

# UNIVERSITY OF CALIFORNIA

## Sustainable Agriculture Research and Education Program

Progress Report

**Grant Award:**  
\$28,268

**Funding Period:**  
FY 1997–2000

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## A Grower-Managed Biorational Pest Management Program for Artichokes on the Northern Central California Coast

### Objectives

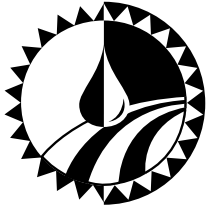
1. Design and demonstrate a grower-managed biorational artichoke pest management program in selected artichoke production sites in coastal Santa Cruz, San Mateo, and Monterey counties, in a farmer-led, participatory management team setting.
2. Apply and monitor critical components of the management program, including conducting mass releases of the locally-reared egg parasitoid *Trichogramma thalense*; monitoring pest abundance through trapping and heat/degree day accumulation; monitoring native beneficial insect abundance; and monitoring artichoke plume moth damage for program fields and matched non-program controls.
3. Evaluate the potential economic profitability of integrating weather and field monitoring, mating disruption, cultural controls, and mass release of *T. thalense* into existing artichoke production procedures.

### Summary

A native egg parasite, *Trichogramma thalense* was mass-reared in the laboratory, and released a maximum of 13 times against the eggs of the artichoke plume moth (*Platyptilia carduidactyla*) in three, five-acre biointensive artichoke production fields on the northern coast of Santa Cruz/San Mateo counties in 1998. A biorational grower-managed pest management program for these fields (BIORAPP) was used in the 1998-1999 season and monitored by a management team consisting of three growers (one grower is also an independent pest control advisor), and both an artichoke industry and a university researcher. Mass-released parasites were recovered from artichoke plume moth (APM) eggs collected post-release on only three dates, and in only one of the BIORAPP fields, in 1998; however, APM egg deposition was low in all other fields. Parasites were not recovered from any of the three adjacent, five-acre, non-release conventional artichoke fields.

The impact of BIORAPP management (trichogramma release, pheromone-based mating disruption, double-cut cultural control, and intensive monitoring on APM abundance and artichoke damage) was also monitored in the fields. APM damage to buds, male artichoke plume moth flight, and larval density, were measured from June 1998 (cutback) through May 1999 (double cutback). The BIORAPP combination of pheromone-based mating disruption, release of *Trichogramma thalense*, and intensive weekly monitoring resulted in a six-month insecticide stress-free production period for the BIORAPP fields. Two of the BIORAPP fields and one control field exceeded the action threshold of 4 percent bud damage on individual dates; however, average seasonal bud damage for all fields was below 4 percent through May 1999. Buds were not sampled frequently enough in two fields (one BIORAPP and one control) to accurately assess percent damage. Two organic artichoke growers have recently enrolled new fields and joined the BIORAPP management team for 1999.

The complete report of this project is available on SAREP's Web page at:  
[www.sarep.ucdavis.edu/grants/Reports](http://www.sarep.ucdavis.edu/grants/Reports)



# UNIVERSITY OF CALIFORNIA

## Sustainable Agriculture Research and Education Program

Final Report

**Grant Award:**

\$15,000

**Funding Period:**

FY 1997–98

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## Native Grass Species for Use as Perennial Cover Crops in San Joaquin Valley Vineyards

### Objectives

1. Determine the suitability of California native grass species for use as permanent cover crops in vineyards, in terms of cover crop establishment and ability to compete with weeds.
2. Analyze phenology (active growth season, flowering, dormancy period, etc.) and biomass produced for the native grasses studied.
3. Measure effects of native grasses on vineyard water and nitrogen use, water infiltration, weed control, effect on spring frosts, soil quality, vine water/nitrogen status and spider mite populations.

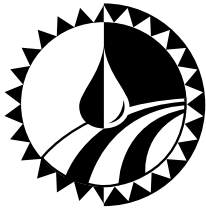
### Summary

Perennial native grasses were tested as cover crops in two vineyards at the Kearney Agricultural Center in Parlier, Calif. In a drip-irrigated vineyard of Barbera, the cover crops which established were nodding needlegrass, California barley prostrate and a blend of the two. An attempt to establish oniongrass failed. In a flood-irrigated block of Grenache grapes, the cover crops which established were purple needlegrass, nodding needlegrass, California brome and a blend of California brome and blue wildrye. Meadow barley was seeded but failed to establish. Seasonal monitoring was done for in-row and between-row soil moisture and plant water status, at-harvest yield was measured, and in-winter pruning weights were taken as an estimate of vine vigor.

At the drip-irrigated site, overall soil moisture status was higher in-row for the nodding needlegrass treatment at 1' to 4', but soil moisture levels were higher between-rows for clean cultivation. At the flood-irrigated site, soil moisture in the nodding needlegrass treatment was lower until the first irrigation. With each irrigation (July 10, July 27 and August 25), soil moisture status at the deeper levels was elevated in the needlegrass treatment.

Very few significant differences were found among cover crop treatments in yield or pruning weight. The pattern of average yields at the drip-irrigated site were: highest in the nodding needlegrass and Blando brome treatments; intermediate with clean cultivation, nodding needlegrass/California barley blend and resident vegetation; and lowest with the pure stand of California barley; average pruning weights closely followed this pattern. The pattern of average yields at the flood-irrigated site were: highest in the clean cultivated treatment; intermediate in the blando brome, purple needlegrass and nodding needlegrass treatments; and lowest in the California brome/blue wildrye blend and pure stand of California brome.

The complete report of this project is available on SAREP's Web page at:  
[www.sarep.ucdavis.edu/grants/Reports](http://www.sarep.ucdavis.edu/grants/Reports)



# UNIVERSITY OF CALIFORNIA

## Sustainable Agriculture Research and Education Program

### Progress Report

**Grant Award:**  
\$44,000

**Funding Period:**  
FY 1997–2000

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## Impact of Dairy Waste and Nutrient Management on Shallow Groundwater Quality

### Objectives

This integrated farming/groundwater study is using an existing network of monitoring wells on five dairies in Stanislaus and Merced County to:

1. Determine the nature and extent of nitrate groundwater contamination under dairies and provide an improved understanding of the nitrogen pathways from various components of the dairy operation (corrals, ponds, spills, manure application to fields) and how these contribute to the degradation of groundwater quality.
2. Provide baseline data on groundwater quality that can be used to determine future improvements in groundwater quality due to improved nutrient management and dairy operations practices on selected dairies.
3. Demonstrate and evaluate short-term as well as long-term changes in groundwater quality at shallow depths due to improved nutrient management within the dairy operation at selected field sites (in conjunction with a dairy waste management and nutrient management project).
4. Educate dairy operators and the communities in Stanislaus and Merced County, local and state regulatory agencies, and water management agencies on the impact of various nutrient management alternatives on groundwater quality and cooperatively develop sustainable solutions to protect groundwater quality from excessive salt and nutrient loading under dairies.

This proposal was submitted jointly with a proposal on the use of dairy lagoon water in the production of forage crops [see project summary *Use of Dairy Lagoon Water in Production of Forage Crops*, Marsha Campbell Mathews].

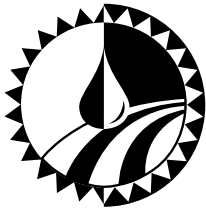
### Summary

California is the largest dairy producing state in the United States. Environmentally sustainable management of these dairies is critical to the economic health of California's agricultural community. This project focuses on understanding the link between dairy waste management and shallow groundwater quality, and on developing improved dairy waste management methods that will ensure impacts on groundwater quality are minimized. Shallow groundwater quality has been monitored on cooperating dairies in the San Joaquin Valley. Waste management practices on these five dairies are considered to be representative of many dairies, particularly in the northern San Joaquin Valley, where the depth to groundwater is shallow and soils are predominantly sandy. The researchers classified the monitoring wells, to the extent possible, according to the proximity of dairy landuses that are most likely to influence the water quality in a particular well: the corral, pond (or lagoon) where dairy waste is stored, and the field where lagoon water is applied.

Consistent with previous reports, nitrate levels in wells associated with all land uses were found to exceed the maximum contamination level of 10 mg/l. The mean concentrations found in shallow groundwater underneath fields and corrals were much higher than those of upgradient shallow groundwater wells. Within each dairy, nitrate levels varied by up to one order of magnitude between monitoring wells. Additional variation was found in particular wells, where nitrate concentrations sometimes increased or decreased by more than 100 percent over the period the study. Given the high variability over time and between wells, average concentrations must be interpreted carefully. However, the data clearly suggest that nitrogen concentration in shallow groundwater significantly increase as groundwater is recharged across the dairy. On the other hand, it is expected that shallow groundwater moving off the dairies is diluted with recharge from non-manure excess irrigation water. Nitrate may also be subject to denitrification. Both processes reduce nitrogen levels in shallow groundwater.

Besides seasonal changes, no discernable trend was observed in the average nitrate concentration over the three-year observation period. The data suggest that significant amounts of nitrate leaching takes place in fields receiving excess manure water applications. Less is known about potential nutrient leaching from corrals and ponds, although both have been shown to contribute some nitrate to groundwater. Ongoing research includes monitoring groundwater quality responses due to improved manure management in selected fields. Work is considered to be ongoing and results are preliminary.

