First Input __________
Second Input __________

CALFED CATEGORY III PROPOSAL
INITIAL REVIEW - RFP #1 (v4, 7/31/97)
July/Aug 1997

I1-092

Proposal # F1-~~263~~ Applicant UC - DAVIS

I1-092

Initial Review Recommendation:

Pass Initial Review? Yes No

If no, reject based on: ____

FORMATTING REQUIREMENTS

APPLICANT

1. Applicant/Organization

2. Applicant Type (Identify lead applicant, include one of types 1-6)
    - [✓ 1.] California State Agencies (include in-state universities)
    - 2. Federal Agencies
    - 3. Non-profit Organizations
    - 4. Other Private Entities
    - 5. Other Public Agencies (includes out-of-state universities)
        - a. Educational Institution
        - b. Resource Conservation District
        - c. Irrigation/Water District
        - d. Reclamation District
        - e. City
        - f. County
        - g. Other
    - 6. Joint Venture (this only applies if applicant includes more than one of the 1-5 categories.

3. Name of Applicant

4. Address

5. City

6. State

7. Zip Code

8. Phone

9. Fax

10. Email

DESCRIPTION

1. RFP Group Type
    1. Public Works/Construction
    2. Land Acquisition
    3. Other Services

2. County

3. Requested Amount (in thousands)

4. Cost Share Amt (in thousands)

5. Cost Share Partners
    a. CVPIA
    b. Four Pumps
    c. Tracy Fish Agreement
    d. Applicant

6. Duration of Category III Funding 0.5 1.0 1.5 2.0 2.5 [✓ 3.0] years

TECHNICAL REVIEW

Reviewed by dg

Is project in ERPP Study Area? No

Note: If project is not in ERPP Study Area, project does not pass initial review, no further review needed. Indicate reasons for rejection on first page.

PROJECT TYPE - for definitions refer to pgs 6-7 of RFP (circle all that apply, mark a P next to the Primary category) **If proposal clearly breaks out dollars by category and each amount in over $1 million, fill out additional sheets for each category with dollar amount indicated.**

1. Watershed Management Planning & Implementation
2. Construction
3. Land Acquisition
4. Aquatic and Terrestrial Habitat Restoration
5. Water Quality

[✓ 6.] Monitoring, Assessment and Reporting (site specific or large scale)

7\. Research

P [✓ 8.] Education

9\. Operations and Maintenance

WATERSHED (MUST select one or more of types 1-22, may also include one or more of subcategories) **If proposal clearly breaks out dollars by region and each amount is over $1 million, fill out additional sheets for each region with dollar amount indicated.**

1. Sacramento-San Joaquin Delta
   a. North Delta
   b. East Delta
   c. South Delta
   d. Central and West Delta
2. Suisun Marsh/North San Francisco Bay
   a. Suisun Bay and Marsh
   b. Napa River
   c. Sonoma Creek
   d. Petaluma River
   e. San Pablo Bay
3. Sacramento River
   a. Keswick Dam to Red Bluff Diversion Dam
   b. Red bluff Diversion Dam to Chico Landing
   c. Chico Landing to Colusa
   d. Colusa to Verona
   e. Verona to Sacramento
4. North Sacramento Valley
   a. Clear Creek

   b. Cow Creek
   c. Bear Creek
   d. Battle Creek

5. Cottonwood Creek
   a. Upper Cottonwood Creek
   b. Lower Cottonwood Creek
6. Butte Basin
   a. Paynes Creek
   b. Antelope Creek
   c. Mill Creek
   d. Deer Creek
   e. Big Chico Creek
   f. Butte Creek
   g. Butte Sink
7. Colusa Basin
   a. Stony Creek
   b. Elder Creek
   c. Thomes Creek
   d. Colusa Basin
8. Feather River/Sutter Basin
   a. Feather River
   b. Yuba River
   c. Bear River and Honcut Creek
9. American River
10. Yolo Basin
    a. Cache Creek
    b. Putah Creek
    c. Solano
11. Eastside Delta Tributaries
    a. Cosumnes River
    b. Mokelumne River
    c. Calaveras River
12. San Joaquin River
    a. Vernalis to Merced
    b. Merced to Mendota Pool
    c. Mendota Pool to Gravelly Ford
    d. Gravelly Ford to Friant
13. East San Joaquin Basin
    a. Stanislaus River
    b. Tuolumne River
    c. Merced River
14. West San Joaquin Basin
15. North Sacramento River Watershed

16. East Sacramento River Watershed
17. West Sacramento River Watershed
18. San Joaquin River Watershed
19. South and Central San Francisco Bay
20. Fresno Sough/Mendota Sub Region
21. Ocean
22. Not Applicable

HABITAT - for definitions refer to pgs 20-23 of RFP (circle all that apply)

1 Tidal perennial aquatic habitat (freshwater)
2 Seasonal wetland and aquatic
3 Instream aquatic
4 Shaded riverine aquatic
5 Saline emergent wetlands (tidal)
6 Midchannel islands and shoals
7 North Delta agricultural wetlands and perennial grasslands
[✓ 8 Not applicable]

SPECIES - for definitions refer to pgs 23-24 of RFP (circle all that apply)

1 San Joaquin river and east-side tributary fall-run chinook salmon
2 Late-fall run chinook salmon
3 Winter-run chinook salmon
4 Spring-run chinook salmon
5 Delta smelt
6 Longfin smelt
7 Splittail
8 Steelhead trout
9 Green sturgeon
10 Striped bass
11 Migratory birds
[✓ 12 Not applicable]

STRESSOR CATEGORY - for additional definitions of each stressor category see the Attachment C in the RFP, pgs 25-33

1. Hydrograph Alterations - includes changes in flows such as quantity, timing velocity and depth of flow--water acquisitions proposal are not eligible
2. Entrainment - includes direct mortality of fisheries due to unscreened diversions, diversions not screened to current standards, inoperable screens and impingement
3. Migration barriers and straying
4. Floodplain and marshplain changes - includes physical or hydrological isolation of floodplain, elimination of fine sediment replenishment, land use changes in floodplain/marshplain

