% of participants indicated that they made at least one positive behavior/nutritional change including increasing dietary calcium intake and increasing weight bearing exercise.

- Participants responding to a 6-month follow-up survey for a food safety conference indicated that 88% made at least one behavior change including extending the information in college courses, at staff trainings, and at clientele training.

- Development of local campaigns and programs has enhanced nutrition knowledge and increased community involvement and awareness. In the Los Angeles region, the UC Extension "5 A Day Power Play!" campaign reached 157, 587 nine, ten and eleven year olds with the 5 A Day message. The "5 A Day Family Fest" reached over 500 children and their families. Mini-grants awards to school and agencies allowed them to enhance the Power Play message. These activities led to an increased number of lunch salad bars for students in the school districts providing healthy nutritional choices. In addition, community youth organizations have changed their snack policy to include more fruits and vegetables. Evaluations from activities revealed that children are more familiar with more types of fruits and vegetables and are willing to try and eat them. In addition, the children indicated that they usually eat at least one additional serving daily of fruit or vegetable after participation in the 5 A Day activities.

- There are significant economic, environmental and social benefits of increasing the duration and exclusivity of breast feeding. UC researchers completed a study of risk factors for delayed onset of lactation and poor neonatal weight gain among 280 breast feeding women. The results showed that the delayed onset of milk production occurred in 24% of women and was more common in first-time mothers and those with a long labor or a C-section. Results also showed exclusive breast feeding for six months is beneficial to mothers and infants, and that assistance from trained health care providers at 3-4 days postpartum is essential for increasing the rates of exclusive breast feeding.

- UC studies showed micronutrient fortification of processed infant foods is an efficacious method to enhance the micronutrient status of infants at risk of deficiency. Zinc supplementation of children with acute and persistent diarrhea in high-risk populations can reduce diarrheal severity and/or duration. In addition, greater education of girls in low-income settings may result in improved nutritional status of their children

Health Promotion
Recent findings from the Diabetes Prevention Program indicate that intensive lifestyle modifications—daily moderate physical activity and 5-7% weight loss—can decrease the risk of developing type 2 diabetes in individuals at high-risk of this disease by 58%. African Americans and Latinos are two racial/ethnic subgroups at high risk for type 2 diabetes.

Activities of this workgroup have focused on identifying needs, channels, and approaches for reaching these two target groups with diabetes awareness and prevention education. Several members of this workgroup developed and piloted a curriculum unit, Take Care of Yourself, designed specifically to deliver diabetes awareness and prevention messages to Latino audiences. The unit was pilot-tested among 89 Latinos participating in the Expanded Food and Nutrition Education Program (EFNEP). Compared to those in the usual EFNEP classes, participants exposed to the diabetes awareness curriculum were more likely to have encouraged a family member to be screened for diabetes and reported greater increases in their level of physical activity at a three month post-intervention follow-up ($p < 0.05$).

In 2000-2001, the workgroup conducted seven focus groups among African American adults not yet diagnosed with diabetes. Many participants felt that not enough information about diabetes was reaching the African-American community, in spite of the high prevalence of the disease in this population. Although obesity is considered a major risk factor for developing type 2 diabetes, most linked poor eating patterns, rather than body weight, to the high rate of diabetes among African Americans. Taste, family pressure, and lack of social support were most commonly mentioned as barriers to dietary changes. Based on these and other findings from the study, the workgroup is continuing to work closely with the African American communities to develop an outreach campaign to encourage earlier screening and treatment of the disease.

Maternal Infant Nutrition

The Southeast Asian population has the lowest rates of breast feeding initiation and duration in California. The UC WIC-EFNEP postpartum in-home support program is designed to fill the critical gap in lactation support services. To date, 22 women are enrolled in the project and 10 babies have been born. UC researchers have completed data collection on 7 mothers. All 7 mothers continued to breast feed during the six home visits and were beginning to bottle feed along with breast feeding during the three month follow-up visit. The WIC Lactation consultant has been readily available and accessible to provide assistance, support, and encouragement to the mothers ensuring their continued success.
A statewide breast feeding needs assessment survey has been developed, pilot tested and sent to the breast feeding coalitions throughout the state. This survey is intended to assess factors associated with breast feeding initiation and duration and the delivery of lactation support services in the state of California as perceived by breast feeding advocate groups. This project will result in increased networking and sharing among the existing breast feeding coalitions across the state. Further, the information gathered will be used to provide an overall view of the "state of breast feeding" to the Department of Health Services, determine future goals of breast feeding outreach programs from the University of California at Davis, and to assist coalitions in obtaining funding for local projects.

1% Milk Campaign Results in Dramatic Rise in Sales
Sales of 1% milk at four Fresno grocery stores soared following an 18-week *"1% Milk - Healthy and Delicious!"* campaign aimed at raising public awareness about the health benefits of lower-fat milk. A program representative for California Nutrition Network based at the UC Cooperative Extension office in Fresno collected milk sales information from four grocery stores in two Fresno ZIP codes before initiating a multi-faceted campaign which targeted Spanish-speaking and English-speaking Hispanic mothers of young children. After the campaign, sales of 1% milk were 43.8% higher.

The Central Valley LEAN coalition, comprised of community agencies from all health fields, defined the problem: the Hispanic population consumes more whole milk than non-Hispanic populations. Whole milk has 8 grams of fat in one cup, while 1% milk has 2.5 grams of fat in one cup. Low-fat 1% milk has more calcium and protein per cup than whole milk while its vitamin D content is the same. Whole milk can contribute to overweight, obesity, heart disease, cancer, stroke, and type 2 diabetes, conditions disproportionately high in the Hispanic population.

The campaign included milk taste tests and presentations at schools and grocery stores; posters and brochures at supermarkets; television, print, and radio promotions; dissemination of materials at WIC clinics, health provider sites, and health fairs; and collaboration with the Fresno Unified School District to serve 1% milk. The post-campaign survey of milk sales at the four grocery stores showed a significant increase in 1% milk sales and a progression to 1% milk. There was a 7.8% decrease in whole milk sales, 11.5% increase in 2% milk sales, 43.8% increase in 1% milk sales, and a 31.7% increase in flavored 1% milk sales. The 1% milk campaign will expand into three new ZIP codes in Fresno beginning in spring 2002. In addition, a protocol will be developed and provided to groups that wish to present a 1% milk campaign in their own communities.

Body Weight & Health

The first statewide Child Obesity Conference was held in March this year, thanks to collaboration between the Body Weight and Health Workgroup, the Center for Weight and Health, and the California State Department of Health Services (DHS). The purpose of the conference was to heighten awareness of child obesity, motivate participants to take actions and provide them with information and tools to do so. Attendance at the conference far exceeded expectations, with 965 total attendees representing 29 states. Fourteen members of the work group attended the conference and 9 workgroup members were conference presenters, a total of 30 different workshops were offered, generating positive feedback and desire for similar educational assemblies in the future. Eighty-four percent of the evaluations rated the conference and the general session presentations as either "excellent" or "very good." Based on the overwhelmingly positive responses a follow-up conference in 2003 is being discussed.