The complete report of this project is available on SAREP's Web page at:  
[www.sarep.ucdavis.edu/grants/Reports](http://www.sarep.ucdavis.edu/grants/Reports)



# UNIVERSITY OF CALIFORNIA

## Sustainable Agriculture Research and Education Program

Progress Report

**Grant Award:**

\$18,272

**Funding Period:**

FY 1997–2000

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## Effects of Cover Crops on a Vineyard Ecosystem in the Northern San Joaquin Valley

### Objectives

1. To determine the effects of several popular cover crop mixes on grapevine shoot growth, water stress, nutrient status, and fruit production and quality.
2. To evaluate the biomass production and nitrogen content of cover crop mixes.
3. To evaluate the effects of cover crops on soil microbial ecology.
4. To determine the economics of using different cover crop systems.

### Summary

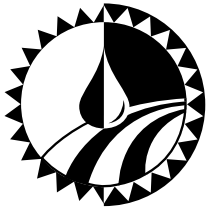
The cover crops used in this study had minimal effects on the vines in the first year. Vine water stress, although minimal, was greatest in the native grass and clover mixes before the first irrigation only. Petiole nitrate-nitrogen content was somewhat higher in the vetch/bell bean/pea/barley treatment and lower in the native grass treatment. However, yields were similar and juice analyses were not greatly different.

There were substantial differences in biomass of the cover crops. Annual clovers grew little during the winter and did not catch up to the other species one month later. The vetch/bell bean/pea/oat mix produced the greatest biomass by April (67 percent greater than the clover mix). Weed suppression was also slightly greater in this treatment. The biomass of the resident vegetation (control) was about a quarter to a third that of the cover crop treatments.

The total nitrogen content of the vetch/bell bean/pea/oat increased dramatically in March and early April, and was about 50 percent greater than that of the clover mix in April. On a per-acre basis, the vetch mix added just over 100 lbs. of nitrogen; this amount is excessive if continued over time.

Of the four cover crop treatments, annual clovers showed the lowest cost both in terms of establishment (\$83.21 per acre in year 1), and in continued maintenance (\$18.74 per acre for year 2 and beyond). Native grasses were the most expensive to establish (about \$185 per acre in this study) due to the high cost of seed; after establishment costs dropped to about \$31 per acre mainly for mowing and extra fertilizer. Overall, planting seeds and disking, when needed, are the costliest operations involved in using cover crops.

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# UNIVERSITY OF CALIFORNIA

## Sustainable Agriculture Research and Education Program

Final Report

**Grant Award:**

\$46,722

**Funding Period:**

FY 1997-99

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## Defining Changes in Soil Organic Matter Quality During the Transition from Conventional to Low Input Organic Systems to Identify Sustainable Farming Practices

### Objectives

1. Determine the change in soil organic matter (SOM) quality during the transition from conventional to low-input organic farming systems.
2. Provide farmers with soil quality criteria to help them implement farming practices that promote SOM maintenance.
3. Demonstrate the critical importance of SOM maintenance in promoting the sustainability of agroecosystems.

### Summary

This research has focused on defining the characteristics of soil organic matter (SOM) that contribute to cropping system sustainability. To quantify these characteristics, the researchers have begun to examine and compare soils managed in fundamentally different ways at the UC Davis Sustainable Agriculture Farming Systems (SAFS) project. The management practices examined cover conventional practices to alternative practices designed to increase the level of SOM. It has been difficult to assess soil fertility based on gross measures of SOM, such as total soil carbon and nitrogen. For example, nitrogen budgets in the SAFS project have shown that the "organic" treatment (manure and cover crop) has accumulated the most soil nitrogen, but appear to be the most nitrogen limited treatment. On the other hand, the "low-input" treatment (cover crop and fertilizer nitrogen) has accumulated less soil nitrogen, but has consistently out-produced the "organic" and "conventional" corn rotation treatments. These results indicate that it is not the quantity of SOM, but rather the quality of SOM that may control soil fertility. The researchers believe increased understanding of SOM composition will improve soil health, sustain long-term food production, and will help growers become informed of the value of the alternative cropping system management designed to enhance SOM.

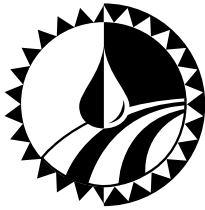
Project results show a significant increase in SOM in alternative system (low-input/organic) vs. conventionally managed plots. The inclusion of additional rotation crops did not effect SOM in the conventional treatment. The addition of partially composted poultry manure and cover crops increased SOM more than any other treatment. However, because of the large amount of carbon and nitrogen added to the organic system, this system lost more carbon and nitrogen through mineralization compared to the conventional system. The low-input system appears to be the least efficient in retaining carbon input, or in other words converting crop residues into SOM. The conventional treatment was the most efficient at converting crop residues into SOM. However, since the conventional system received less carbon and nitrogen inputs than the alternative systems, it produced less SOM than the alternative systems. The low-input treatment, which uses a winter cover crop and reduced fertilizer input, was the least efficient at converting crop residues into SOM. The increase of SOM in the organic treatment shows the importance of recycled agricultural wastes, such as composted poultry manure, in increasing SOM. In contrast, the low-put system was the most efficient at storing nitrogen compared to the conventional and organic systems. These results show that formation of SOM is dependent on both soil management and types and or quality of soil inputs.

The research has shown that the low-input treatment has had comparable or increased yield compared to the conventional system. This, however, was not obvious because assays to predict nitrogen availability showed the low-input treatment had the lowest rate of potentially mineralizable nitrogen (PNM). However, the low-input treatment had the largest active pool of nitrogen compared to the other systems. These results indicate that standard assays of soil fertility are not always applicable and may also not be suitable for soils managed alternatively since these methods were primarily developed for conventionally managed soil. The above results may be explained by the timing of soil nutrient release for plant uptake. Even though the low-input system produced the least available nitrogen it may have supplied the nitrogen it mineralized at the time of maximum plant uptake. These observations are interesting and show that a hybrid system, such as the low-input treatment, has incorporated the positive aspects of the conventional and organic management

philosophies in such a way as to enhance soil fertility. The results also show the importance of designing cropping system practices that influence both the level of SOM and the ability to supply nutrients when crops demand them.

The interest of local farmers in the SAFS project is tremendous and allowed the researchers to disseminate their results to the local farm community through independent presentations and SAFS extension activities. Greater farmer appreciation is expected since the research results generated for SAFS is applicable to other agricultural regions in California, especially the San Joaquin Valley.

The complete report of this project is available on SAREP's Web page at:  
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# UNIVERSITY OF CALIFORNIA

## Sustainable Agriculture Research and Education Program

Progress Report

**Grant Award:**  
\$46,210

**Funding Period:**  
FY 1997–2000

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**William R. Horwath,**  
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## Use of Dairy Lagoon Water in Production of Forage Crops

### Objectives

1. Demonstrate effective use of dairy wastewater for the production of forage crops associated with dairies in Stanislaus and Merced counties to reduce groundwater contamination by nitrates in this area.
2. Develop a method for in-field rapid determination of ammonium ( $\text{NH}_4\text{-N}$ ), the primary immediately available nitrogen component of dairy lagoon water, and demonstrate its use in substituting lagoon water nitrogen sources for commercial nitrogen fertilizer.
3. Develop practical procedures for estimating flow of irrigation and lagoon water throughout the course of an irrigation, and demonstrate how these can be used in conjunction with laboratory nutrient analysis or quick test  $\text{NH}_4\text{-N}$  results to calculate the amount of crop nutrients being applied to a field.
4. Confirm that the altered nitrogen management practices will not compromise yield or contribute to excess salt accumulation in the soil.
5. Show how increased pond capacity can improve flexibility in management of lagoon water nutrients, ultimately resulting in an improvement in groundwater quality.
6. Manage a demonstration area large enough to show improvements in groundwater quality as a result of using these sustainable practices. Nitrate under these fields will be monitored under the joint proposal "Impact of Dairy Waste and Crop Nutrient Management on Shallow Groundwater Quality."
7. Educate dairy operators, crop consultants and others on effective, practical methods of managing dairy lagoon water applied to cropland to avoid groundwater contamination.

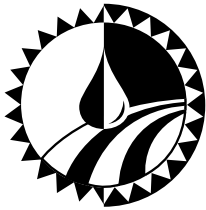
### Summary

A study of 44 monitoring wells on five dairies in the northern San Joaquin Valley has indicated that the largest source of excess nitrate in shallow groundwater on dairies comes from the fields (Harter 1999). In this project, the researchers implemented management practices aimed at improving groundwater quality by 1) minimizing excess pond water nitrogen applications to fields, especially during the winter months, and 2) eliminating the use of commercial nitrogen fertilizer by substituting similar amounts of pond water to supply the nitrogen needs of silage corn.

Despite the rich nutrient content of dairy lagoon water, many corn silage growers in the San Joaquin Valley have considered it unreliable as a primary source of nitrogen for their crops. A major portion of this project, begun in spring 1998, was aimed at developing methods of measuring and metering dairy lagoon water nitrogen in order to use this as a nutrient source for the corn without over- or under-application. Last season, a four-minute quick test for ammonium (the rapidly available form of nitrogen in lagoon water) was developed and used in conjunction with a hand-held flow meter inserted down an irrigation standpipe to adjust lagoon water nitrogen to match target application rates. An outstanding silage crop was produced. On the replicated field, the average yield for the corn silage was 41.6 tons per acre for the anhydrous control and 44.5 tons per acre pond water nitrogen (well above the 1997 Stanislaus County average of 27.2 tons per acre). Based on these results, the cooperating dairy producer is installing \$200,000 of improvements to the waste handling system on the dairy to facilitate use of lagoon water nutrients over the entire acreage.