5. Alteration of channel form or meander - includes channel aggradation due to increase in fine sediments, channel form changes, prevention of meander, loss or reduction of riparian zone, isolation of side channels and tributaries
6. Reduction of gravel recruitment
7. Water quality - includes increase contaminants, salinity, and nutrient or carbon input
8. Water temperature
9. Invasive plants
10. Invasive organisms
11. Adverse fish and wildlife harvest impacts
12. Artificial propagation of fish
13. Land use changes - includes grazing, gravel mining, urbanization, forestry and agricultural practices
14. Wildfire
15. Human disturbance - includes disturbance of fish and wildlife populations by anglers, boaters and other recreational users

I1-092
F1-263

COOPERATIVE EXTENSION
AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF CALIFORNIA

Sustainable Agriculture Research and Education Program
University of California, Davis, CA 95616-8716
Tel: (916)752-7556 Fax: (916) 754-8550

DWR WAREHOUSE
97 JUL 28 PM 3:56

July 28, 1997

Ms. Kate Hansel
CALFED Bay-Delta Program
1416 Nineth Street, Suite 1155
Sacramento, California 95814

Dear Ms. Hansel:

Please find enclosed 10 copies of the two page inquiry submittal along with attachments in response to the Bay-Delta Category III Request for Proposals. We are very excited about this program and the possibility of obtaining support for our proposal entitled " Training and Support for Pest Control Advisors (PCAs) in Agricultural Pollution Prevention". We have attached two articles on the accomplishments of the Biologically Orchard Systems (BIOS) program as an example of the kinds of projects that the proposed independent PCA's would be involved with and would help create the next generation of BIOS-like projects. Other possible projects include the Biologically Integrated Farming Systems (BIFS) projects currently funded through UC SAREP; the Lodi-Woodbridge Winegrape Commission's BIFS project and the West Side row crop rotational project. In addition, there are various new demonstration projects funded by the Department of Pesticide Regulation's Pest Management Grants program which J.C. Broome helped to develop.

As this is only an inquiry we have not provided all the contact information for all the partners in the project, however all have expressed interest and excitement about being involved in this project. At this time, please direct any communications written or verbal to Paul A. Feder at USEPA.

Sincerely,

Janet C Broome

JCB for Paul A. Feder
Agricultural Policy Analyst
US EPA Region 9

Janet C. Broome
BIFS Coordinator
UC SAREP

University of California and the United States Department of Agriculture cooperating.

INQUIRY SUBMITTAL

I. Project Title/Applicant Name

Training and Support for Pest Control Advisors (PCAs) in Agricultural Pollution Prevention
Contact: Paul A. Feder, Agricultural Policy Specialist, 415-744-2010
United States Environmental Protection Agency (EPA) Region 9,
Agriculture Initiative, 75 Hawthorne Street San Francisco CA 94105
Dr. Janet C. Broome, University of California Sustainable Agriculture Research and Education Program
Jill Klein, Community Alliance with Family Farmers

II. Project Description and Primary Biological/Ecological Objectives

The goal of this project is to expand the on-farm implementation of targeted pollution prevention activities through the education and on-farm deployment of pest control advisors (PCAs). Pest control advisors, known as PCAs, provide management recommendations to growers and therefore play a critical role in determining on-farm practices. Project objectives will include: 1) training and on-farm apprenticeships for new PCAs; 2) targeted educational workshops for current PCAs; and, 3) education and on-farm implementation for growers. The focus will be to capitalize on existing opportunities for targeted pesticide-use reduction in almonds and other crops known to contribute to non-point source pollution. The primary ecological benefit will be the reduction of the organophosphate insecticide diazinon and other pollutants which are currently affecting the instream aquatic habitat of the San Joaquin River and its tributaries. The project will be implemented in four major agricultural counties in the San Joaquin Valley: Merced, San Joaquin, Fresno, and Madera.

III. Approach/Task/Schedules

The project will target current graduate programs in pest management and provide more focused hands-on education and apprenticeships with successful pollution prevention projects such as the Biologically Integrated Orchards Systems (BIOS) projects.

Major Tasks:

2/98	1) PCA Recruitment. Establish hiring protocols, contracts, and recruit 10 graduate student PCA interns from major technical agriculture programs in California.
2/98- 4/98	2) Establish Apprenticeship Program. Coordinate apprenticeships with successful, pollution prevention-oriented PCA companies that will help in first year training and field placement leading to full apprenticeships for successful program graduates in second year.
4/98-	3) Implement Pollution Prevention Training. Establish PCA curriculum targeted at Diazinon-free production practices and schedule four workshops in four participating counties (16 total).
9/98-	4) Implement Pollution Prevention Practices. Develop educational/promotional 9/99 materials for farmers and deploy trained PCAs to implement reduced use practices with 30 growers (up to 4500 acres) in each of the four counties.
9/98- 9/2000	5) Implement Year 2 and 3 Transition. Each year 10 new interns will be selected and 5 of the graduating interns will move into subsidized positions with selected PCAs.

IV. Justification for Project and Funding by CALFED

While the University of California's Cooperative Extension Service (UCCE) remains an important source of pest management information, pest control advisors (PCAs) are the major suppliers of day-to-day information affecting farmers' pesticide decision making. Despite the fact that California has the most comprehensive PCA permitting and licensing program in the country, PCAs' knowledge of pollution prevention practices is often limited. In addition, most of the more than four thousand

PCAs giving recommendations in California work for chemical companies and are reimbursed for their chemical sales, not for the time they spend assisting in pest management decision making. Unfortunately, education and the development of market-driven incentives for independent PCAs have lagged behind support for chemical company PCAs. This proposal seeks to address this through educating and providing cost sharing in support of independent PCAs in California.

By focusing on PCAs, this proposal provides a strategic approach to extend the multi-purpose pollution prevention benefits of projects like the Category 3 funded, Biologically Integrated Orchard Systems (BIOS) Project. A single PCA, once established in the community often manages between ten and thirty thousand acres. The proposal will focus on widely replicating the successes of BIOS Independent PCA, Cynthia Lashbrook, who helps growers eliminate the use of targeted pesticides such as diazinon, while also reducing erosion and synthetic nitrate applications. For example, one of Cynthia's large corporate clients has eliminated diazinon applications on 1,000 acres of almonds and has saved nearly a half million dollars in pesticide costs over the last several years. California cotton and citrus farmers who utilized the services of independent pest control advisors saved money and significantly reduced their pesticide use (California Agriculture, October, 1975).