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.

Progress has been made by UC DANR in all areas identified in the Plan of Work for Goal 4. The vast extent of research and extension outputs is indicated by the large number of publications in this area over the last year. California academics published 741 peer-reviewed articles, 20 non-refereed publications, and 94 extension publications to address Goal 4 last year. Over 160 local extension programs were delivered in this area. In addition, 25 statewide collaborative workgroups composed of both AES and CE academics planned and conducted research and extension projects.

FY 2000-2001 Allocated Resources

Extension Federal Funds (Smith Lever 3 b&c)	Extension State Match	Research Federal (Hatch)	Research State Match
$1,496,095	$15,566,142 [92.60 FTE]	$1,503,185	$34,481,647 [117.77 FTE]

Outputs, impacts and outcomes:

- UC Extension advisors assisted local communities to preserve productive farmland in California by providing technical expertise, advice and assistance in planning land use policies and developing priorities. In a Central Valley county, a local farmland trust was established with a voluntary program by which farmers can sell or donate conservation easements. Three commercial farms have transferred development rights and several more are in the application process. The impacts: local jobs that are based on agricultural production have been saved; open space that is important to wildlife and scenic needs are being preserved, and local residents are recognizing the value of preserving farmland.

- The urban horticulture workgroup composed of CE advisors, CE specialists, and AES faculty developed a statewide educational program to make residents aware of the potential for surface water contamination with organophosphate insecticides and ways to prevent it. One of the successful efforts to achieve this goal was the development of consumer pest management cards. Eighty thousand consumer cards outlining alternatives to OP insecticides for 8 key insect pests, safe use and disposal of pesticides and use of beneficial insects and IPM were distributed to 22 California CE county offices. The cards have gotten rave reviews. The California Association of Nurserymen (CAN) has indicated an interest in distributing them through CAN nurseries. A CALFED proposal to fund printing for CAN nurseries received preliminary go ahead for the next stage evaluation. A survey is currently underway to evaluate local interest. The cards are being translated into Spanish and will be made available on the UC IPM website.

- A UC project studying the biostructural and biochemical diversity in woody plants has provided evidence in support of the existence of Quercus parvula in central coastal California. Understanding the distinction of this species from Q. wislizenii will influence the management of coastal oak woodlands in face of poor regeneration and disease. Research information on genetic diversity has been used to develop conservation strategies for a number of rare or threatened species.

- Rapidly urbanizing parts of California are places where endangered species and communities are at risk. A UC CE Specialist worked on a project to assess the effectiveness of local land use regulatory procedures in mitigating the effects of development on endangered species. With his colleagues, he conducted research on local management of anadromous fish in nine counties and oak woodlands in three counties. Results were communicated to local decision makers and within UC. While modification of land use management and regulation in counties may lead to increased costs to local government and developers, there will be improved chances for recovery of listed anadromous fish stocks and improved local regulation of impacts to oak woodlands as well as greater environmental awareness by county governments.

- Fire occurs frequently in California's oak woodlands: the area burned by wildfire has increased the past decades and prescribed burning for forage and shrub management is a common practice. The severity of recent wildfires in California oak woodlands prompts interest in use of prescribed burning to limit fuel accumulation. However, the effects of fire on the majority of terrestrial vertebrates are largely unknown. In 1996, the Intgrated Hardword Range Management Program (IHRMP) established, and subsequently has sampled, 22 grids (small mammals), six 1,000-m transects (winter birds), 83 points (spring birds), and 1,224 coverboard stations (herpetofauna--half each in treatment (prescribed burn) and control (not burned) sites in relatively unmanaged oak woodland at a California study site. In October1997, the California Department of Forestry (CDF) conducted experimental burns on the treatment areas (202 ha). Post-burn data on winter and spring birds, small mammals, herpetofauna, vegetation, and oak saplings continued this year (FY 2000/2001). In response to the prescribed fire conducted in fall of 1997, four of the 13 vegetation and habitat components measured were reduced significantly (grass, shrub cover, course woody debris, woodrat houses; $P < 0.05$) by the fire. However, no change in relative abundance of small mammals, breeding birds, amphibians, or reptiles in response to the prescribed fire were observed. The results of the project show that light to moderate prescribed burning has little, if any, adverse impact on small vertebrates in oak woodland, but the benefits of prescribed burning on fuel load and vegetation rejuvenation is substantial.

- Utilization of biomass resources for energy, chemicals and other products has beneficial environmental impacts in substitution for fossil fuels and reductions in net atmospheric carbon emissions. Using a range of agricultural, forest, and solid waste fuels, alkali partitioning to the gas and particle phases and the concentrations of nitrogenous species including NOx, NH3, and HCN were determined to assess the use of biomass derived fuel gas for reburning applications. Studies were also conducted on the commercial feasibility of using leached rice

straw as a blending fuel for existing biomass power plants in California. Current state incentives and subsidies are sufficient to make straw competitive in price with other available biomass fuels. Steam explosion of wood residues under different temperature and chemical conditions was studied for pretreating the wood residues to increase their digestibility. It was found that steam explosion improved the digestibility of wood residues considerably, by over 50%. Higher temperature and use of acids during steam treatment resulted in higher digestibility. Fish waste imposes challenges for anaerobic digestion due to its high contents of fat, oil and protein. Experimental results indicated that if supplemented with a biodegradable carbon source, fish waste could be readily digested producing a high biogas yield. Local benefits are also derived from improved crop residue management techniques and reductions in pollution stemming from traditional disposal practices. Improved techniques for using rice straw offers reductions in air pollution from open burning, as well as economic benefits to growers facing higher production costs.

- A Northern California CE advisor worked with vineyard growers in his county to reduce soil erosion in new vineyard projects by educating them on the proper techniques to protect soil. Nearly 4,500 acres were planted in grapes in the last four year in areas planted previously to walnuts in more upland areas on slopes prone to soil erosion when not properly managed. Information garnered from UC long-term research in soil quality and conservation assisted growers in preventing soil erosion and subsequent water pollution. Research findings showed a mix of subclovers, bur clover, rose clover and 'Blando' brome are useful for vineyard sites that are managed under a non-tillage regime. Five years ago, few growers used erosion prevention techniques, such as avoiding tillage during the heavy rainfall months, straw mulching, cover crops and other proven practices. Since that time, these have become routine practices incorporated into nearly every new development. Grower practices have definitely been changed, and environmental quality greatly improved. In addition to erosion prevention measures, growers informally receive other suggestions and ideas for vineyard design and construction. Today nearly 100% of new hillside developments are planted to permanent sod forming cover crops.