This is a progress report and represents only the first year of what is intended to be a multi-year project.

The complete report of this project is available on SAREP's Web page at:  
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# UNIVERSITY OF CALIFORNIA

## Sustainable Agriculture Research and Education Program

Final Report

**Grant Award:**

\$10,000

**Funding Period:**

FY 1996–97

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## Alternate Side Irrigation to Control Root Rot in Avocados

### Objectives

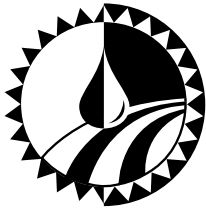
1. To establish a small-scale pilot project to establish the efficacy of using alternate side irrigation with and without mulch applications as part of an integrated pest management (IPM) program to control root rot in avocado.
2. To determine the water use requirements of trees infected with avocado root rot.

### Summary

*Phytophthora* root rot of avocado (*Persea americana*) has devastated thousands of acres of trees in California. Without treatment, tree decline and mortality can be rapid. This experiment examined the use of alternate side irrigation and composted green waste mulch applications to control root rot caused by *Phytophthora cinnamomi* in avocados. Four treatments were evaluated: a control irrigated at 30 centibars (cb) of soil tension; alternate side irrigation, irrigated at 60 cb of soil tension; alternate side irrigation with mulch applied, irrigated at 60 cb of soil tension; and standard irrigation with mulch applied, irrigated at 30 cb of soil tension.

Treatments were evaluated by counting new, non-infected root tips on four occasions and by measuring *Phytophthora* propagules per gram of soil once. Prior to the start of the experiment, initial root tip counts showed a virtual absence of non-infected root tips and no significant difference in the number of non-infected root tips among the treatments. As the growing season progressed, alternate side irrigation with mulch produced the fewest non-infected root tips and was significantly lower than the other three treatments in July and October. Standard irrigation with no mulch (control) produced the most non-infected root tips, but overall, was not significantly different than alternate side irrigation with no mulch and standard irrigation with mulch. Standard irrigation with mulch produced the fewest *Phytophthora* propagules per gram of soil, while alternate side irrigation with no mulch produced the highest number of propagules per gram of soil. However, there was no significant difference in the number of propagules per gram of soil between any of the four treatments. Based on this experiment, it did not appear that alternate side irrigation is a viable control strategy for avocado root rot.

The complete report of this project is available on SAREP's Web page at:  
[www.sarep.ucdavis.edu/grants/Reports](http://www.sarep.ucdavis.edu/grants/Reports)



# UNIVERSITY OF CALIFORNIA

## Sustainable Agriculture Research and Education Program

Final Report

**Grant Award:**  
\$30,000

**Funding Period:**  
FY 1996–99

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## Development of a N-Fertilizer Recommendation Model to Improve N-Use Efficiency and to Alleviate Nitrate Pollution to Ground Water from Almond Orchards

### Objectives

1. Conduct field validation of leaf nitrate analysis in almond orchards.
2. Develop an “on-site” test of tissue nitrate concentration throughout the growth season.
3. Determine almond tree seasonal and total nitrogen (N) demand for optimum yield.
4. Develop a grower-used computer-based site-specific N management program.

### Summary

Overfertilization in almond orchards is attributed to the lack of reliable tools for measuring tree N status, tree N demand and soil N availability. The purpose of this project was to provide better tools for distinguishing between fertilizer applications that are essential and those that are excessive, and provide growers guidance on when and how much N fertilizer should be applied to obtain optimum yield while minimizing the potential pollution to the environment.

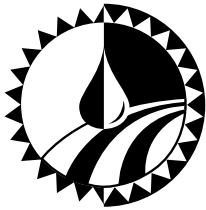
Previous research suggested the potential value of leaf  $\text{NO}_3\text{-N}$  as an indicator of N status in almond orchards. Contrary to earlier results, studies conducted here demonstrated that leaf nitrate analysis is an unreliable indicator of tree N status due to large variations in tree nitrate concentrations over time and a strong interdependence on plant water status.

The second aim of this research was to determine the seasonal patterns of N demand in mature almond orchards. To this end sequential whole tree excavations were conducted at January 21, March 20, and May 20, 1997 at the Delta college orchard, Manteca, Calif., and there was one excavation at harvest and in the spring of 1998. Weight of individual trees excavated range from 570 kg to 799 kg dry, with corresponding total N content of 4 to 6 kg N. The highest proportion of total N was present in root and root stock in January and March. Fruit and canopy had the largest proportion of total N in May. Nitrate and total soluble N represented only a small proportion of total N presented in the whole tree.

The researchers have completed analysis of seasonal N uptake dynamics and total yearly N demand. This information has now been integrated into a user-friendly interactive computer program that is available for distribution. In summary, the determination of N fluxes in almond orchards demonstrates that the majority of N uptake and demand occurs from late February through to early September and that the primary demand for N is for nut fill and nut development. N demands can therefore be predicted by estimating yield and can be applied during the periods of greatest N uptake from the soil which occurs during nut development.

By timing N applications with periods of greatest demand, and matching N application rates with crop load this research provides growers with a tool that will encourage maximum efficiency of use of N fertilizers. Maximum efficiency of use will result in a minimization of N loss from the orchard system.

The complete report of this project is available on SAREP’s Web page at:  
[www.sarep.ucdavis.edu/grants/Reports](http://www.sarep.ucdavis.edu/grants/Reports)



# UNIVERSITY OF CALIFORNIA

## Sustainable Agriculture Research and Education Program

Final Report

**Grant Award:**  
\$8,573

**Funding Period:**  
FY 1996–97

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## The Impact of a Sustainable Agricultural Practice with Grapes on Pesticide Use in California

### Objectives

1. To determine the progress California has made towards reducing fungicides on grapes, fungicide use will be measured using the California Department of Pesticide Regulation's (DPR) Pesticide Use Reports between 1990 and 1995.
2. To assess to what extent grape canopy management (e.g. leaf removal) has contributed and could contribute to future reductions in fungicide use on grapes.

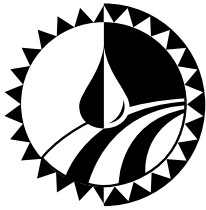
### Summary

California's unique Pesticide Use Reports (PUR) provide an opportunity to analyze grower chemical control practices. Individual applicator records submitted to the state were electronically cleaned of some of the errors in the database. Then, applicable records were converted into output that described California vineyard chemical control programs for bunch rot of wine and table grapes between 1992 and 1995. The data indicated that overall in California, only 21 percent and 11 percent of the wine and table grape vineyards, respectively, applied fungicides for bunch rot to their grapes per year, and of those, the median vineyard made only one application per field. The amount of fungicides used to control bunch rot of grapes remained fairly constant between 1992 and 1995; there was no evidence from the PUR that usage of leaf removal to control bunch rot resulted in decreased fungicide use between 1992 and 1995. In contrast to the comparatively stable use of the fungicides used on grapes to specifically control bunch rot, the percentage of growers using inorganic copper, and the percentage of hectares treated with inorganic copper, increased between 1992 and 1995.

Major conclusions from this study include:

1. Although use of leaf removal on wine grapes in the North Coast probably increased during the study period, there is no evidence from the Pesticide Use Reports that there was a decrease in fungicide use.
2. The frequency of use of fungicides used to control bunch rot is less than might be expected from reading the IPM literature.

The complete report of this project is available on SAREP's Web page at:  
[www.sarep.ucdavis.edu/grants/Reports](http://www.sarep.ucdavis.edu/grants/Reports)



# UNIVERSITY OF CALIFORNIA

## Sustainable Agriculture Research and Education Program

Progress Report

**Grant Award:**

\$23,508

**Funding Period:**

FY 1996–99

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## The Contribution of Ranch Roads, Cattle Trails and Bed Load to the Sediment Budget for a Grazed Watershed in the Central Sierra Foothills

### Objectives

1. Estimate sediment delivery to a stream channel from roads and cattle trails in a grazed watershed.
2. Estimate stream channel bedload sediment transport in a grazed watershed.
3. Test the utility of sediment traps for rapid cost-effective monitoring of sediment delivery to stream channels.
4. Extend the results of this information to community watershed groups, rangeland owners, range management professionals, and land management and regulatory agency staff.

The Rangeland Watershed Program (RWP) expects to develop a sediment budget for a grazed watershed. This project supports the addition of sediment budget components that were not previously being measured. The RWP was able to develop a grazed watershed research site beginning in 1993 with funding from the US Environmental Protection Agency (EPA). The primary objective of this three-state EPA-funded project (\$500,000) was to evaluate the effectiveness of range management practices for controlling or preventing grazing-induced sediment. The sediment budget components that have been measured since 1994 were funded by this EPA project. Funding from the Integrated Hardwood Range Management Program (\$200,000) will support continued measurement of these existing components through 2001, as well as development of new research watersheds at the Sierra Foothills Research and Extension Center.