V. Budget Costs and Third Party Impacts

The budget for three years is $925,000. Training and apprenticeships for PCAs will cost $100,000 for the first year to train and provide a 6-month stipend of $10,000 for 10 interns. In years two and three this cost will double because in addition to the 10 new interns, 5 graduating PCAs will receive a subsidy of $20,000. Educational workshops for PCAs, four a year in 4 counties (16 total) plus educational materials will cost $40,000. Farmer education and outreach on this proven opportunity for pollution prevention through pest monitoring will cost $30,000 the first year and $10,000 each year thereafter. Coordination, administration, and overhead for the project will cost $75,000 per year.

VI. Applicant Qualifications

SAREP staff have extensive experience in research and extension, the development of educational programs, and in the administration of competitive grants programs. Staff are highly skilled with expertise in the fields of soil science, entomology, plant pathology, pomology, public policy, communications, meeting facilitation, community development, and nutrition. Paul A. Feder, Agricultural Policy Specialist, with the U.S. EPA Region 9's Agriculture Initiative, has extensive experience with agriculture and water quality and has helped to manage a variety of agricultural pollution prevention projects in the San Joaquin and Sacramento Valleys.

VII. Monitoring and Data Evaluation

Targeted pesticide use on participating farms will be monitored using county pesticide use reports as well as California's 100% pesticide use reporting system. Reduction in nitrate applications and the use of erosion control technologies will also be documented through baseline and end-of-year surveys. All PCAs involved in the training and apprenticeship program will be tracked to determine their success at maintaining viable career tracks in agriculture.

VIII. Local Support/Coordination with other Programs/ Compatibility with CALFED objectives

The project will build on the well established local and statewide networks developed by the Community Alliance with Family Farmers and its Category 3 funded, Biologically Integrated Orchard Systems (BIOS) project as well as several related projects in other commodities supported by SAREP.

California Agriculture

JANUARY-FEBRUARY 1995
VOLUME 49, NUMBER 1

Building habitats for beneficial insects

University of California • Division of Agriculture and Natural Resources • Reports of Progress in Research

Science brief

BIOS recognized for innovation

A program helping Merced County almond growers farm with fewer pesticides was recently honored for its efforts in integrated pest management by California's Department of Pesticide Regulation (DPR). The Biologically Integrated Orchard Systems (BIOS) program in Merced County was one of five recipients of DPR's "IPM Innovator" award.

UC's Sustainable Agriculture Research and Education Program (SAREP) in Davis provides technical information, such as managing cover crops, beneficial insects and earthworms, to the 26 Merced County almond growers enrolled in this project. Two new BIOS projects have been added, in which 18 walnut growers in Yolo and Solano counties and 25 almond growers in Stanislaus County are enrolled.


Community Alliance with Family Farmers Foundation

Hilmar almond grower and BIOS management team member Glenn Anderson, center, looks for soil health indicators such as earthworms in an orchard planted with cover crops.

All three BIOS projects employ guidelines and monitoring techniques developed by the UC Statewide Integrated Pest Management Project.

BIOS is coordinated by the nonprofit Community Alliance with Family Farmers Foundation.

The project evolved from Merced County farm advisor Lonnie Hendricks' 6-year monitoring project of orchards growing almonds with and without synthetic pesticides (see page 5).

UC to update pest containment facilities

To expand research on pest management using biological control and biotechnology, UC plans to construct containment and quarantine facilities in Davis and Riverside. These facilities will support a comprehensive, integrated program designed to draw upon the unique expertise and strengths of each campus.

The two facilities will be separate but complementary. Both will support research into environmentally compatible pest management strategies. UC Riverside's insectary and quarantine facility is designed to accelerate research leading to the development of biological and other natural pest controls. The UC Davis containment and quarantine facility will address research on bioengineering, genetically engineered organisms and other biotechnology applications.

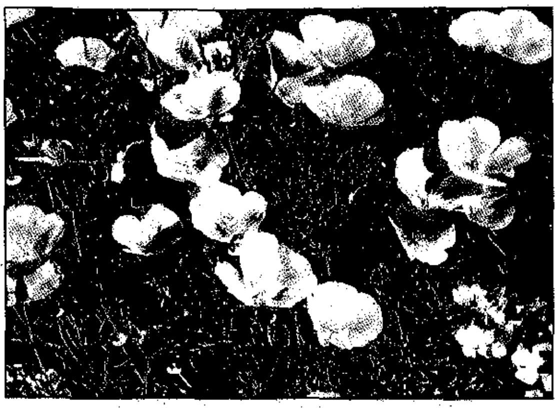
A total of $35 million will be required to complete the two facilities, with costs being shared equally by the U.S. Department of Agriculture and UC. So far, $4 million has been appropriated — $3.9 million in federal funds and $290,000 in state funds.

The 39,000-assigned-square-foot (asf) lab proposed for the Davis campus will provide the state-of-the-art containment needed for biotechnology research. "Currently there is no facility like it on either campus," said Frank Zalom, acting director of the Center for Pest Management Research and Extension.

He noted that existing UC research facilities have not kept pace with advancing technology. "Both biotechnology and biocontrol are important areas that we can't adequately address with what we have currently," Zalom said.

In addition to being dilapidated and overcrowded, UC Riverside's existing facility, built in 1930, has only 577 asf of containment and is rated seismically poor. Lack of space has forced UC Riverside to turn down requests from outside agencies to evaluate potential biological control agents for pests including alfalfa weevil and silverleaf whitefly.

"We are seriously hampered in our ability to serve California agriculture and in fact, the entire western region of the United States," said Michael Rust, chairman of UC Riverside's Department of Entomology. "The new 17,000-asf facility will considerably expand and accelerate our research programs, improve faculty's ability to attract grants, and increase UC Riverside's ability to recruit the strongest potential candidates for future positions."



***Above*, California poppies and mixed wildflowers planted along the orchard's border provide nectar and pollen to improve the biological diversity of insects.**

***Left*, in this low-input orchard, halves of the middles were mowed on an alternating basis to provide a continuous habitat for beneficial insects.**

Almond growers reduce pesticide use in Merced County field trials

Lonnie C. Hendricks

California almond growers commonly use organophosphate pesticides, which can be disruptive to biological control. Sprays during the spring and summer kill beneficial arthropods, including parasitic and predatory insects and spiders. In addition, pesticides have been detected by Cal EPA in winter fog and in runoff water flowing into the rivers of the San Joaquin Valley, which may lead to further restrictions in pesticide use. However, some almond growers are able to grow nuts with low insect damage without using toxic insecticide sprays. This article reports the results of a 6-year study, begun in 1988, of three almond orchards in Merced County to identify grower practices that permit reduced pesticide use.