- The treatment and reuse of wastewater from agriculture, industry, and municipalities are becoming necessities throughout the world. A UC researcher studied treatment processes to remove toxic trace elements from contaminated water. An important finding is that uranium is only partially reduced by zero-valent iron, and upon exposure to oxygen can be reoxidized to its soluble form. Thus, the spent iron metal must be collected and isolated to prevent recontamination of the water. This research has identified a new way to safely treat contaminated water using iron filings and the oxides that form during the rusting of the iron metal. Zero-valent iron has been shown to be beneficial, and cost effective in treating water contaminated with uranium, selenium, chormium, and arsenic. Treating water to remove toxic trace elements will result in extending limited water supplies.

- The fate and toxicity of chemicals in nature depends upon their molecular shape and bonding. Water influences these chemical properties dramatically and UC researchers are comparing

experimental and theoretical rates of bond rupture. This research is critical to the mission of DANR because it provides a scientific basis for decisions about the use of chemicals and their effect on soil and soil solutions. The work has already been incorporated into text books used to train agricultural students and agricultural professionals.

UC-DANR's Natural Resources Programs Covering:

- **Wildfire Science and Management**
- **Water Quality, Water Quantity, Water Allocation and Watershed Management**

WILDFIRE SCIENCE AND MANAGEMENT

DANR focused its research and extension resources on reducing the risk and intensity of wildfire and to improve public understanding of the role of wildfire in the functioning of an ecosystem. Programs were delivered by individuals and collaborative groups including a statewide workgroup composed of both AES and CE academics. To accomplish this, 42 Extension programs were delivered and four Extension and outreach publications and 22 peer reviewed research papers were published.

Research and Extension Performance Goals:

- Evaluate alternative systems of vegetation management comparing the benefits and costs from both an environmental and an economic viewpoint.
- Coordinate educational efforts directed toward those in positions of managing wildfire and fuel loads, and those affected by wildfire.
- Inform policy makers and others who influence policy decisions on wildfire management.
- Determine current fuel loads in various vegetation types.
- Identify costs and environmental consequences associated with different fuel modification strategies.
- Employ interdisciplinary teams to evaluate consequences of wildland prescribed fires on various ecological processes.
- Conduct research and technology transfer to address role of wildfire management on ecosystem sustainability.

Wildfire Science

Key Theme: Wildfire Science and Management

Short Term Impacts

- Initiated California component of fire and fire surrogates study. This research effort is investigating silvicultural practices to assess their ecological effects, economic return and fire hazard reduction in comparison to those that a fire regime would create. This study may lead to development of forest management strategies that lessen wildfire hazard while sustaining a viable forest products industry.

- The properties of woody biomass materials, drying characteristics, and utilization potential of small diameter trees have been determined. This woody biomass material, which accumulates to hazardous levels in forestland, rangeland and urban forest environments, has potential for a number of high value products. Utilizing this information in identifying high value products has the potential for establishing production industries in rural areas while reducing the threat of catastrophic wildfire through the reduction in biomass (fuel) loads in wildlands.

Long Term Impacts

- Reseachers conducted laboratory testing vegetation fire resistance, resulting in a classification system for fire resistance. This led to changes in plant material utilized for landscaping, particularly at the urban-rural interface, significantly reducing the risk of wildfire damage to life and property.

- The results of a variety of research projects led to the revision of the California Vegetation Management Program EIR. The revision of the EIR provides vegetation managers with an expanded number of techniques to reduce or eliminate wildland fuels in efforts to mitigate extreme fire hazards. This has led to a trend of reduced resource losses from significant wildfires and has the potential to save millions of dollars in fire suppression costs yearly.

- Researchers conducted an evaluation of statewide code enforcement activities (related to fire hazard programs) at state and local levels of government. The assessment led to a categorization of hazard assessment systems in use in California. Recommendations regarding effectiveness of systems were made which will lead to more effective programs, safer construction, and less loss of life and property, particularly at the urban-rural interface.

Source of Federal Funds: Smith Lever 3b&c and Hatch.
Scope of Impact: State specific

WATER QUALITY, WATER QUANTITY, WATER ALLOCATION AND WATERSHED MANAGEMENT

DANR focused its research and extension resources on the following goals: improve the integration of all water quality factors when determining the beneficial uses of water; improve the decision-making process when reallocating existing developed surface water; ensure water resources are valued and priced using appropriate means; maximize the utilization of reclaimed water under appropriate conditions; improve public understanding and knowledge of all water rights and their consequences when making policy decisions regarding water management; improve the standardization, coordination and dissemination of water information when dealing with quality, quantity and interagency transfer efforts; improve watersheds while sustaining local, natural resource-based economies; and improve the integration of sound, ecologically-objective information for the benefit of all watershed components.

Programs were delivered by individuals and collaborative groups including 2 statewide workgroups composed of both AES and CE academics. To accomplish this, 125 Extension programs were delivered and 60 Extension and outreach publications, 79 peer reviewed research papers and eight other media were published.

Research and Extension Goals:

- Facilitate interdisciplinary research on water quality issues.
- Disseminate research-based information on the effects of various activities on water quality to public policy decision-makers and other stakeholders.
- Facilitate discussion of water issues in a collaborative manner at the state, regional, and local levels by determining the relationship between state and regional water management plans and local, site-specific implementation of projects consistent with those higher level plans and objectives.
- Disseminate research-based information to public policy decision-makers and stakeholders regarding regulation, allocation and end uses, costs, and water quality assessment and technology.
- Conduct research and outreach programs related to development of new technologies that are usable in the laboratory or in the field for measuring and monitoring water quality.
- Conduct research and outreach programs related to estimating yields, water runoff, drainage, and benefits and costs of various management activities. Downstream effects including those on coastal and estuarine environments, as well as those within the watershed, should be assessed.
- Improve coordination among watershed planning groups, agencies, etc.
- Demonstrate to stakeholder audiences effective watershed management practices.
- Facilitate the exchange of information on watershed concepts and the effects of various management options among stakeholders in watershed planning efforts.
- Assist agencies, landowners, and watershed groups in designing and interpreting long-term monitoring programs assessing new management practices and restoration efforts.

DANR Water Quality Education Program
Key Theme: Water Quality

A comprehensive DANR Water Quality Planning Course has been developed. The course has:

- Delivered educational programs that teach private landowners about watersheds, water quality regulations, rangelands, grazing, and environmental assessment and monitoring.
- Conducted training for Cooperative Extension Advisors, USDA Natural Resource Conservation Service personnel, and other agency personnel in the area of rangeland watershed management.
- Provided information to public policy makers.
- Developed effective methods for monitoring California rangelands and associated water bodies.

- Characterized the hydrology, ecology and water quality of rangeland watersheds, riparian areas and associated stream systems.
- Developed and improved "best management practices" and tested their effectiveness.
- Determined the influence of livestock on grazed watersheds.