### Summary

Sediment transport was significantly greater in the cattle trails than the vegetated areas in the rainfall years ending in 1997 and 1998. There was no significant difference in 1999. In 1997 and 1998 there was sufficient rainfall to generate measurable runoff and the intermittent streams began flowing in January of those two rainfall years. Rainfall in 1998-99 was low resulting in little runoff and no stream flow

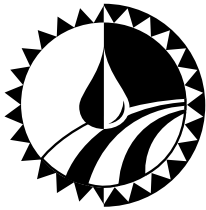
These sediment traps are easy to install and to clean on each sampling date with minimum error. By frequently checking and cleaning the traps we have reduced the losses due to overfilling. While cattle rarely damage one of the traps they do tend to walk around them establishing a new trail. Therefore, we must move the traps each year to keep them in active trails. The Alameda Resource Conservation District used our sediment traps as a model to build traps for use in measuring sediment from roads, trails and bare areas in the Alameda Creek watershed near Livermore.

Due to the low rainfall in the 1998-99 rainfall year, no bedload measurements were taken. In the 1997-98 rainfall year bedload was estimated from a series of storms at the end of January and during the first week of February. The means of three hourly samples were plotted against flow (cfs) to develop a linear model for predicting bedload from flow. Flow accounted for 79 percent of the variation in bedload. This study will be continued for at least one more year. The results will be added to the 1998-99 results to develop a bedload prediction equation for the research watershed at San Joaquin Experimental Range.

This study shows that cattle trails are an important conduit of sediment from the uplands to stream channels. Practices that reduce trailing across stream channels or provide ground cover along cattle trails immediately adjacent to stream channels will help to reduce this source of sediment from grazed watersheds. The bedload study requires additional data before it will be useful in addressing sediment sources.

The results of the trail and bedload studies have been used in 24 Ranch Water Quality Planning Short Courses since September 1997. During this short course various nonpoint sources of pollution associated with livestock grazing and ranching, including sediment, are covered with participating landowners. During these short courses more than 300 ranchers have completed water quality plans for nearly 1 million acres of privately owned rangeland. These plans follow the California Rangeland Water Quality Management Plan approved by the State Water Resources Control Board in 1995.

The complete report of this project is available on SAREP's Web page at:  
[www.sarep.ucdavis.edu/grants/Reports](http://www.sarep.ucdavis.edu/grants/Reports)



# UNIVERSITY OF CALIFORNIA

## Sustainable Agriculture Research and Education Program

Final Report

**Grant Award:**  
\$8,287

**Funding Period:**  
FY 1996–97

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## Do Soils Suppressive of Phylloxera Exist?

### Objectives

**Long-term:**

1. To develop a substantive hypothesis of the mechanisms of the vineyard soils which suppress phylloxera damage.
2. To determine vineyard management methods to make practical use of the knowledge of which soils suppress phylloxera to control damage.

**Short-term:**

1. To test the hypothesis that vineyard soils exist which are suppressive or tolerant of phylloxera growth in areas where the decline of the vineyard would be expected.
2. To determine whether suppressiveness is due to increased vine tolerance, inhibition of phylloxera population growth, or inhibition of secondary pathogen infection of wound sites.

### Summary

Root samples were taken from organically and conventionally managed phylloxera-infested vineyards in northern California. Roots infested with phylloxera from organically managed vineyards showed significantly less root rot (11.8%) than phylloxerated roots from conventionally managed vineyards (27.1%). Incidence of fungal rot was significantly correlated with phylloxera populations in conventionally managed vineyards, whereas it was not in organically managed vineyards. Fungal cultures of necrotic feeding sites on roots showed no differences in pathogen species composition, however, occurrence of the pathogen antagonist *Trichoderma* was more prevalent in the cultures from roots from organically managed vineyards.

The importance of “feeding the soil” with organic matter is underscored in this research. Organic matter is important not only in nutrient retention and release but in the regulation of microbial populations for optimal root health as well. Damage from phylloxera feeding is less severe in soils managed with high organic matter inputs, possibly due to the facilitation of growth of pathogen antagonist microbes such as *Trichoderma*. The decoupling of phylloxera numbers and root damage, possibly mediated by pathogen antagonists in the rhizosphere, may be a fruitful area of study in other crop/pest systems.

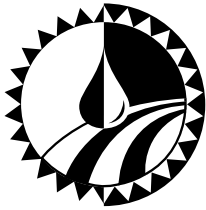
Phylloxera infested vineyards have a soil ecosystem that is characterized by continual wounding of perennial plant roots. This creates an ongoing and long term dynamic between 1) root pathogens, 2) pathogen antagonists, if present, 3) soil organic matter serving as a microbe energy and plant nutrient source, and 4) the plant.

Recently discovered susceptibility to phylloxera of current “resistant” rootstocks in Germany, the 5C rootstock in particular, lends urgency to the task of developing alternative strategies for phylloxera. While no major rootstock with 100 percent North American heritage has been shown to be susceptible to phylloxera damage in California despite extensive testing, there is no guarantee of rootstock invincibility. California may be at the stage of phylloxera infestation Germany was 40 years ago, with “resistant” rootstocks such as 5C beginning to show nodosities but lacking damage (Porten 1997). German vines have developed phylloxera damage in the last two decades on these rootstocks, which are currently being used as phylloxera-resistant replanting stock in California. However we should note that the climate in Germany favors midsummer nodosities which seem to be the cause of their damage, while these would not occur in California as readily. Some systems of replanting vineyards in California are optimal for selection for phylloxera virulence; if growers continue to replant into infested vineyards where infested roots intertwine with the newly planted roots, virulence may become more common.

The complete report of this project is available on SAREP’s Web page at:  
[www.sarep.ucdavis.edu/grants/Reports](http://www.sarep.ucdavis.edu/grants/Reports)

### Resources

Lotter, D.W., Granett, J., and Omer, A.P. 1999. Differences in Grape Phylloxera Relation, Grapevine Root Damage in Organic and Conventional Managed Vineyards in California. *Hort Science* 34:1108-1111.



# UNIVERSITY OF CALIFORNIA

## Sustainable Agriculture Research and Education Program

Final Report

**Grant Award:**

\$18,400

**Funding Period:**

FY 1996–98

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## Role of Soil Microbial Community in Suppression of Rhizoctonia Stem Rot of Cauliflower

### Objectives

1. To establish microbial community profiles or “signatures” of soils conducive or suppressive of Rhizoctonia stem rot/wirestem disease (RWS) in fields sites at the West Side Research and Extension Center, Fresno County.
2. To determine changes in the microbial community profiles associated with loss of RWS suppressiveness associated with mild heat treatments.
3. To construct microbiological media selective for microbes present in RWS suppressive soils but not in RWS conducive soils (natural soils and in those where suppressiveness is lost with mild heat treatments) for the isolation of these microbes and for measuring the quantitative and qualitative differences in individual microbes between suppressive and conducive soils.
4. To measure RWS in soils (sterilized soil, conducive soil, and potting mixes) amended with microbes most affected by mild heat treatment of Rhizoctonia suppressive soils.

### Summary

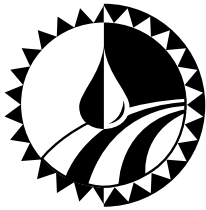
Soils from sample sites 100 feet apart in a field at the West Side Research and Extension Center (Fresno Co.) were consistently either suppressive (DS) or conducive (DC) to Rhizoctonia wirestem disease of cauliflower (RWS) in September 1996 and March and June 1997. Populations of general bacteria and fluorescent pseudomonads were similar in magnitude in the DS and DC soil samples in both September 1996 and March 1997 when the differences in suppressiveness were greatest between the two sites. Actinomycetes were up to eight-fold higher in the DS soil than in the DC soil. Microbial “metabolic fingerprints” of DS and DC soils were similar.

When seedlings of cauliflower were grown in transplant-plug trays, RWS was less severe when transplants grown in DS soil were planted into Rhizoctonia infested UC mix (very disease conducive) than transplants grown in DC or heat-treated DS soil. Protection against RWS by plug-transplants did not seem to be a consequence of physical interference with the pathogen.

The degree of disease suppressiveness of soil from the suppressive site declined progressively over the course of the year from September 1996 to September 1997. In September 1997 the soils were conducive at both sites. Disease suppressiveness was destroyed when soil was heated at 40° C or higher for an hour, which suggested that suppressiveness had a biological basis. When soil was washed from roots of plug-transplants, plants grown in DS soil were as susceptible to RWS as those grown in DC soil. This indicated that suppressiveness was protective rather than an enhancement of plant resistance to RWS. In support of this interpretation, we found that protection against RWS was lost when efficacious biological control agents isolated from DS soil were washed out of the UC mix plugs to which they had been applied.

Screening of a large number of isolates of actinomycetes from DS soils resulted in the recovery of a few isolates of *Streptomyces* species that protected cauliflower seedlings from RWS when seedlings had been grown in plug trays in UC mix drenched with inoculum of these microbes. In the plug-transplant system some commercial and locally formulated potting mixes suppressed RWS without amendment. Results of this work showed that the suppressiveness of certain soils to RWS is transferable to plug-transplants, that certain actinomycetes from DS soils can confer suppressiveness to RWS, and that potting mixes that are DS could offer a practical means of avoiding seedling diseases after transplanting into pathogen infested soils.

The complete report of this project is available on SAREP's Web page at:  
[www.sarep.ucdavis.edu/grants/Reports](http://www.sarep.ucdavis.edu/grants/Reports)



# UNIVERSITY OF CALIFORNIA

## Sustainable Agriculture Research and Education Program

Final Report

**Grant Award:**

\$8,880

**Funding Period:**

FY 1996–98

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## Evaluation of Cover Crop Mulches in No-till Processing Tomato Production Systems

### Objective

1. To evaluate the effectiveness of surface organic mulches in reduced-tillage processing tomato production systems for:

- a. suppressing weeds;
- b. improving production efficiencies in terms of nutrient inputs;
- c. providing optimal soil temperature regimes for crop growth; and
- d. conserving soil moisture.