Many almond growers encourage the survival of beneficial insects and spiders in their orchards by reducing or eliminating the use of toxic pesticides. Growers also plant cover crops that host insects such as aphids that provide food for beneficials. A lush cover crop will host an abundance of prey insect species, and the predators and parasites that feed on these insects will enhance control of the almond pests. This change in orchard management is especially evident in the Central San Joaquin Valley.

The twospotted spider mite is the primary web-spinning summer mite in this area. Spider mite outbreaks often follow disruptive sprays, and control is usually not required in orchards that are unsprayed or that are sprayed only with non-disruptive insecticides such as *Bacillus thuringiensis* (Bt). The western orchard predator mite (*Metaseiulus occidentalis*), the sixspotted thrips (*Scolothrips sexmaculatus*) and other predators usually control spider mites very well under favorable conditions. These conditions include good moisture conditions, low dust levels, elimination of disruptive sprays, and good cover-crop management to provide an insectary for beneficials. Scale can be controlled with dormant sprays, but scale is seldom a problem in unsprayed almonds.

A study was begun in 1988 in Merced County to learn why some almond growers are able to grow nuts with low insect-damage levels without using toxic insecticide sprays. The study was designed to learn what grower practices allow reduction of pesticide use in almonds. A secondary goal was to measure or monitor other components such as numbers and types of arthropods in the orchard, tree nutrition, soil organic matter and earthworms in each orchard.

Whole-farm comparison

This project was designed as a whole-farm comparison project with 20 acres in each comparison block. Replication was not attempted because replication within one orchard would require very large plot sizes to minimize the effects of pest and beneficial insect migration, and this amount of acreage was not available. Furthermore, replication within one orchard would require the orchard owner/manager to be skillful in both conventional and organic methods without

Chuck Ingels

Beneficial insects were inventoried by vacuuming the foliage of the cover crops and trees.

interjecting some bias into the management process. Therefore the whole-farm comparison method was chosen.

This was observational and dependent upon the growers to maintain reasonably consistent practices. The organic orchard remained strictly organic and is certified organic. The low-input orchard started conventional and transitioned to no insecticide use, but continued fungicides, fertilizers, some herbicides, and so on. The conventional remained conventional, but did use Bt at times, as is true of the industry. I did not specify which treatments could or should be made since my desire was to see the three divergent methods at work. This was much more flexible than a rigid replicated trial would be.

Three orchards planted with alternating rows of 'Nonpareil' and 'Carmel' cultivars were used for this comparison. The first orchard is a certified organic orchard, planted in 1981, which in this report is designated "organic." The organic orchard had a dense cover of 'Lana' vetch and ripgut bromegrass, which was mowed in May and disked before harvest. During the study this orchard was converted to mowing alone and was not disked before harvest. This orchard has not been sprayed with insecticides throughout its life, and no herbicides or fungicides have been used during the years of this comparison.

The second orchard, called the "low-input" orchard, which was planted in 1980, was farmed as a conventional orchard, using an organophosphate plus oil dormant spray and a May or July (hull split) organophosphate pesticide application. This grower eliminated the insecticide spraying after the first year of the study. Since 1990 no insecticides have been used in this orchard, but herbicides, nutrient sprays, and fungicides are still used. The organic and low-input orchards are adjacent to one another, and both orchards are flood-irrigated.

The low-input orchard had a sparse resident vegetation cover crop at the beginning of the test in 1988. This cover was chemically mowed before almond bloom for frost protection and closely flail-mowed through the spring and summer. Beginning in 1989 the vegetation was allowed to grow tall and was alternate-row mowed until June or early July, when close mowing for harvest preparation begins. Alternate row middles were mowed on one date, then the remaining middles were mowed 2 to 3 weeks later. This provided a continuous habitat for beneficials.

A third orchard, located a quarter-mile north of the low-input orchard, was added to the project in 1989. This orchard has remained conventionally sprayed with a dormant spray of insecticide and oil and a May or a hull-split spray. This flood-irrigated 'Nonpareil' and 'Carmel' orchard was planted in 1975. It is designated as conventional and was added for two reasons. First, it was a heavily sprayed and clean-disked orchard with severe worm problems. And second, the low-input orchard was in transition to no insecticide spraying and much better cover-crop management. Two very important requirements for organic and low-input culture are the use of cover crops to promote and protect beneficials and no use of toxic insecticides that disrupt biocontrol. The conventional orchard had no cover crop and used toxic sprays, and further, it had a worm problem to solve. It replaced the low-input orchard, which had been conventional. The conventional orchard was converted from disking to mowed resident vegetation in 1990, and a cover crop of vetch, clovers and grasses was planted in 1993.

Navel orangeworm. The navel orangeworm, *Amyelois transitella* (NOW), is the major pest of almond, and is responsible for the majority of the inedible nuts (rejects) at harvest. In evaluating these orchards, counts of overwintering almond nuts remaining in the trees (mummies) were done as a method of estimating the potential threat of navel orangeworm to the following year's crop. Navel orangeworm overwinters as an immature larva in mummies, and feeds on these mummies during the winter and spring. Sanitation by removing and destroying mummies is extremely important in managing NOW; the goal is winter counts of less than one to two mummies per tree. Navel orangeworm egg-laying activity was monitored with the use of four Pherocon IV egg traps per orchard. Eggs were counted twice per week from March until harvest.

Peach twig borer. The peach twig borer, *Anarsia lineatella* (PTB), can be a major pest in some years, especially if the PTB hatch coincides with hull split. Peach twig borer flights were monitored with two Pherocon 1C traps with Trece septa per orchard, and were checked twice per week. Peach twig borer pheromone traps are used to determine flight timing, but cannot be used reliably to estimate insect populations. Percentages of inedible nuts (rejects) due to NOW and PTB damage at harvest were determined by sampling 2,000 nuts directly from the harvest windrows. Samples were hand-cracked and the type of damage determined by inspection of the feeding damage.

Spider mites. The twospotted spider mite, *Tetranychus urticae*, is the primary web-spinning summer mite in this area. It can cause defoliation when approximately 50% of the leaves are infested. In this comparison, spider mites were monitored by collecting 50 leaves at random through each orchard and counting mites to determine the number of mites per 50 leaves.