Short Term Impacts

- A new program, the Central Coast Farm and Ranch Water Quality Planning Project, has taken the model of The UC Ranch Water Quality Planning Short course and adapted it to meet the needs of production agriculture in addition to rangeland livestock production. This course will educate growers about methods for minimizing water quality impacts and lead them through the development of a water quality plan for their agricultural operation. This program has the potential to significantly reduce water quality impacts, including sediments and chemicals, in coastal water systems. Broad implementation begins in 2002.

- Researchers are bringing together the basic research on livestock behavioral mechanisms that regulate grazing distribution patterns and the field of landscape ecology to develop strategies and practices for attracting cattle away from riparian zones or other environmentally critical areas. This research will address the impacts that grazing livestock can have on water quality, biodiversity, and fish and wildlife habitats by attracting them away from environmentally sensitive areas. This work has the potential to result in the maintenance, and perhaps enhancement, of the range livestock industry in California.

- A two year study has begun to assess water quality of rangeland streams across the state. This will be the first consistent rangeland water quality survey. This will provide the data necessary to accurately assess the relationships between water quality and important watershed specific characteristics, compare the current quality to existing standards, and to determine the outputs of pollutants from these rangeland streams with known and expected inputs from livestock production, geologic sources, wildlife, and other uses of rangeland. The results of this project will provide the basis for evaluation of a multitude of management activities, with the potential for significantly improving water quality around the state.

- Researchers are investigating the relationship of residual dry matter, used as a management standard on annual grassland ranges, to water quality, biomass production, and vegetative diversity. Results of the study have generated management guidelines for the amount of residual dry matter needed to promote maximum productivity the following growing season while enhancing the diversity of vegetation community. This information is developing the relationships of these residual dry matter standards to the production of sediment and movement of nutrients from these sites. This project has already resulted in developing information which will provide land managers with information to improve productivity and diversity of the annual grassland. Subsequent information will provide recommendations that will also enhance water quality.

Long Term Impacts

- Through the effort of The UC Ranch Water Quality Planning Short Courses, over 1,100,000 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.

- A statewide project has begun to identify "riparian friendly" livestock grazing management practices that safeguard riparian area values while allowing for economic use of the range resource for livestock production. This cross sectional survey of California's rangeland riparian grazing management is identifying the site factors and management measures that result in healthy riparian systems and productive range livestock production. The result is cleaner water, better habitat and viable livestock production operations.

Source of Federal Funds: Smith Lever 3b&c and Hatch.
Scope of Impact: State specific

Sudden Oak Death
Key Theme: Natural Resources Management

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.

Short Term Impacts
- The causative agent of sudden oak death has been identified as Phytophthora ramorum. Based upon morphology, the isolates examined in detail do not match any Phytophtora 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.

Long Term Impacts

- Researchers have established a composting treatment for wood from trees infected with the fungi Phytophora ramorum which effectively kills the fungi. This treatment will aid in halting the spread of Sudden Oak Death significantly reducing the environmental and safety impacts of the disease, specifically the increase in potential for catastrophic wildfire threat and associated loss of property, life and degraded water quality.

Source of Federal Funds: Smith Lever 3 b&c; Hatch
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. The Division is uniquely positioned to strengthen the linkages between research and practice to address these issues.

Over 180 local extension programs were delivered in this area. In addition, 17 statewide collaborative workgroups composed of both AES and CE academics planned and conducted research and extension projects. California academics published 99 peer-reviewed articles, 17 extension publications, 12 non-refereed publications, and 8 other media to address Goal 5 last year.

FY 2000-2001 Allocated Resources

Extension Federal Funds (Smith Lever 3 b&c)	Extension State Match	Research Federal Funds (Hatch)	Research State Match
$1,125,776	$6,005,169 [49.16 FTE]	$140,144	$3,329,225 [13.75 FTE]

Outputs, impacts and outcomes:

- A UC Home Economist in Southern California provided training and tools (Kindergarten Prep program) to low-income parents to assist their preschool children in becoming kindergarten ready through educational play. Focus group interviews with 16 parents at 6 sites indicate that 95% of the parents interviewed use the Kindergarten Prep program at least two times weekly with their children.

- In an effort to enhance science literacy, after school programs are eager to incorporate engaging educational activities, such as YES (Youth Experiences in Science), that seek to stimulate scientific thinking and develop an enthusiasm for science in both elementary school children and teenagers living in low-income communities. Research results show that after participating in YES, teen teachers were more confident in public speaking and working with children, felt more positive and knowledgeable about science and increased their skills in working with peers.

- UC advisors in several counties assisted low-income populations in increasing food safety, reducing hunger and building teen programs by building community-based teams focused around these three topics. In addition, hunger studies for two counties have been published and shared with community. As a result, members from various communities within the counties have come together with the shared goal of "feeding" hungry people, and a Long Range Plan from participating agencies and groups will be presented to the Board of Supervisors as a countywide effort to reach hungry people.

UC-DANR's Human Resources Programs Covering:

- **Human and Community Development**
- **Economically Viable Families and Communities**

HUMAN AND COMMUNITY DEVELOPMENT

UC-DANR focused its research and extension resources on the need to create supportive environments in which culturally diverse youth and adults can reach their fullest potential and to strengthen the capacities of families and individuals for self-sufficiency and well-being by improving life skills. Programs were delivered by individuals and collaborative groups including 9 statewide workgroups composed of both AES and CE academics. To accomplish this, 166 Extension programs were delivered and 17 Extension and outreach publications and 99 peer reviewed research papers were published.

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.

Out-of-School
The Out-of-School workgroup members conducted technical assistance and in-service training for staff of after-school programs. Workshops topics included A Positive Approach to Managing Groups of Kids, Curriculum Development, Working with Challenging Children, Fostering Resiliency, Intercultural Understanding, Fostering Language Literacy, and Program Evaluation. Approximately 200 after-school staff were trained this year. Workshops are evaluated by different methods including the retrospective pre and post-test. The results from a workshop on program evaluation found that 96% of the participants had growth in at least one of the following areas.

1. Understand the potential value of evaluating parent education programs. (21% "pretty well, " 79% "very well," and 68% reported improvement by at least one step.) 2. Understand the
3. Have ideas about when written surveys, interviews and observations are most appropriate. (4% "a little," 46% "pretty well," 50% "very well," and 85% reported improvement by at least one step.)
4. Have a rough plan for how I might evaluate my program. (53% "pretty well," 47%"very well," and 89% reported improvement by at least one step.)

Latino Pregnancy Prevention
Although much media attention has been given to declining teenage pregnancy rates, the US continues to have the highest teen pregnancy rate of any Western nation. A disproportionate number of teen births occur to Latino teens; California is among the states with the highest Latino teen birth rates. To address this issue, UCCE developed a handbook that summarizes years of research, making 12 "best practices" accessible to pregnancy prevention practitioners. The handbook is widely requested, is in its second printing, and has been reviewed in multiple state and national youth-related publications. Trainings based on the handbook have been presented to numerous audiences within California, and at 3 national conferences. As a direct result, pregnancy prevention programs in local communities have improved.