### Summary

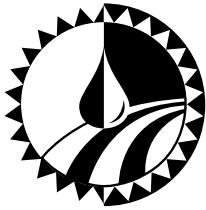
A two-year field study was conducted in Five Points, Calif., to evaluate and refine the potential of using surface organic mulches in no-till transplanted processing tomato production systems. The winter cover crops rye/vetch, triticale/vetch, Sava and Sephi medic were grown and converted to surface mulches and compared with conventional fallow production systems.

Preliminary findings of this work include:

1. Transplanting and harvesting processing tomatoes in surface cover crop mulches is feasible.
2. Cover crop mulches may actually contribute more favorably to annual water balances than previously thought. Soil water content (0 to 9 feet depth) was generally higher under cover crop mulches from May through August relative to conventional tillage bare surfaces.
3. Earthworm populations tended to be higher under cover crop mulch surfaces than under fallow surfaces at the beginning of the second year of the study.
4. Soil carbon content was increased by mulch surfaces relative to fallows.

Economic analyses comparing production costs between conservation tillage and conventional tillage systems are needed as are in-season, post-transplant weed control by appropriate bed shoulder cultivation or chemical materials to make conservation tillage production more farm-ready. These modifications are the focus of our ongoing 1999 studies at a number of sites.

The complete report of this project is available on SAREP's Web page at:  
[www.sarep.ucdavis.edu/grants/Reports](http://www.sarep.ucdavis.edu/grants/Reports)



# UNIVERSITY OF CALIFORNIA

## Sustainable Agriculture Research and Education Program

Final Report

**Grant Award:**  
\$15,000

**Funding Period:**  
FY 1996–97

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## FARMS (Farming, Agriculture and Resource Management for Sustainability)

### Objectives

1. Provide an opportunity for a diverse group of high school students, teachers, college faculty and farmers and ranchers to work together. Participants will learn about proven agricultural practices and technologies through farm demonstrations, best management practices through experiments and research, and the relationships among soil, water, food and the environment through observation and experience. An advisory committee will establish guidelines and select students for the project.
2. Provide participating FARMS teachers and students with California Foundation for Agriculture in the Classroom lesson plans to provide in-class training and interdepartmental information programs to teach every teacher and student in participating schools about sustainable agricultural practices.
3. Encourage participants, over the course of one school year, to work with their teachers, local agriculturalists and mentors from UC Davis to develop and conduct research projects related to progressive agricultural practices. This project will be presented both in writing and orally to the FARMS committee, related businesses, local growers, and the students' peers.
4. Conduct farm workshops throughout the year where students learn by seeing and doing first-hand. An overnight stay with a farm family culminates the students' exposure to a diminishing way of life and a changing culture.
5. Introduce students to a college campus and university faculty to help them learn about potential careers in agriculture and the environmental sciences. Motivate students to become responsible adults and challenge them to make a difference with their lives by continuing their education.
6. Develop an outreach model program that can be adopted in other areas of the state.
7. Conduct an evaluation of the FARMS program to ascertain changes in knowledge regarding sustainable practices and assess student interest in agriculture as a result of the FARMS program. In addition, local grower supporters, student and teacher participants and steering committee members will be surveyed to determine the effectiveness of the program.

### Summary

The 1996-97 and 1997-98 Farming, Agriculture and Resource Management for Sustainability (FARMS) programs effectively increased the skill level and appreciation for sustainable agricultural practices among the 60 high school participants (30 each year), 12 teachers and numerous farmers involved in the project. In addition, sustainable agriculture and science concepts were shared with more than 120 elementary school students through cross-age tutoring activities, and representatives from the Natural Resources Conservation Service (NRCS), Yolo County Resource Conservation District (RCD) and University of California interacted with students on a mentor-student basis.

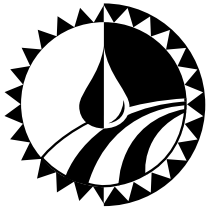
The 30 students from Winters, Florin, Armijo (Fairfield) and Terra Linda (San Rafael) high schools participated in five workshops and one evening introductory activity over the course of the 1996-97 school year. Thirty students from Davis, Luther Burbank, Winters, Armijo and Terra Linda high schools participated in seven workshops during the 1997-98 school year in addition to the evening introductory activity. In these workshops, students studied soil microbiology and soil characteristics and a variety of sustainable practices, including: use of raptors for rodent control, beneficial and detrimental insect identification, use of cover crops in orchard systems, use of earthworms for soil and organic matter modifications, and the use of native plants for beneficial insect habitats. Past participants have also studied the economics of organic, low-input and conventional farming systems.

Each student or team of students developed and conducted a research project relating to sustainable agricultural practices utilizing the expertise of the mentors from UC Cooperative Extension, Natural Resources Conservation Service, UC Davis and other organizations. These research projects were presented to their peers, teachers and mentors at the final FARMS event of the year.

A highlight for the 1996-97 FARMS students was the coordinated workshop with the Sustainable Agricultural Farming Systems (SAFS) staff at UC Davis. Through this workshop, high school students were able to observe and participate in on-going university research projects. This reinforced student interest in post-secondary education and further study of sustainable agricultural practices.

Through the 1996-97 FARMS program, 30 students received extensive experience in sustainable agricultural practices, reinforced their science skills and were introduced to a university environment. In addition, numerous elementary students were provided with information on the balance between agriculture and the environment and the conservation practices which are used in progressive farming systems. All objectives of the 1996-97 SAREP grant proposal for the FARMS program were completed. These objectives have also been met, or surpassed, during the first half of the 1997-98 FARMS program, which is partially funded through support from SAREP.

The complete report of this project is available on SAREP's Web page at:  
[www.sarep.ucdavis.edu/grants/Reports](http://www.sarep.ucdavis.edu/grants/Reports)



# UNIVERSITY OF CALIFORNIA

## Sustainable Agriculture Research and Education Program

Final Report

**Grant Award:**

\$27,100

**Funding Period:**

FY 1996–98

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## Environmental Fate and Characterization of Selenium Supplemented to Intensively Grazed Beef Cattle

### Objectives

1. Characterize the environmental fate of selenium (Se) supplemented to beef cattle and Se used to fertilize pastures on which beef cattle were intensively grazed.
2. Quantify Se concentrations in pasture soils and plants, comparing control and Se treatments in pastures.
3. Measure the nutritional Se status of the grazing cattle in the four treatment groups.
4. Measure the Se concentration in cattle excreta (feces and urine) at steady state, in the control and treatment groups.
5. Evaluate the Se uptake by plants from cattle excreta in a greenhouse experiment to estimate Se bioavailability.
6. Characterize the chemical species of Se in the excreta and water (water from pasture run-off) and to characterize the chemical species of Se in the soil-water-plant fractions collected in the greenhouse study.

All of the above objectives, which were listed in the original proposal, were accomplished except Objective 6. The amount of Se in the water leaving these pastures was below the method detection limit (2 micrograms/liter) in most specimens from the first series of samples, so valid comparisons of data were not possible and collections were discontinued. Also, attempts to speciate the various Se compounds in cattle excreta were not successful due to the organic matter matrix. Also, the Se concentration in the excreta of all groups was very low, which did not allow for characterizing these chemical species of Se in the greenhouse studies. Future research will need to focus on speciation of Se in these various organic materials, to further understand possible interactions.

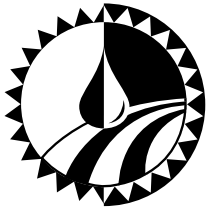
### Summary

Selenium deficiency is the number one cattle disease problem diagnosed by the University of California's Veterinary Diagnostic Laboratory. Three methods were used to supplement selenium (Se) to cattle in an intensive pasture grazing system: subcutaneous injection of a commercial Se product, Se fertilization of the pastures, and a rumen Se bolus. Selenium-deficient control animals were maintained in these studies.

The Se status of the cattle was significantly influenced by treatment, and control cattle remained Se deficient. The Se injection cattle showed a slight increase in Se status versus controls for one or two months before returning to control levels. The Se status of both the rumen bolus cattle and the Se fertilizer cattle was greatly increased above the control group. The Se rumen bolus group status was higher and more consistent than the Se fertilizer group. The Se status of the cattle in the Se fertilizer group was correlated with pasture Se concentration. There was no difference in the Se concentration of the excreta of the control group, injection group, and fertilizer group at the end of the 4 month periods (10 to 20 ppb); however, the bolus group had higher Se concentrations in the excreta (170 ppb). When the excreta was studied in the greenhouse experiments, there was no differences observed in the Se concentrations of the various plants species due to Se treatment of the cattle. This indicates that Se bioavailability in the feces and urine of cattle is not affected by Se supplementation methods and remains very low.

Two methods of Se supplementation for cattle look particularly promising from this study. The use of a rumen Se bolus and Se fertilization of pastures for grazing and perhaps forage production appear to be potentially beneficial in preventing Se deficiency. Selenium in the excreta of cattle is not biologically available according to our data and Se supplemented to cattle does not appear to accumulate in pastures or soils. These methods (Se bolus and Se fertilization) appear to be both safe and efficacious for the cattle as well as for the environment.