San Jose scale. San Jose scale, *Quadraspidiotus perniciosus*, can cause the death of spurs and shoots. Twenty-five watersprouts were collected per orchard during the dormant period. The number of live and dead scale per 6-inch portion of the base of each watersprout was counted under a binocular microscope.

Beneficial insects. Beneficial insects were collected for a timed period in both the cover crops and the trees with a vacuum device called a d-VAC. Collections were made by vacuuming the foliage up to 7 or 8 feet and by vacuuming the orchard floor while walking through the test area. Counts in the cover crops were also made with sweep nets, using insect numbers per 25 sweeps while walking through the test blocks. None of the three orchards in this whole-orchard comparison has had releases of beneficial insects, so these were not a factor in the counts. Some of the insects that were being monitored were the convergent ladybird beetle (*Hippodamia convergens*), the lacewings (*Hemerobius* spp. and *Chrysopa* spp.), assassin bugs (*Zelus* spp.), big-eyed bugs (*Geocoris* spp.) and parasitic wasps. Observations indicate that orchards that are not disrupted by harsh pesticides have a very high level of spider activity. Spiders have recently been recognized as good generalist predators in vineyards, but no counts of spiders were made in this study.

Soil organic matter and fertility. Soil organic matter levels were monitored as a way to estimate and compare the soil fertility of the three orchards. It is generally accepted as fact that a soil with a high organic matter level is more fertile and more biologically active than a similar soil with low organic matter. The organic matter in these orchards is largely from residues of the cover crops, but organic matter is also derived from shredded prunings, manure or compost, leaves, hulls and other plant residues. Composite soil samples for organic matter analysis were collected from a number of random sites in each orchard from surface to 6-inch depth and 6- to 12-inch depth, during the spring and summer months. Early in the comparison it was noted that the highest organic matter levels were usually found in April, and that the more significant changes occurred in the top 6 inches. In later years most samples were taken only from the surface to 6-inch depth.

Leaves were collected annually in June or July and analyzed for levels of nitrogen, potassium, sodium, chloride, zinc and boron. Leaf analysis was done to monitor the nutrients to detect any deficiencies that could adversely alter the orchard comparisons. Grower treatments were made periodically to maintain acceptable nutrient levels, but no applications were made as part of this comparison.

Earthworms. Earthworms are a good measure of soil health and biological activity in the soil. They are important in the recycling of organic material such as cover-crop residues, leaves, shredded prunings and manure or compost. They also leave nutrient-rich worm castings, and they aerate the soil as they burrow. Measurements of earthworm numbers in the experimental orchards were made by using a very mild solution of formalin or powdered mustard poured into the soil inside four observation rings per orchard. The observation rings are made from the top half of 5-gallon plastic buckets. This caused the earthworms in the immediate area to come to the surface where they could be counted, collected and identified.

Study results

Rejects due to worm damage at harvest. Rejects at harvest are commonly caused by navel orangeworm (NOW) and peach twig borer (PTB).

TABLE 1. Almond kernel damage from NOW and PTB

Orchard	Pest	Rejects due to NOW and PTB 1988	1989	1990	1991	1992	1993
Organic	NOW	0.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	PTB	1.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Low-input	NOW	2.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	PTB	0.3*	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Conventional	NOW	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	PTB	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

*Dormant spray 1988 and 1989 only.

TABLE 2. Mite species associated with almond trees in June and July 1993

	Average no. of mites/50 leaves				
Orchard	Brown almond	European red	Twospotted	Tydeid	*M. occidentalis* predator
Organic	3.8	[illegible]	1.4	20.6	[illegible]
Low-input	7.5	1.0	[illegible]	10.0	[illegible]
Conventional*	0.2	0.0	0.0	0.0	0.6

*Following mite control spray.

TABLE 3. Average number of live San Jose scale on 6-inch basal portion of almond watersprouts in late winter

	SJS/shoot on 25 shoots				
Orchard	Feb. 1989	Feb. 1990	Feb. 1991	Feb. 1992	Feb. 1993
Organic	0.3	0.4	0.2	0.3	0.2
Low-input	0.1*	1.0*	5.0	0.8	2.0
Conventional	—	0.5*	0.4*	0.6*	[illegible]

*Following dormant sprays.

Gummy and shriveled kernels are also rejects, but are not related to insecticide use. Hand-cracked samples of nuts from windrows at harvest showed very similar reject levels for the organic and low-input orchards over the 6 years of the comparisons (table 1). Although the differences were small, the organic orchard had lower reject levels in 4 of the 6 years of the trial.

In the conventional orchard, rejects due to NOW and PTB were extremely high at 9.5% in the 1989 harvest. This was attributed to the high survival of NOW in the 50 to 60 mummies per tree. In succeeding years this grower has adopted an aggressive program of mummy removal and destruction and the harvest grades have improved greatly, even though the insecticide spray program has remained quite constant. Rejects have been reduced to an acceptable level, but have not been lower than the organic orchard in any of the 5 years.

Twospotted spider mite. In the organic and low-input orchards, spider mites have not increased to damaging levels in the absence of pesticides (table 2). The results have been similar in each year of the study. The only severe mite outbreak was in 1990 in the conventional orchard following a disruptive summer spray of synthetic pyrethroid for NOW control. Tydeid mites have been very prominent in the organic orchard, and have been found in small numbers in the low-input orchard. The Tydeid mite can be beneficial, because it does not damage almond leaves and is an alternative food source for mite predators.

San Jose scale. The organic orchard has never had sufficiently high numbers of San Jose scale to cause spur and shoot damage. In 1993 scale counts increased slightly in the low-input and conventional orchards, but remained virtually the same as in the previous 4 years in the organic orchard (table 3). This is most likely the result of natural parasitism and predation. At least two resident wasp parasites have been reported to parasitize scale, and generalist predators feed on scale as well.

The low-input orchard had low to moderate San Jose scale numbers in the first 3 years of the observations, but scale levels stabilized at a moderate level after insecticide use was terminated. Careful monitoring of scale insects is very important, because San Jose scale can be very damaging if populations become too high. Winter scale counts of five per 6-inch shoot have been well below the level that would cause severe damage. The conventional orchard receives annual winter sprays, which keep scale levels low.

Beneficial predators and parasites. Predator and parasite monitoring by d-VAC or an insect sweep net showed ladybird beetle numbers high in the organic orchard and parasitic wasp numbers much higher in the organic and low-input orchards than in the conventional orchard in 1993 (tables 4 and 5). A sweep net was found to give insect catches roughly equivalent to d-VAC counts and may be preferred for cover-crop evaluations because less trash was collected with sweep nets.