On the Wild Side
On the Wild Side is a collaborative program of the Sacramento UCCE 4-H Youth Development Program, Sacramento START, Camp Fire USA, and the Sierra Club, to offer an opportunity for urban youth to experience the outdoors. For many youth, it is their first chance to discover lakes and waterfalls and to experience singing around a campfire, or falling asleep under the stars. Eight Sacramento after school START sites and 128 children participated in the program this year. Children learned about the natural world and also about conservation. Teenage volunteer staff taught "hands-on" educational activities, which included:

2. How to observe wildlife and record the visualizations through art
3. What factors affect water bird migration
4. How to identify trees by touch on a blindfolded walk
5. How to use sampling techniques to investigate a lake

6. How to "hunt" for evidence of wildlife
7. How to canoe safely.

Sixty-six subjects at five START sites participated in the pre and post-test surveys that measured knowledge gained during their outdoor experience. Knowledge scores were significantly higher ($p > .000$) on the post-test at each of the five sites. Nine youth had participated in this program the prior year and results for this group were exciting and point to the possibility of cumulative effects of programs. Specifically, returning youth scored higher on the pre-test, indicating that they may have retained much of what had been previously learned. They also scored higher on the post-test, indicating that they had experienced further increases in knowledge. The small sample size precludes any ability to test significance levels, but future research with larger samples may point to the cumulative effects for youth who participate in these types of youth programs.

Science Literacy Education

The traditional projects in 4-H have always stressed a science and researched based education. This continues, but specific programs that look at science processes, inquiry learning, and current issues have also been added. The 4-H SERIES and YES programs focus on teens as teachers, use the learning cycle, and employ hands-on and heads-on fun activities. Topics addressed during this review period were: water resources, environment and land use, recycling, worms, oak woodlands, and kitchen science! Teens have been trained and have used these science programs at after-school sites, 4-H science camp, HUD sites, 4-H clubs, and in the community.

Within Merced County, programs were conducted at three schools, with special education youth and adults, 4-H camps, at four HUD sites, and more. As part of a grant from the Family Resource Council, two science training workshops were conducted in the Dos Palos area. This grant sponsored the training of 70 teens, adult coaches and schoolteachers. Teams of teens and adults were recruited to attend the STEL workgroup sponsored In-Touch Science training in January of 2000. These teams have used their experience to share at county events like 4-H EXPO and at regional LCORT conference in 1999. The impact has resulted in over 50 teens and adults trained to extend science education in five specific community organizations in Dos Palos. Youth and staff at four housing sites are using new approaches to looking at science. Additionally, teachers and other 4-H programs in the county have more resources to choose from to reach youth.

ECONOMICALLY VIABLE FAMILIES AND COMMUNITIES

UC-DANR focused its research and extension resources on the need to improve the capacity of consumers to efficiently use economic and personal resources and strengthen the capacity of communities, families and individuals to create and maintain sustainable economic growth. Programs were delivered by individuals and collaborative groups including 8 statewide workgroups composed of both AES and CE academics. To accomplish this, 21 Extension programs were delivered and four peer reviewed research papers and 2 other media were published.

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.

Money 2000+ for Teens

Teens want to learn about money management. A survey of California teens indicated that they are interested in learning about how to get the best buy (52%), easy ways to save (54%), savings accounts (41%), car buying (66%), and general shopping tips. Teen also said they would prefer to learn about money in school (56%), by receiving newsletters/magazines in the mail (41%), or through youth organizations (26%). Responding to this interest, the University of California Cooperative Extension developed *Money Talks...Should I Be Listening?* This fun and interactive money curriculum includes four colorful newsletters and corresponding teaching guides that explore the topics of easy ways to save, getting the best buy, spending habits and money personalities, and car buying. The curriculum is adaptable for use in the classroom or during youth meetings and the newsletters can be used as stand alone pieces that can be distributed to teens in group settings or through the mail.

Providing money management information that teens want does make a difference. Pre/post evaluations indicate that after completing the *Money Talks* program, teens were more likely to have identified their values related to money (11% vs. 75%), to spend their money based on their values (25% vs. 35%), and to have identified easy ways to save money. Additionally, teens completing the *Money Talks* curriculum showed improved knowledge gains regarding the costs of owning a car and credit card management. A web site is currently being developed which will

allow teens and their teachers to play interactive financial games and download the newsletter in English and/or Spanish.

Gateway to a Better Life
The Center for Law and Social Policy reports that, "While welfare recipients face a variety of barriers to employment, job retention, and job advancement; low basic skills stands out as the common barrier to steady work and, by far, the strongest single predictor of whether a recipient will work at all." The Gateway curriculum was developed to meet this need.

The Gateway workgroup has just completed a survey with 28 trainers who have used the Gateway curriculum. Almost 68% of the trainers had been trained by UCCE, while 29% had received no training at all. The majority of trainers interviewed had used only parts of the curriculum. The primary reason for not using the entire curriculum was that not all the lessons applied to their program mission (46.4%). While all the lessons received a rating of 7.5 or better on a scale of 1 to 10, the lessons that received highest ratings were: The Application Process (8.79), Interviewing Skills (8.79), Dressing for Work (8.71), Keeping the Job (8.64), and Reaching Your Goals (8.61). Trainers indicated that their greatest barrier in presenting the curriculum was getting clients to attend sessions (28.6%).

The Life Skills newsletter was developed to bring research-based information on the subjects of welfare reform and life skills to agencies and individuals who are assisting low-income households in their quest to improve their well-being. The quarterly newsletter, which always includes at least one bilingual client handout, is sent out to more than 1000 agencies and individuals nationwide. A survey is currently being conducted to determine the usefulness and future direction of the newsletter.

Money Sense
Since its inception, the Money Sense program has trained over 160 community volunteers in Kern County, CA. The volunteers consist of agency staff as well as agency volunteers. The volunteers attend a total of 15 to 21 hours of training.

A team of students from California State University Bakersfield, Masters of Public Administration Program, evaluated Money Sense, a train-the-trainers money management program. Of the 110 surveys mailed to the Money Sense graduates, 15 were returned as undeliverable. The evaluators received 39 completed surveys, which provided a 41.05% response rate.

From the findings, it is clear that the Money Sense graduates use the program information, with 95% reporting having used the money management information in their personal lives. Graduates are sharing information on all subject areas. However, the data shows the five subject areas chosen most frequently by graduates for personal use are the same five shared most with others. The subject areas are: budgeting, your food dollar, goals/choice making, skillful shopper and savings. Depending upon the subject area, Money Sense graduates share information with an

additional 23.44 to 37.50 individuals. The information was shared most often at home (76%) and work (73%).