The complete report of this project is available on SAREP's Web page at:  
[www.sarep.ucdavis.edu/grants/Reports](http://www.sarep.ucdavis.edu/grants/Reports)



# UNIVERSITY OF CALIFORNIA

## Sustainable Agriculture Research and Education Program

Final Report

**Grant Award:**  
\$7,946

**Funding Period:**  
FY 1995–97

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## Assessing the Environmental Risk from Rangeland Cattle Shedding *Cryptosporidium parvum* in Their Feces

### Objectives

Determine if *C. parvum* oocysts excreted in the feces of livestock can survive ambient temperatures typical of California rangeland from spring through fall.

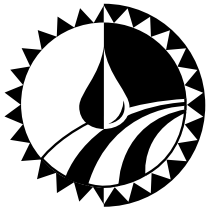
1. Acquire internal thermal profiles of fecal patties from April through September, stratified by location (exposed to sun or under a tree in the shade).
2. Determine the effect of diurnal temperature on the viability of *C. parvum* oocysts.

### Summary

This project's specific goal was to determine if temperatures occurring on California rangeland from spring through fall would inactivate (kill) bovine-derived oocysts (eggs) of the parasite, *Cryptosporidium parvum*. The project's two aims were to acquire thermal profiles of fecal patties from April through September, stratified by sunny or shady locations, and then determine the effect of these diurnal temperatures on the viability of *C. parvum* oocysts.

Sun-exposed manure commonly exceeded 50°C while shaded manure ranged from 40 to 50°C. The researchers found that one 24-hour cycle of a 40°C profile mimicking shaded manure resulted in an 18 to 22 percent loss of oocyst viability. One 24-hour cycle of a 50°C and 60°C profile for manure on open range resulted in 50 to 70 percent loss of viability. Four days of the 24-hour 40°C profile resulted in 82 percent loss of oocyst viability. Four days of the 24-hour 50°C profile resulted in a 95 percent loss of oocyst viability, or only 5 percent remaining viable. These data suggest that manure containing oocysts may serve as a source of infection for a few days, but that five days or more of 350°C will likely kill nearly all oocysts. The fecal deposits which accumulate underneath shade trees may, during summer thunderstorms, serve as a source of viable oocysts if the oaks are located near water and the oocysts are capable of traveling sufficiently far in overland or subsurface flow. Furthermore, shaded manure may serve as a source of infection for newborn calves.

The complete report of this project is available on SAREP's Web page at:  
[www.sarep.ucdavis.edu/grants/Reports](http://www.sarep.ucdavis.edu/grants/Reports)



# UNIVERSITY OF CALIFORNIA

## Sustainable Agriculture Research and Education Program

Final Report

**Funding Period:**  
FY 1995–97

**Grant Award:**  
\$16,250

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## Fostering Transition toward Balanced Predator/Prey Mite Populations in Vineyards Using Narrow Range Summer Oil

### Objectives

1. Evaluate effects of narrow range summer oil on predator/prey seasonal dynamics when applied on Pacific mite populations in outbreak phase.
2. Foster a transition from reliance on chemical miticides to a balanced predator mite/spider mite population.
3. Estimate yields and quality of harvested grapes for the different treatments.

### Summary

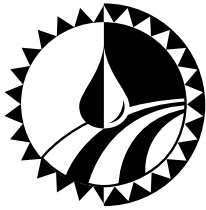
Spider mites are consistent and economically important arthropod pests of grapes in California. Two species of spider mites can reach pest status, Pacific mite (*Tetranychus pacificus* McGregor) and Willamette mite (*Eotetranychus willametti* [McGregor]). Dusty conditions and vine water stress, which are common in much of the raisin producing area of the central San Joaquin Valley, encourage mite outbreaks. Propargite (Omite) is most frequently applied because of its effectiveness on the Pacific mite and low toxicity to predatory arthropods, but has a 30-day re-entry period and is scheduled for cancellation due to the Delaney Clause. Narrow range summer oils have a very short re-entry period (12 hours) and resistance has never been reported.

This study was designed to test two factors simultaneously on the populations of Pacific mite and western predatory mite. These were 1) the maintenance of in-season vineyard ground cover and 2) the use of horticultural oil against Pacific mite. Two experiments were established in vineyards designed as a randomized complete block/split plot, with four replications. The main plot factor was the presence or absence of a cover crop and the subplot factor was the type of spray applied (1.5 percent narrow range oil, propargite, and a no spray control).

Results of the study suggest that oil has the potential to both exacerbate spider mite populations as well as be an effective miticide. In addition, for an increasing spider mite population, oil has a very short-lived effect. However, for a decreasing population, oil can accelerate the decline. Compare the two years of the study in which the oil/Omite treatments were applied, Jameson in 1996 and Easton in 1997. The treatments were applied at different points in the population growth cycle. In 1996, treatments were first applied when spider mites density was on the upswing. The oil treatment resulted in a decline in Pacific mite, but this was short lived (curiously, the control treatment declined at this point too, probably because of a cool, wet weather front that passed through at this time). Two weeks after treatment, mite density in the oil plots was higher than the control plots, and remained so until the second spray application three weeks later. At that point, Pacific mite density began to decline naturally, and the oil treatment had the effect of accelerating the decline. At the Easton site, the first and only oil treatment was applied relatively late in the season, also just before the natural decline of the Pacific mite population, and again, this had the effect of accelerating the decline. It appears, then, that for a rapidly increasing Pacific mite population, only about one to two weeks of control could be expected with oil. Therefore, in order to achieve the same amount of control compared to Omite, at least two, but more likely three to four oil sprays would be needed. The oil treatment did have the effect of preserving predator mites, but this had little practical value given the low predator/prey ratios at the critical Pacific mite buildup period.

Agroecological theory suggests that a cover crop will lesson the risk of a spider mite outbreak, but this effect was not seen in this study. The cover crop in this study had no effect on the buildup or final density of Pacific mite, nor did it affect vine growth and yield parameters.

The complete report of this project is available on SAREP's Web page at:  
[www.sarep.ucdavis.edu/grants/Reports](http://www.sarep.ucdavis.edu/grants/Reports)



# UNIVERSITY OF CALIFORNIA

## Sustainable Agriculture Research and Education Program

Final Report

**Grant Award:**

\$48,405

**Funding Period:**

FY 1995–98

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Tomato, pepper, specialty leafy  
greens and grape operations

## Alternative Postharvest Treatments for Decay and Insect Control

### Objectives

1. Demonstrate the effectiveness of heat treatments (hot water) for decay control on peppers and tomatoes in laboratory and commercial scale testing.
2. Demonstrate the dual-purpose treatment of high CO<sub>2</sub> atmospheres for control of *Botrytis* rot and insects in Thompson Seedless table grapes during storage or transport.
3. Demonstrate the effectiveness of short-term high CO<sub>2</sub> treatments at lower temperatures for control of insects on a diversity of leafy greens.
4. Demonstrate the effectiveness of the combination treatment of high CO<sub>2</sub> and heat for control of codling moth in Bartlett pears.

### Summary

Heat treatments have potential to provide an alternative control measure for postharvest decay. The researchers have developed a solid database of effective hot water treatment regimes for postharvest decay control on peppers and tomatoes. *Botrytis* is the main test organism. Based on decay control scores, heat injury scores and overall pepper quality, the following hot water treatments were potentially useful: 55°C (131°F) for four to six minutes, 58°C (136°F) for three to four minutes, and 60°C (140°F) for two minutes. These treatment regimes are similar to those found effective for decay control on mature-green and pink tomatoes. Firmness and color quality of pink tomatoes can be reduced by these treatments; heat-treated mature-green tomatoes ripened normally. These treatments can work well as batch treatments, but are not feasible for current continuous water flume systems. Short hot water dips are potentially useful for control of microorganisms on the surface of products used for minimal processing. These results were discussed in numerous meetings with vegetable industry members.

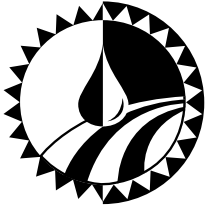
The effects under this project supported development of a 45 percent carbon dioxide treatment to control three pests of table grapes, western flower thrips, Pacific spider mite and omnivorous leafroller. Probit 9 mortality for the three pests was achieved within 13 days at 2°C. Grape quality studies indicated that tolerance to this treatment for ten days was excellent; however, quality after 15 days was slightly reduced due to berry softening and rachis browning. Sensory studies indicated no detrimental effect on consumer acceptability. The researchers also evaluated the effect of the 45 percent CO<sub>2</sub> atmosphere on *Botrytis cinerea*, the cause of gray mold of grapes. These results indicated that shipment under the 45 percent CO<sub>2</sub> quarantine atmosphere may allow for a reduction in the use of sulfur dioxide fumigation for decay control of grapes. Continued work on grape mealybug, another pest of grapes, indicates it is not controlled by the carbon dioxide treatment. A sulfur dioxide/carbon dioxide pre-treatment in combination with the 13-day carbon dioxide treatment showed promise for adults and crawlers; however, eggs appear more difficult to kill. Additional work is needed before a workable treatment is developed for grapes; however, these treatments may have application for other commodities.