The number of beneficials present seems to be related more to the type of cover, the prey feeding on the cover, and the time of year rather than past spray history. But beneficials are seriously reduced immediately by toxic sprays. Even if beneficial numbers are quite high in the early spring in a well cover-cropped conventional orchard, they can be drastically reduced for weeks following a toxic spray.

Observations indicate that unsprayed orchards have a very high level of spider activity, and spiders are widely recognized as good generalist predators. In the biologically active organic and low-input orchards, spider webs often stretch between limbs and from tree to tree. Spiders are often found on and under cover-crop clippings, on tree trunks, and deep in the cover crop. Spiders are very sensitive to toxic sprays.

Commonly seen predators are the convergent ladybird beetle *(Hippodamia convergens)*, the lacewings (*Hemerobius* spp. and *Chrysopa* spp.), assassin bugs (*Zelus* spp.), big-eyed bugs (*Geocoris* spp.), spider-mite destroyer *(Stethorus picipes)*, western orchard predator mite *(Metaseiulus occidentalis)* and sixspotted thrips *(Scolothrips sexmaculatus)*. These predators are often found in the conventional orchard as well, but numbers are sharply reduced following pesticide sprays.

Soil organic matter and fertility. The organic matter level has remained high in the organic orchard (table 6). The late spring organic matter level in the organic orchard has been moderate to high, at 1.1 to 1.8%. The low-input orchard was closely mowed in 1988 and 1989 and had low organic matter. In 1990 and later, as a change was made to denser covers and alternate-row mowing, this level increased to 1.0 to 1.5% organic matter. The disked

TABLE 4. [illegible]

Orchard	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Organic	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Low-input	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Conventional	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 5. [illegible]

Orchard	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Total
Organic	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Low-input	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Conventional	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 6. Organic matter in surface 6 inches of soil in April

Orchard	1989	1990	1991	1992	1993
Organic	1.4	[illegible]	1.1	0.9*	[illegible]
Low-input	0.6	1.0	1.4	0.9*	[illegible]
Conventional	—	1.0	0.8	0.7*	0.9

*June sample only 1992

TABLE 7. Average number of earthworms per observation ring in three almond orchards

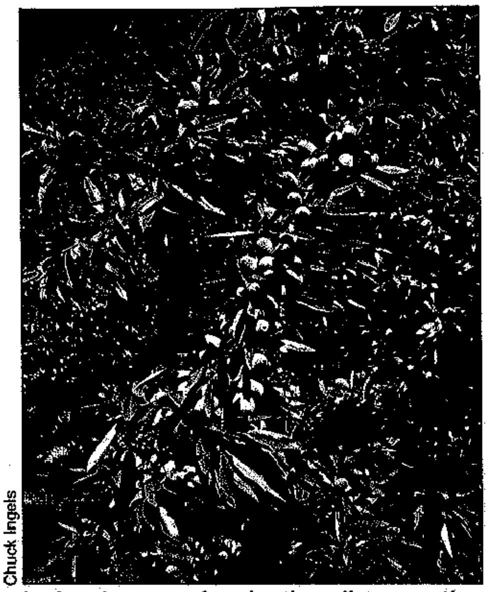
Orchard	1993				1994
Orchard	[illegible]	6/7	[illegible]	[illegible]	[illegible]
Organic	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Low-input	[illegible]	[illegible]	[illegible]	20	[illegible]
Conventional	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

conventional orchard remained at 1.0% or less organic matter through 1993. In 1993 the organic matter increased in all orchards. The organic matter levels build in the spring to a peak in April to May. Then, as decomposition takes place and nutrients are released, the level drops to a low point in late summer.

Nutrients are supplemented in each orchard to keep the essential elements in a sufficient range. The irrigation water in this area supplies these orchards with approximately 100 pounds of nitrogen per acre through the normal flood irrigations. No nutrient treatments were made as part of this experiment.

Earthworms. Earthworm numbers were measured periodically in these orchards, especially in 1993 and 1994 (table 7). Both the organic orchard with a dense vetch cover, and the low-input orchard with a lush resident vegetation cover have very high numbers of earthworms. Two species were found and identified by Dr. Matthew Werner, soil ecologist at UC Santa Cruz, as *Aporrectodea turgida* and *Microscolex dubius*. The conventional orchard, which had been disked for many years, had no earthworms in 1993, and still has only a very few earthworms in 1994, after 2 years of cover cropping. This lack of earthworms is common in these very sandy soils, unless a special effort is made to add organic matter to the soil through cover cropping and additions of organic materials. Earthworms can flourish in sandy soils if sufficient organic residues are provided through cover cropping and the addition of manures and composts.

Yields. Yield data from three orchards under different management and cultural practices cannot be used to draw valid conclusions about the effectiveness of any one cultural or management practice; nor do these data reflect the much more complex picture of comparative profitability. However, yields can be seen as general indicators of the viability of orchard systems. In 1990 all three of the observation orchards produced within 20 pounds of 2,100 pounds of 'Nonpareils' per acre. In 1989, with less favorable weather conditions, the organic orchard produced about 20% less than the two sprayed orchards. Organic orchards can be maintained at good fertility and insect pests can be effectively controlled, but the limiting factor often is springtime diseases. Severity of these diseases is roughly proportional to the amount and duration of rain at bloom and postbloom. We lack effective bloomtime disease controls for organic orchards. Blossom brown rot *(Monilinia laxa)* and shot hole *(Wilsonomyces carpophilus)* are the two most damaging diseases, and are the most likely to reduce crop yields.



Chuck Ingels

In the absence of springtime diseases, the organic orchard's yields were comparable to yields of the low-input and control orchards.

Management with fewer pesticides

This whole-farm comparison looked at the orchard systems, and not at individual pest-prey relationships within the systems. Organic and low-input farmers and their pest control advisors insist that the whole system must be in place to effective, and that manipulating part of the system will not give the same beneficial result achieved with a whole system. An integral part of the system is a well-managed cover crop as a refuge for beneficial insects. This area of the San Joaquin Valley has a good supply of water, which makes cover-crop growing affordable. Water supplies and costs could be limiting in other growing regions. Similar results could be expected in other areas of California if the pest and beneficial complexes and timing are similar to this area. Similar approaches should be tried cautiously in other areas. Growers' experience has been that several years may be required to establish a balanced and effective orchard system.