SECTION B. STAKEHOLDER INPUT PROCESS

The University of California Division of Agriculture and Natural Resources (UC DANR) 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. Listed below are several of the formal mechanisms. In addition, CE advisors delivering programs in 58 California counties receive input on local needs from their local clientele on a daily basis.

Program Planning Advisory Committees (PPACs)

These committees are comprised of forty-five Division members representative of the diversity of UC DANR disciplines and program areas, from all Division-affiliated campuses and from county offices throughout the state. The specific charge of the PPACs is to identify and prioritize statewide programmatic issues annually, to develop three-to-five year Division-wide research and extension goals that address high priority issues, and to recommend approaches and methods for attaining those goals. Fifteen individuals serve on each of three subject area committees, Agricultural Resources, Human Resources and Natural Resources, that are charged with recommending Division-wide program priorities within their respective subject areas.

During 2001, PPAC members consulted with their UC DANR colleagues on the selection and prioritization of Target Issues, specific research or extension topics that reflect current stakeholder concerns to which new ANR resources could be of substantial benefit. Target Issues were assigned to individual PPAC members for revision and solicitation of input from both internal and external ANR stakeholders to help assess the description and relative importance of the candidate Target Issues. Draft Target Issues were circulated to the workgroup chairs so that they could provide feedback based on their workgroup discussions. CE county directors and campus department chairs were also contacted via e-mail to provide feedback via a web-based survey and forwarded this request for input along to CE advisors and campus faculty and CE specialists.

UC DANR Workgroups

Program workgroups provide grassroots leadership for statewide program development by bringing together AES scientists, CE advisors, CE specialists, and non-DANR partners, cooperators and clientele to work on emerging and continuing issues in Division program areas. Non-DANR 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.

The Rice Workgroup is an example of how the Workgroup structure builds strong linkages with different segments of the industry to improve coordination of efforts and identify high priority issues affecting clientele. The Rice Workgroup initiated a committee of industry representatives and Workgroup members to collectively prioritize concerns. Representatives from the California Warehouse Association, Farmers Rice Cooperative, California Rice Commission, the Rice Experiment Station, and the Rice Research Board worked closely with DANR personnel in this endeavor. This was a landmark effort to pull together the various factions of the rice industry to collectively address problems. Leadership provided by DANR Workgroup members that provided the catalyst for this action cannot be understated. Rice industry representatives recognized the utility of the DANR Workgroup structure in facilitating interaction with the University.

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 DANR 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. The DANR workgroups, as described in Section B., provide an important forum for California AES researchers, CE specialists, and CE advisors and external stakeholders to identify and plan programs to address critical issues in the state. In addition, the county CE advisors interaction with the local communities throughout the state are the conduit for communication of local and regional issues to the campus community.

Critical issues such as the invasive pests threatening the food supply, the implementation of Welfare Reform and its effect on families and communities, water quality and water quantity issues have been addressed by teams of AES faculty, advisors and specialists across disciplines and subject matter expertise.

(*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.

- The recently redesigned UC ANR web site now gives the user the ability to have the entire web site presented in Spanish. This should allow users whose primary language is Spanish to access information about statewide and local programs more easily.

- A survey in 1992 found 62% (530) of all Asian farmers in Fresno County to be Hmong. Refugees continued to come to the U.S. (and Fresno) until 1998. It has always been difficult to attract large numbers of Hmong to meetings and only a limited number of the farmers used Cooperative Extension Small Farm services. With over 800 Hmong farmers in the county, a way to reach large numbers of farmers was needed. This project had two primary objectives, namely to increase Hmong clientele use of CE services and attendance at informational meetings, and to investigate the possibility of using mass media (specifically radio) to inform Hmong farmers about community services. The Fresno CE Small Farms office started Hmong radio broadcasts three years ago. The project has changed very little except that now the project is a collaboration between the Small Farm Center and USDA-FSA. The 30-minute broadcasts are aired every other Monday evening from 9:30- 10:00 P.M. on K-BEF 900 Radio in Fresno. The signal is picked up from Bakersfield to Stanislaus. The office has recorded a significant increase in phone calls and

office visits over the last five years and especially over the last three years. Records show a 300% increase in Hmong clientele contacts in 1998, a 500% increase in 1999, and a 800% increase in 2000. The director of the USDA-FSA office in Fresno commented "We've seen a dramatic increase in the number of Hmong farmers coming into UC extension offices for farm loans and disaster assistance. The radio program has also helped the Hmong implement better farming practices and understand the need for record keeping."

- The greatest concentration of dairies in California exists in the Central Valley and a particularly high percentage of employees on dairy farms are Spanish-speaking. They are being promoted to areas of greater responsibility on the dairy operation such as the dairy herdsman. Dairy operators requested a dairy herdsman seminar to update their herdsmen on the best management practices concerning these areas of responsibility. The Dairy Quality Assurance Workgroup is developing a seminar that will address this need with on site translation of the presentations and written material translated to Spanish. The potential impact to the Spanish-speaking clientele will be great as this may be the first exposure of this type for those who speak Spanish.

- UC researchers explored design methods for housing low-income families in medium density settings that must be integrated with middle and upper income single family housing. Issues considered were efficient space use, energy conservation, and effective use of simple construction materials to create positive environmental impacts. The projects will benefit low-income families (mostly farmworkers) in rural and suburban communities. Specific projects include 1) affordable housing for mentally disabled individuals, studying 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) multi-social service center for low-income families, exploring the use of manufactured buildings in low budget project with services offices, counseling and training facilities, clinic, and child care center. Project in construction phase; 3) low-income multi-family dwellings and community center, exploring the skillful use of medium density housing in a single family residential area. Project in design development phase with construction anticipated to start Fall 2002.

    - Outreach efforts include adding minority clientele to newsletter lists and inviting minority growers to be cooperators in research studies. In a Central Valley county, the CE advisors annually organize and deliver a worker pesticide safety meeting. In order to properly advertise this meeting last year, both English and Spanish flyers were mailed to growers and their workers, and the meetings were advertised in the Madera Tribune and in the Vida En Valle, a Spanish newspaper. The meetings were also advertised on KMJ-News and KMMM-Spanish radio. These efforts resulted in a total of 301 attendees with 228 Hispanic, 25 Asian and 48 Caucasian participants

- A Central Valley CE advisor aggressively developed programming for local minority groups. He conducted two workshops on strawberry production targeting Southeast Asian farmers; nearly all the farmers in this group attended. He revised a manual for them on irrigation of strawberries that he wrote the previous year. He presented an irrigation workshop for foremen and irrigators of row and vegetable crops in Spanish. He is developing an irrigation manual for these same people in both English and Spanish. In addition, he has made personal visits to Southeast Asian growers to encourage their participation in upcoming workshops.