The researchers used various carbon dioxide concentrations, combination atmosphere treatments, heat treatments and storage periods to control Western flower thrips and Green peach aphids, common insects occurring on a wide range of green vegetables. The researchers tested the tolerance of asparagus, broccoli, celery, a wide range of specialty salad greens, and iceberg lettuce to some of the potentially useful treatment combinations. In the current protocols, insects are allowed a 24-hour recovery period at 20°C (68°F). Effective treatment periods of 36 to 48 hours at 0° to 5°C (32 to 41°F) are required for complete kill with 93 to 100 percent CO<sub>2</sub> atmospheres. Some green vegetables will tolerate exposures up to 24 hours, but lettuce did not tolerate more than eight hours. An eight-hour exposure weakened the insects and substantially increased mortality levels, but must be followed by some other control measure. Another interesting alternative treatment the research documented was a

short-term "shock" treatment (none or extremely low O<sub>2</sub> at ambient temperature) followed by low temperature storage; high mortality rates were observed. Depending on temperature, lettuce can tolerate periods of 24 to 72 hours under nitrogen without a decrease in storage quality. We also evaluated short-term high CO<sub>2</sub> treatments at 42°C (136°F) since higher temperatures increase the efficacy of the insecticidal atmospheres; broccoli and celery, but not lettuce, tolerated two hours under these conditions.

A high temperature (46°C [115°F]) controlled atmosphere (1% O<sub>2</sub> /15% CO<sub>2</sub>) treatment was tested for two years on Bartlett pears for control of codling moth. In both years, the treatments slowed the rate of fruit ripening, even after several weeks in cold storage. This could be considered a benefit for exported fruit that are often marketed without cold storage. The rate of fruit heating appeared to influence the effect of the treatment, with the more rapid rate of heating having a bigger influence on the rate of fruit ripening (1996 work). Additional testing is necessary to test this theory. Nevertheless, this appears to be a promising quarantine treatment for pears.

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[www.sarep.ucdavis.edu/grants/Reports](http://www.sarep.ucdavis.edu/grants/Reports)



# UNIVERSITY OF CALIFORNIA

## Sustainable Agriculture Research and Education Program

Final Report

**Grant Award:**  
\$10,919

**Funding Period:**  
FY 1995–97

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## History of Grazing on the Shasta-Trinity National Forest: Implications for the Future

### Objectives

The objective of this project is to reconstruct the history of grazing on the Shasta-Trinity National Forest, determine the cause for the tenfold reduction of grazing activity on it, and analyze the relationship between federal grazing policy as implemented at the allotment level and changes in the use and management of base properties. This information will provide valuable insight into causes of land use change over the last 100 years. The information developed from this study could be used to demonstrate how reduction in livestock grazing on public land translates to private land use decisions. In addition to collecting information on animal numbers, the US Forest Service (USFS) has periodically collected vegetation information on some of its lands grazed by livestock.

### Summary

This project looked at the history of grazing on the Shasta-Trinity National Forest and impacts on related private land. The researchers looked specifically at: changes in animal numbers, season of use, and livestock management methods, range condition, and any communications between the Forest Service and the tenant related to resource quality or policy changes. Data sources included historic USFS documents, archival level research, and interviews of current and past grazing tenants, and was cross referenced with digitized maps of the area.

The information compiled from this study has helped explain how and why livestock grazing has changed on the Shasta-Trinity National Forest across time. The Shasta National Forest was reserved in 1905, the Trinity in 1906. The USFS began to limit grazing access in 1907 (on both forests). Early grazing permits specified the number, kind and class of stock grazed as well as season of use and grazing boundaries. Livestock grazing decreased on the Shasta-Trinity National Forest for a variety of reasons that included economics, vegetation management policy and land development.

**Economics.** The market value of livestock (wool, lamb and beef) was converted to real dollars and plotted. The value for all three commodities peaked in 1920 (just post WWI) correlating with peak grazing numbers on the forest. Numbers slid as the value of livestock decreased through the depression and picked up slightly during WWII. Since WWII the increasing value of livestock did not result in a corresponding increase on the number of livestock accessing forage on the Shasta-Trinity National Forest. Interviews with former permittees on the Shasta-Trinity National Forest stopped grazing the forest because it was no longer economical to do so.

**Vegetation Change.** Prior to being reserved, many stockmen on the forest had used fire to limit brush. When the USFS began managing the forest, they enacted a no burn policy. One permittee (Stillwater Land and Cattle) eventually lost their grazing permit for failing to comply with this policy. Consider this telegram from a district ranger in Mt. Shasta to his superior in San Francisco (Dec. 22, 1917):

*Forty-seven fires set by stockmen now burning Squaw Creek district doing little damage at present. Some circumstantial but no direct evidence. All local stockman favor burning results on public sentiment bad will spend no money fighting fires but something must be done about whole situation. See previous correspondence Stillwater Land and Cattle Company. Present circumstances similar. Can you suggest anything?*

The USFS was managing for timber early in their tenure. The Summary of Grazing Condition on the Trinity National Forest (1910) notes:

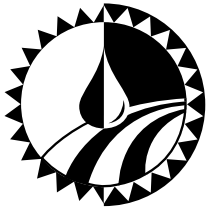
*The grazing areas on the Trinity are gradually coming to a timber growth and in some situations very rapidly. This is more noticeable at from 3,000-5,000 foot altitudes. At lower elevations on south and west slopes the young pines are, in a great many places, filling up the thinly wooded slopes. At higher elevations, the brush ranges remain about the same, as the timber seems to encroach on these areas very slowly. The forage crop throughout the Forest is improving but grazing land is on the decrease.*

**Land Development.** Landscape level changes have occurred over the last 90 years. Shasta and Trinity dams were built, lumbering increased, wilderness designated and development of an extensive road system has been developed. Lands that once served as base property for ranches dependent upon public land for grazing have been subdivided. The impact of this development is difficult to establish. At least five ranches dependent upon public forage were flooded with the construction of Trinity Dam (1962). Our data did not indicate a large percentage reduction in grazing on the forest.

## **Conclusion**

It is clear livestock grazing pressure has decreased nearly 20 fold since the lands of the Shasta-Trinity National Forest were removed from the public domain. When management of these lands fell to the USFS, they began to actively manage these lands with the best information available. Clearly, reduction in season of use and limited access to the forage on the forest, management toward timber (and away from grazing) and no-burn policy all contributed to reduced forage harvest on the forest. When past permittees were interviewed, the majority recognized changes in vegetation made it difficult (if not impossible) for the forest to carry as much stock as it did historically. Most permittees also cited personal circumstances and the economic of the livestock industry as reasons for giving up grazing on public lands.

The complete report of this project is available on SAREP's Web page at:  
[www.sarep.ucdavis.edu/grants/Reports](http://www.sarep.ucdavis.edu/grants/Reports)



# UNIVERSITY OF CALIFORNIA

## Sustainable Agriculture Research and Education Program

Final Report

### Grant Award:

\$48,500

### Funding Period:

FY 1995–98

### Principal Investigators:

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## Controlled Grazing on Foothill Rangelands

### Objectives

The goals of the Sustainable Ranching Research and Education Project are:

1. Develop, demonstrate, and extend research-based management strategies to optimize economic and environmental sustainability of ranching.
2. Develop a facility to foster controlled grazing and sustainable livestock production research and education.

These goals are supported by the following objectives: a) Demonstrate controlled grazing on foothill range/annual grassland and irrigated pasture; b) Demonstrate monitoring procedures to assess range condition and trend and livestock performance; c) Teach research-based controlled grazing practices to livestock producers; d) Compare the effects of controlled grazing to conventional grazing management in livestock production and economic performance; e) Compare the effects of controlled grazing to grazing exclusion and conventional grazing management on plant communities; f) Determine the effects of controlled grazing on trace mineral nutrition of cattle; g) Determine the effects of controlled grazing on parasitization of cattle.

### Summary

The project developed a 250-acre watershed into 23 rangeland and two irrigated pasture paddocks. Water was developed to every paddock using both permanent and portable water points. Innovative technologies were demonstrated fencing, water development, and pumping. Grazing planning was used to ensure rest periods of 30 to 45 days during fast growth and 90 to 120 days during slow growth. The project herd of fall calving cows was established. Calving season was switched to spring to match the animal's greatest demand with nature's largest supply, eliminating the need to purchase costly energy off the farm (hay) and feed to the animals. Forage samples were collected on a monthly basis for the purpose of developing a supplement that made up for all deficiencies except for energy—which would come from the land.

Three years of data show that it is possible, and may be more profitable, to eliminate hay feeding from a year 'round cow/calf operation on California's annual rangeland. To eliminate hay feeding, however, ranches must be restructured so the cow's production cycle matches the forage cycle. Although more research is needed before specific management recommendations can be made, there are a number of significant findings that can be used to improve or refine current management systems:

1. Cows can be bred during the heat of the summer. The project had 100 percent conception rates on cows during the two years they calved in the spring (1998 and 1999, breeding in July).
2. The calving interval between spring calving cows of 1998 and 1999 was 357 days. (The usual average is more than one year.) Calving season (when calves are born) lasted 42 days in 1998 and 19 days in 1999. The shorter the calving season, the more uniform the calves and the easier the management. Calving seasons were short because cows were in adequate body condition with BCS at 7.9 in 1998 and 6.6 in 1999. The single most important indicator for a cow is adequate body condition at calving which shortens the postpartum period and increases the potential success of getting cows re-bred quickly.
3. Heifers (young breeding female under age three) had an 80 percent conception rate and calved at BCS 4.7. The combined demands of growth, gestation, and lactation typically make it challenging to get heifers in adequate body condition.
4. Fall calving cows were used in the project's first year; the transition was then made to spring calvers. Comparing the calf weights of fall- and spring-born calves at similar ages revealed a 53-pound advantage for six-month-old fall calves. By 11 months of age, there was no difference. This suggests the need for a stocker phase (an intermediary stage after weaning and before entering the feedlot) for spring-born calves.