Future research could be directed toward better identifying the role of each of the many generalist predators present in the orchards. Then perhaps the orchard systems could be modified to encourage the more effective predators.

Sanitation is extremely important in managing NOW. Winter mummy counts of more than one to two mummies per tree often lead to high NOW reject percentages at harvest. Past UC research has demonstrated good correlations between mummy counts above one per tree and increased harvest damage. The same results have been seen in this comparison. High NOW damage followed high mummy counts in the conventional orchard in the first year of the study, even though insecticides were used. However, in some years high mummy counts in the low-input and organic orchards did not result in high NOW rejects at harvest. This confirms the contention of organic growers that mummy removal is not important in an almond orchard that has a high level of biological control.

Peach twig borer may damage the almond kernel from hull split through harvest. A number of formulations of *Bacillus thuringiensis* are now marketed for PTB control without disrupting beneficials. The conventional orchard has used Bt, but neither the organic nor the low-input orchards has needed to use a pesticide for PTB control. Peach twig borers are trapped in these orchards, but damage is low.

Recently the California gray field ant, or "crazy ant," has been reported to be a good predator of PTB, and pest control advisors have observed this ant feeding on PTB in almond trees. This ant is commonly found on the cover crop, on the orchard floor, and in the almond trees. The California gray field ant has been observed frequently in these orchards, but no monitoring of its numbers has been done.

Growers often feel that it is imperative to spray for control of twospotted spider mites and San Jose scale. In the low-input and organic orchards, spraying has not been necessary.

Many almond growers are now using low-input methods with similar good results. They are demonstrating that 'Nonpareil' almonds in the northern San Joaquin Valley can be successfully produced without an insecticide program. Careful winter mummy removal and mummy destruction is very important, especially when starting the transition process. Good cover-crop management provides a habitat for beneficial arthropods, and biological control is enhanced if harsh pesticides are not used.

The steps to reducing pesticide inputs that we have found in this study and through the experience of successful growers are:

1. Elimination of in-season insecticide sprays by practicing good winter sanitation and mummy destruction.
2. Establishment of a good cover crop and mowing middles alternately.
3. Monitoring pests, especially scale, very carefully and not using disruptive insecticide sprays.
4. Using two Bt applications at bloom rather than an organophosphate plus oil dormant spray.
5. Using oil dormant spray if needed for scale and mite egg control.
6. Introducing the navel orangeworm parasite *Goniozus legneri*, if needed, when converting to lower input.
7. Harvesting promptly.

The system outlined in this report may not work for growers throughout California or eliminate all pesticides in almond orchards. However, for many growers these practices will comprise an integrated program of cultural, biological and chemical pest control. These practices also add resilience and inertia to the orchard system, so that the biological balance is resistant to disturbance.

L.C. Hendricks is Farm Advisor, Merced County Cooperative County.

Crop and farm diversification provide social benefits

Gary W. Johnston ❑ Suzanne Vaupel ❑ Franz R. Kegel
Melissa Cadet

Agronomic and economic benefits of diversification have been well documented, but social benefits are less well known. Two recent California studies show that diversity of crops and farm enterprises creates year-round or extended season employment for farmworkers. Additional strategies for doing so are paced work, selective mechanization, new technologies, break-even crops and coordinating work with other farmers or local industries. Workers employed on a year-round basis or for a longer season have higher incomes, more employer-paid benefits and can provide a better standard of living for their families than their seasonal counterparts. Farmers have found many benefits from a year-round or extended employment system. Some of these are increased worker availability, increased productivity and dependability, less need for worker training and increased personal satisfaction.

For many years, growers have used crop diversification to improve soils and increase profits, but recently farmers have found additional benefits for their employees. While its agronomic and economic benefits are well known, the social benefits of diversification have received relatively little attention. Diversification strategies include rotating to other crops, double cropping and intercropping.

This article reports on two studies of crop diversification systems and employment patterns. The first study investigated the effect of multiple cropping and crop rotation systems of San Joaquin County farmers on farm employment. The second study consists of case studies of three farms (in the Coachella Valley, the Sacramento Valley and the North Coast) that intentionally diversified in part to provide year-round employment to seasonal workers. These studies show economic benefits for both growers and farmworkers.

Crop diversification systems also tend to be more agronomically stable and resilient. In its 1989 study, *Alternative Agriculture*, the National Research Council identified some of the common advantages found in most diverse systems: reduced disease, weed and insect pressures; reduced need for nitrogen fertilizer; reduced erosion; increased soil fertility and increased yields.

Diversification also can provide habitat for beneficial insects and reduces pest numbers by rendering host crops less apparent for colonization by pests. Diversification increases economic stability by reducing financial risk, stabilizing farm income, and increasing choice of farm practices.

Social benefits from diversification result from the opportunity to stabilize employment through an extended on-farm work season. The work force at most farms consists of a group of core workers (usually referred to as "permanent," "regular" or "year-round" workers) and a larger number of seasonal and casual workers, who are often brought to the ranch by farm labor contractors (FLCs). A high degree of turnover has been common among seasonal and casual workers. In a year-round operation, the employment system shifts to a more stable system with fewer workers employed over a longer period of time.

San Joaquin study

San Joaquin County commercial farmers normally grow three or more

The Davis Enterprise, Sunday, May 4, 1997

Pesticide alternatives showcased

By MELANIE TURNER
Enterprise staff writer

WINTERS — As the environmental and health effects of pesticides become more widely recognized, there is a movement to implement farming practices that use fewer chemicals and promote ecological farming.

The nonprofit Community Alliance with Family Farmers promoted that movement on Friday while hosting about 70 people on a day-long tour featuring ongoing demonstration projects in Winters, in both Yolo and Solano counties.

The local farm projects are all part of the Community Alliance with Family Farmers' award winning Biologically Integrated Orchard Systems (BIOS) program, which began in 1993 with almond growers in Merced County.

Today, the BIOS program has expanded to include growers in Stanislaus, Madera, Colusa, San Joaquin and most recently, walnut growers in Yolo and Solano counties.

CAFF is a membership-based educational and advocacy organization with regional chapters across the state. Next year is CAFF's 20th anniversary.