- A Northern California 4-H Homework Club provides homework assistance and tutoring to children at risk for academic retention. The program operates on school days, Monday through Thursday from 2:30-4pm daily. All teachers, by personal letter and contact are invited to refer students to the 4-H Homework Club. Parents are contacted by school personnel and 4-H staff to encourage enrollment. There is a teacher-parent-4-H staff conference to provide information about the program and the expectations of the child. Last year, 62 youth, 48% of whom were minority, participated. Migrant Education has assisted in encouraging migrant youth to participate and two migrant teens were hired as tutors to be role models for the Hispanic youth and provided bilingual support. In addition, two staff members were bilingual (English and Spanish).

- A Southern California CE vegetable crops advisor works with the local small farms advisor to identify minority growers who might benefit from his program expertise. He uses the Small Farms advisor's mailing list to reach minority growers, to develop awareness for the program in minority communities, and to increase minority grower participation. He coordinated programs and plans with the small farms advisor to better meet minority growers needs and gave presentations at limited scale workshops designed for minority and new entry growers. The extension program he developed addresses the needs of minority, female, and new entry or limited scale minority vegetable growers in the county and has included special efforts to help Southeast Asian refugees through the development of simpler more cost effective production methods for smaller minority growers, and a computer program to help limited scale protected group growers to evaluate production costs and profitability.

- A Central Valley CE family and consumer science advisor used a variety of mechanisms to deliver job preparedness programs such as Gateway to a Better Life, to low income and minority populations in her county. She participated in a Job Faire for CalWORKS clients, speaking to over 128 people, the majority black and Hispanic on topics such as interviewing and resume writing. Another accomplishment resulting from this event was connecting with a hearing impaired teacher who teaches deaf students at a local high school. He expressed interest in using the Gateway to a Better Life curriculum and is now using the curriculum with his high school students. The advisor also regularly speaks at the Teen Moms and Teen Dads programs with the probation department, discussing goal setting, choices and money management. The majority of the teens are black and Hispanic

and many are affiliated with gangs. She speaks to six groups a year with about 24 in attendance in each group. Also, last year, she worked with Employers Training Resources. Through their exposure to the Gateway to a Better Life curriculum, Employers Training Resources have now purchased the curriculum and made it mandatory for themselves as well as their contractors. This curriculum will reach about 2000 low-income participants with the following demographic 35% white, 15% black and 46% Hispanic.

(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?

The integration of strong California AES and CE programs result in effective and efficient programs delivered to the citizens of California. The research-extension continuum in all of the Division programs ensures that local needs and issues will be communicated by the county advisors to the campus based research faculty and specialists so that needed research can be conducted and applied to the issues.

SECTION E. MULTISTATE EXTENSION ACTIVITIES

California Cooperative Extension advisors and specialists collaborated with colleagues in other states on the following activities.

NATIONAL GOAL 1

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

National Pork Board Extension Educators Advisory Committee: 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 will be hosting the 2002 educational tour. The cooperating institutions are: Clemson University, Iowa State University, Michigan State University, University of Tennessee, Mississippi State University, Washington State University, Montana State University, University of Vermont, Utah State University, University of Illinois, University of Minnesota, University of Georgia, University of Wisconsin, Pennsylvania State University, Ohio State University, Oklahoma State University, Kansas State University, Auburn University, University of Kentucky, Oregon State University, University of Nebraska, University of Missouri, North Carolina State University, Purdue University, North Dakota State University, Texas A&M University, South Dakota State University, University of Arkansas. Proceedings of the 2001 Educators Conference were distributed on a CD.

Potato Seed Conditioning Trial: A California advisor and specialist and Oregon State researchers conducted field experiments at IREC and the OSU Klamath Experiment Station to determine rather 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. The cooperating institution is: Oregon State University.

Planting Methodology for the Production of New Potatoes: A California advisor performed trials at the IREC 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. The cooperating institution is: Oregon State University.

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. The cooperating institution is: Oregon State University.

Intermountain Winter Seminars: Annual winter seminars are conducted jointly by UC and Oregon State University in the Klamath Basin. In 2001, an all-day pest management seminar was conducted as was a full-day seminar on agricultural marketing. The cooperating institution is: Oregon State University.

Biological Control of Oak Root Rot and Nematodes with Trichoderma Harzianum: A California advisor designed a pot study to evaluate the effects of the biological control agent, trichoderma harzianum, on the development of Armillaria. Results from the California pot study will be used in conjunction with a concurrent study at Clemson University in South Carolina. Additional pot studies will be conducted with trichoderma harzianum amended soil and with T-budding infected toothpicks into the tree cambium area, as well as, field studies with different rootstocks in Armillaria infested sites.

Harvest Aid Performance and Fiber Quality Evaluations: A California advisor collaborated 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. They also evaluated 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. Several articles and reports have been published, including, "California Cotton Review" newsletter articles on cotton harvest aids and results of research studies and the Cotton Harvest Aid Research Progress Report.

Alfalfa Report: The Alfalfa Report is a bi-monthly newsletter published by the University of Arizona Cooperative Extension Office in Yuma County. A California advisor writes insect pest management articles published in each issue.

Improving the Effectiveness of Livestock Distribution Practices in Grazed Watersheds: California advisors and specialists worked with their Oregon State Extension colleagues on this study to improve the ability to attract livestock away from riparian zones and other critical areas by more precisely defining how cattle use range landscapes and then modifying their behavior by manipulating the location of landscape attractants. This study involves the interactions of the animal and range forage production system, water quality and habitat values. The field study was conducted at the San Joaquin Experimental Range in Madera County. Landscape analysis is being conducted in the GIS laboratory in the Rangeland Resource Department at Oregon State University. Research and extension education publications will be the product of this research. A new study collaborating with this same group is under development in Lassen County, California. Poster and oral presentations at Society for Range Management Meetings. Plans are to continue this project until 2002.

Distribution of Manure in a Grazed Watershed: The objective of this study is to estimate the distribution of manure in a grazed watershed. California advisors and specialists worked with Oregon State University Extension personnel on this project. One research paper has been accepted by the Journal of Range Management. Several extension presentations have been presented in California, Oregon and Nevada. Studies are on-going.

Cotton Insect Loss Committee: The committee is part of the Insect Control and Research Conference of the Beltwide Conferences. The committee documents the crop losses caused by insects. These reports have been made since 1979 and provide a valuable tool for following shifts in pest importance over the years. California advisors provide the estimate of California losses, developed in collaboration with the California State Cotton Workgroup, at its annual planning meeting in November. Current studies are on-going. The cooperating institutions are: Auburn University, University Arkansas , Arizona State University, University of Florida, University of Georgia , Louisiana State University, Mississippi State University, University of Missouri, New Mexico State University, North Carolina State University, Clemson University, University of Tennessee, Texas A&M University ,Virginia Polytechnic Institute. The information is published in the Annual Report of the Proceedings of the Beltwide Conference.

Spinach Downy Mildew: A California advisor collaborated with his counterpart at the University of Arkansas to identify new strains of the spinach downy mildew in California. Results of the project were shared with the California spinach industry at two meetings. An abstract of the project was published in Phytopathology and a plant disease paper has been prepared. Additional research is being conducted and results have been distributed.