The walnut project, now in its third season, has 20 growers who have 550 acres enrolled as demonstration sites in Yolo and Solano. Because of successful experiences with their enrolled acreage, these same farmers now use BIOS practices on more than 1,000 acres of walnuts and other crops.

"I think there is an overarching policy reason why we're here," said Adrienne Alvord, CAFF's policy coordinator, toward the end of the day.

Alvord said people need to understand that as restrictions are tightened on the use of chemicals, farmers are going to have a tougher time using traditional farming practices. In order to advance with alternatives, support has got to come from the research community, the local agricultural establishment, state and federal agencies and groups like CAFF.

"The paradox that we're facing here — some of the very materials that caused some phenomenal successes also have caused daunting future problems," Alvord said.

As John Hasbrook of Davis, president of SunWest Foods, Inc., testified on Friday, by using fewer synthetic pesticides and nitrogen fertilizers with the help of the CAFF program, the "whole vitality of our orchard is a lot better."

BIOS practices not only benefit farmers, but whole communities by increasing water quality, decreasing toxic effluent and reducing air pollution, Alvord said, crediting "forward-thinking" growers for getting the movement going. Alvord added that a concerted effort is necessary to keep the momentum going.

Said Karminder Aulakh, who coordinates the walnut BIOS project for CAFF, BIOS enables growers to reduce chemical inputs without sacrificing yield or economic returns.

According to Aulakh, four basic principles behind the BIOS strategy include: building the soil by inoculating it with earthworms, planting cover crops, or adding organic mulch; creating or enhancing habitat for beneficial insects; monitoring results to provide a basis for biological decisions; and working with nature to prevent weed growth and eliminate the need to use herbicides.

Rolling along the flat Yolo County countryside in a large bus, Aulakh points out walnut orchards along the way where essentially all plant life below the trees has been eliminated. The floor of these orchards is bare.

By contrast, at the first stop tour participants look down a rows of trees that are surrounded by two-foot high plants. The trees are in a demonstration section of the Mariani orchard.

Although Martin Mariani of Mariani Nut Co. has continued to spray herbicides in the rows where trees grow, in between each row of trees is a lush green cover, with from 15 to 20 different plant types, the majority of which are vetches.

Interested in exploring environmentally friendly farming practices, Mariani enrolled a 15-acre block of the orchard in the BIOS program. He said the cover crop helps prevent erosion during the rainy season, helps with water penetration and runoff, and adds organic nutrients to the soil.

Cover crops also keep the dust down, said Esparto BIOS farmer Jim Haag. That's important, since dust carries harmful mites up into the trees.

Unlike organic, BIOS practices are not totally without chemical spray, Haag said. BIOS practices use some mix of chemicals and biologically integrated systems.

Organic is not without its problems, such as with heavy metals and salts. And BIOS, too, has its problems, such as attracting unwanted pests, like gophers. Cover crops make gopher mounds harder to identify, Mariani said.

"We still don't have the magic recipe," Haag added.

But CAFF members are encouraging farmers to adopt whatever ecological methods farmers are comfortable with. Farmer Craig McNamara of Sierra Orchards uses more BIOS practices than Mariani, and Russ Lester of Dixon Ridge Farms in Winters is totally organic.

The Davis Enterprise, Sunday, May 4, 1997

McNamara said he supports BIOS because it's a voluntary program and it takes a proactive team approach. BIOS aims to build a community of farmers, other agricultural professionals and public institutions dedicated to the voluntary adoption of a whole systems approach to farm management.

"We all face a changing agricultural landscape," McNamara said.

Throughout the state, harmful concentrations of nitrates are turning up in the soil due to excessive uses of chemicals, McNamara said. Cover crops can help, by adding beneficial nitrogen to the soil.

"In the last three years we have reduced our dependency on synthetic fertilizers by half" using cover crops, McNamara said.

High school students planted the cover crop at Sierra Orchards through the Farms Project, a partnership with the California Foundation for Ag in the Classroom, UC Davis and the Yolo County Resource Conservation District.

At Sierra, tour participants witness a huge chipper which gobbles up about six car lengths of orchard tree branches in a matter of minutes. The wood chip pile will later be transported to a biomass plant in Woodland where it's converted into energy.

Lester does something different with the wood chips produced on his 230-acre organic walnut orchard. Lester's smaller chipper is fed by hand and spits the chips out onto the orchard floor where they decompose and allow nutrients to go back into the soil.

"Rather than buy into the chemical routine, we recycle it. It goes right back into the ground, back into the trees in a few years."

Lester said beneficial insects are attracted to the cover crop at Dixon Ridge Farms.

"I try to think of (the worms and insects) as our employees," Lester said. "We have thousands and thousands of employees."

A big concern of growers is ensuring the orchard floor is clean come harvest time. Nuts are harvested off the ground, so when they get swept up, growers don't want cover crops, tree branches or other debris to get in the way.

But experienced BIOS participants say it's not a problem. Farmers cut the cover crop low to the ground in June, leaving enough to retain moisture and beneficial insects. They leave it until June so the seeds have enough time to mature and the next year growers don't have to buy as much cover crop seed.

Over the summer the crop decomposes and come harvest time in October, the ground looks nearly bare again, growers say.

According to CAFF officials, since joining the BIOS program, more than 75 percent of all growers have established a successful cover crop, about 50 percent have reduced the amount of nitrogen applied to their orchards, and 44 percent have released beneficial insects.

There are now seven experimental projects in seven counties in California, Aulakh said. Each project has about 15 growers and covers from 15 to 30 acres per grower, she added. That's more than 10,000 acres statewide where BIOS management techniques are being implemented.

CAFF members facilitate the exchange of information between farmers by holding on-farm field days and demonstrations and through publications.

And each BIOS project is coordinated by a locally based management team composed of growers, UC Cooperative Extension researchers, and CAFF staff members to provide technical assistance to each grower.

BIOS projects are funded by contracts from state and federal agencies, as well as from private philanthropic donations.

CAFF members say more research is needed. However, a full-time field scout was hired last year to conduct intensive weekly monitoring of cover crops, pests and beneficial insects in 18 BIOS walnut orchards.

The scout found that 90 percent of all participating growers applied no insecticides and yet had little damage at harvest. Insect damage averaged 2.2 percent.

"I think the best proof that the program works is that it's being copied left and right," said Aulakh.

For more information about CAFF, call 756-8518. CAFF's Web site is at www.caff.org. CAFF's new program e-mail address is: caff@caff.org.