California, Oregon, Idaho, and Nevada (C.O.I.N.) : 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. In May 2001, a three-day conference was held in Klamath Falls, Oregon.

The COIN group also published a rancher's pocket statistic book that was so successful it was published by the National Integrated Resource Management program at the national Cattlemen's Beef Association. Presently, the members are working on a web site that will serve a connecting reference library for agents/advisors and the general public. Collaborating institutions include: Oregon State University, University of Idaho and University of Nevada.

Joint Cotton Variety Trial: A California advisor collaborated 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. Researchers planted nine different cotton varieties with five replications in late March 2001 near Cibola, AZ; the plots were harvested in

January 2002. Local cotton farmers have begun planting based on the research findings. Studies are on-going and plans are to present results in future meetings.

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. These pests were found to be among the most difficult to control with the tested chemistry. Reports were written on the insecticide efficacy ratings for certain pests and beneficial insects. Data and reports of other experiments were also made available via Palo Verde Valley Update newsletter in Arizona.

Beltwide Root Health Study: California Extension advisors worked 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.

Uniform Harvest Aid Performance and Fiber Quality Evaluation, **Cotton Defoliation Work Group**: California Extension advisors worked with their colleagues to develop effective, contemporary harvest aid recommendations that contribute to harvest efficiency and high quality fiber and to evaluate performance of harvest aid treatments to biotic and environmental factors. Results have included improved selection of materials, and how and where they perform the best, and better defoliation guidelines available to assist growers with decisions on harvest aid materials. The cooperating institutions are: Mississippi State University, University of Oklahoma, Texas A&M University, Auburn University, Alabama, University of Tennessee, and the University of North Carolina. The recommendations are published in the publication, Cotton Harvest Management: Use and Influence of Harvest Aids. No. 5, The Cotton Foundation Reference Book Series. (In Press), Extension Newsletter, and Beltwide Cotton Production Conference Proceedings.

California/Oregon Cattle College: With the initial success of the Cattle College in California, the 2001 course was hosted by the cooperating institution, Oregon State University, in Coos County and Curry County, Oregon. California advisors assisted in planning and presenting the materials. The course consisted of six three-hour long sessions and used the multi-state produced Cow/Calf Management Guide and Cattle Producer's Library three-ring binder as a text. Plans for next year's college are underway.

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.

Impact Assessment of the Klamath Basin Water Crisis: Advisors and faculty from the University of California and Oregon State University are working to chronicle the current and potential impacts of the irrigation water cut off that occurred in the Klamath Basin in 2001. More than a dozen academics are participating in the preparation of a final report. Chapters will be organized to cover impacts in four general areas: social, environmental, natural resources and public policy. The report is being prepared in a very short time frame in hopes that it may be used to make more fully informed decisions regarding future water policies in the Basin. The report will provide increased and more readily accessible information on the Klamath Basin Water Crisis. The cooperating institution is: Oregon State University. Project description and draft reports can be accessed via the Internet.

Tri-State Sage Grouse: Sage grouse population is declining and California advisors are working with academics in Nevada and Oregon to establish local conservation strategies to manage the current population and prevent further decline and possible listing as an endangered species.

Living on the Land– Stewardship for Small Acreages: Land stewardship issues and the implication of this clientele group's management practices are of growing importance to natural resources as more people are settling on small acreage properties bordering urban areas. A California Advisor worked with her University of Nevada colleague on a two-year multistate project to develop curriculum for "Living on the Land: Stewardship for Small Acreages." The workshop curriculum consists of five modules addressing landowner goal-setting, soils, water, plants and animals. Each module includes 2 to 4 lessons, complete with lesson plans, evaluation tools, lists or resource materials and web sites and PowerPoint presentations. The first conference was held October 2001. Copies of the curriculum are being distributed on CD-ROM.

Lake Tahoe Environmental Education Coalition: California and Nevada Cooperative Extension joined forces in 2000 and 2001, and continue to provide collaborative coverage in the Tahoe Basin. This unique bi-state collaboration between the University of California Cooperative Extension and the University of Nevada Cooperative Extension provides joint funding for the LTEEC Coordinator to work in both states. The Lake Tahoe Environmental education coalition (LTEEC) is a group of diverse organizations working together on common goals to prevent pollution of Lake Tahoe and enlist citizen participation in protecting the lake's unique beauty. There are eight working groups and each of these groups has a diverse mix of participants, including state and federal agencies, educators, citizens, regulators, non-profits and others. LTEEC serves as an umbrella organization designed to improve the overall effectiveness of environmental education of all types in the Tahoe Basin, facilitate communication and coordination and reduce duplication among groups. The cooperating institutions are: UC Davis, Tahoe Research Group, Tahoe Regional Planning Agency, Tahoe Americorps, California

Conservation Corps, USDA Natural Resource Conservation Service, Nevada Conservation Corps, Nevada Tahoe Conservation District, Parasol Foundation, Sierra Watershed Education Partnerships, Tahoe Resource Conservation District, the League to Save Lake Tahoe, USDA Forest Service, California Tahoe Conservancy, Nevada Division of Environmental Protection, Tahoe Regreen, Waste Not, Incline Village GID, Nevada State Parks, Lahontaon Water Quality Control Board

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. Results are expected to be available beginning Fall 2002. The cooperating institutions is: Oregon State Cooperative Extension.

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.

National CREES/NREM CES-YES Website: A California advisor involved with the National CREES/NREM CES-YES Design Team produced a website that will be launched at the North American Association for Environmental Education Conference. 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. The cooperating institutions are: University of Wisconsin, University of Connecticut, University of Wyoming, University of Vermont, University of Illinois, Puerto Rico Agricultural Extension Service, University of Georgia, Rutgers University, and the University of Florida.

4-H Cooperative Curriculum System, Leadership Curriculum: California Extension advisors authored eight activities geared towards developing leadership skills amongst adolescents in grades K-12. There are plans to have the curriculum peer-reviewed and piloted nationwide. The cooperating institutions are: Clemson University, Oregon State University, University of Maryland, University of Arizona, University of North Dakota, University of Wisconsin, University of Idaho.

Rural Low Income Families: Tracking Their Well Being and Function in the Context of Welfare Reform plan (Multistate Project NC-223): A California Nutrition, Family and Consumer Sciences Advisor is working with colleagues in Colorado, Idaho, Indiana, Kentucky, Louisiana, Minnesota, Missouri, Massachusetts, Michigan, Nebraska, New Hampshire, Ohio, Oregon, Utah, and Wyoming on this Regional Research project 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. Plans are to continue the project until 2003.

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.

In addition, 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.

Thus, California AES and CE were fully integrated administratively and programmatically, thereby ensuring that all major programs included both a research and extension component, planned and delivered as a unified whole.