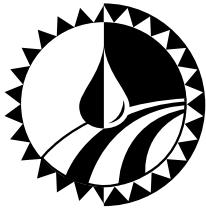
5. Keeping cows and calves together for as long as possible improved weight gain on the calves. Calves weaned at six months of age were 30 pounds lighter at selling than calves weaned at nine months of age. Body condition was the indicator for weaning. Cows with calves were weaned when cows reached a BCS 5; they must be weaned one to two months before they calve again, even if their body condition is adequate.
6. Cows were weighed and body condition scored on a monthly basis. It is possible for cows to use their body condition (stored fat) as an energy source during times when feed quantity is low, as long as an adequate feed period occurs prior to calving to allow them to gain back the condition they lost.
7. Forage samples were taken on a monthly basis for 36 months. Two mineral supplements were formulated based on the results: one for the green season and one for the dry season. The dry season supplement contained urea to make up for forage protein deficiencies in late summer and fall. The mix was primarily salt with trace minerals and urea and was fed in a loose form.
8. Crude protein reached a peak of over 20 percent in late winter and declined to less than six percent by August. This continued to decline to less than four percent in October.
9. Forage energy (mega-calories) levels peaked in February/March and declined 40 percent by mid-summer.
10. The projected gross margin per cow for calves born in 1999 was \$214 or \$18.82 per acre.
11. No mastitis or other udder problems were encountered. Calves did not have pneumonia. Eye problems were typical for the area; most were caused by seedheads penetrating the eye.

The complete report of this project is available on SAREP's Web page at:  
[www.sarep.ucdavis.edu/grants/Reports](http://www.sarep.ucdavis.edu/grants/Reports)

## **Resources**

A project Web site was established and includes several dozen papers on grazing, ecology, nutrition, fencing, and low-stress livestock handling. It also includes information about project events and links to other useful Web sites. The address for the Web site is <http://www.foothill.net/~ringram>.

Four audio-tape programs were developed to provide follow-up support for Grazing Academy alumni and to introduce other ranchers to controlled grazing principles. Each set of tapes includes a small workbook. Information about purchasing these tapes is available at the project Web site or by calling the principal investigator.



# UNIVERSITY OF CALIFORNIA

## Sustainable Agriculture Research and Education Program

Final Report

### Ecology of a Group of Generalist Predators, the Green Lacewings, and their Contribution to Biological Control in Almonds and Walnuts

**Grant Award:**

\$24,000

**Funding Period:**

FY 1995–98

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**Russell Lester,**

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### Objectives

1. To measure the seasonal patterns of abundance of green lacewings in almond and walnut orchards and quantify lacewing survivorship through egg, larval, and pupal stages.
2. To quantify the abundance of other dominant species of generalist predators in almond and walnut orchards.
3. To determine the diet of predatory green lacewings, including their rate of consumption of key almond and walnut pests, through detailed observations of foraging lacewings.

### Summary

Pesticide resistance evolution and the environmental costs of insecticide use are motivating almond and walnut growers to seek non-chemical methods of pest control. One such method is biological control, which uses predators and parasitoids to control insect and mite pests. The ecology of generalist predators is, however, very poorly understood, making it difficult to manipulate predators for pest control. This project's goal is to develop an understanding of the ecology of a key group of generalist predators, the green lacewings (family Chrysopidae).

This project studied predatory green lacewings and other key groups of generalist predators in six crops in Yolo and Solano counties: almonds, walnuts, grapes, tomatoes, alfalfa, and cotton. The researchers first addressed the question of whether lacewing populations occur naturally in agroecosystems at densities as high or higher than those recommended in augmentative releases. Lacewing egg populations were found to peak early in the season in grapes for 1996 only (reaching 11,000 per acre), alfalfa (reaching 58,800 per acre in 1996 and 72,000 per acre in 1997), almonds (reaching 23,000 per acre in 1996 and 36,000 per acre in 1997), and walnuts both years (reaching 7,000 and 19,000 per acre in 1996 and 1997, respectively). In cotton the highest numbers (26,000 per acre in 1996 and 51,000 per acre in 1997) were reached during the late summer. No lacewings were recorded in tomatoes in 1996 and densities were very low during 1997 (maximum density of 2,000 per acre). Lacewings occurred in crops despite the presence of very low densities of prey species (aphids, mites, and thrips). Variation in lacewing densities between crops, between sites within a crop, and seasonally underscore the importance of sampling fields before recommending augmentative releases; however, in many cases augmentative releases can produce meaningful increases in lacewing densities.

Lacewing survivorship through the egg stage, which can be attacked by parasitoids or predators, was generally high (approximately 60 to 80 percent). In contrast, only 30 percent of lacewings survived through the pupal stage, which was also attacked by parasitoids and predators. Other dominant predators included spiders, *Orius tristicolor*, predatory mites, and ants. Direct observations of foraging lacewing larvae showed that lacewings feed on mites and thrips in almonds, and also consumed extrafloral nectar. In walnuts, lacewings consumed aphids and mites.

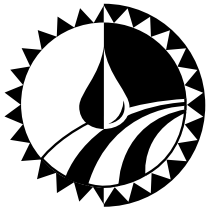
The complete report of this project is available on SAREP's Web page at:  
[www.sarep.ucdavis.edu/grants/Reports](http://www.sarep.ucdavis.edu/grants/Reports)

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# UNIVERSITY OF CALIFORNIA

## Sustainable Agriculture Research and Education Program

Final Report

**Grant Award:**

\$19,155

**Funding Period:**

FY 1994–97

**Principal Investigator:**

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## Suppression of Plant-Parasitic Nematodes in Conventional and Organic Farming Systems

### Objectives

1. To determine whether suppressiveness of soil to root-knot nematode differs in conventional and organic cropping systems.
2. To determine whether species and abundance of fungal enemies of plant-parasitic nematodes differ in conventional and organic cropping systems.

### Summary

Suppression of the root-knot nematode (*Meloidogyne javanica*) and numbers of nematode-trapping fungi were compared in conventionally- and organically managed plots in the Sustainable Agriculture Farming Systems (SAFS) Project at the University of California, Davis. Soil samples were collected three times per year for two years. Suppression of root-knot nematode by organisms was measured in the laboratory. There were three combinations of soil/nematode inoculation: natural soil with added *M. javanica*, natural soil without added *M. javanica*, and heat-treated soil. Soil was placed in containers; appropriate treatments were subjected to heat to kill natural enemies of nematodes. Fourteen days later, containers assigned to appropriate treatments were inoculated with known numbers of *M. javanica* (infective stage). After an additional 66 hours had elapsed, cabbage seedlings were introduced to the containers. An additional five days were allowed to elapse, at which time seedling roots were inspected and scored for incidence of *M. javanica* infection. Suppression was substantial, was not affected by management system, but was correlated with general microbial activity.

Numbers of species of nematode-trapping fungi were slightly but significantly greater in organically-managed plots. Two fungi, *Arthrobotrys dactyloides* and *Nematoctonus leiosporus*, were more abundant in organically-managed plots, whereas two others, *A. haptotyla* and *A. thaumasia*, were more abundant in conventionally-managed plots. Suppression of root-knot nematode was not correlated with numbers of nematode-trapping fungi.

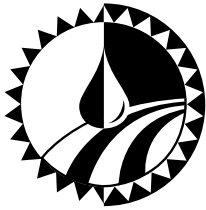
When formulated as hyphae in alginate pellets and added to field soil, *A. haptotyla* substantially suppressed the root-knot nematode but not the cyst nematode in pot experiments; suppression in pot experiments was associated with much greater fungus population densities than detected in the field.

The complete report of this project is available on SAREP's Web page at:  
[www.sarep.ucdavis.edu/grants/Reports](http://www.sarep.ucdavis.edu/grants/Reports)

### Resources

Jaffee, B.A., H. Ferris, and K.M. Scow. 1998. Nematode-trapping fungi in organic and conventional cropping systems. *Phytopathology* 88:344-350.

Jaffee, B. A. 1998. Susceptibility of a cyst and a root-knot nematode to three nematode-trapping fungi. *Fundamental and Applied Nematology* 21:695-703.



# UNIVERSITY OF CALIFORNIA

## Sustainable Agriculture Research and Education Program

Ten Year Progress Report

**Grant Award:**  
\$526,690

**Funding Period:**  
FY 1988–99

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## The Transition from Conventional to Low-Input or Organic Farming Systems: Soil Biology, Soil Chemistry, Soil Physics, Energy Utilization, Economics, and Risk

### Objectives

1. Over a 12-year period encompassing three, four-year rotation cycles, compare four farming systems with different levels of reliance on non-renewable resources with regard to:
  - a. Crop growth, yield, and quality as influenced by different pest management, agronomic and rotational schemes of the four farming systems.
  - b. Abundance and diversity of weed, pathogen, arthropod, and nematode populations and their impact on crop growth, yield, and quality.
  - c. Changes in soil biology, physics, chemistry, and water relations and their impact on soil quality and productivity.
  - d. Cost of production inputs, value of production, economic risk, energy budgets for agricultural production under the four farming systems.
2. Compare and evaluate existing and/or novel low-input and organic farming tactics, with emphasis on innovations that correct deficiencies, enhance profitability or decrease risk in each farming system.
3. Distribute and facilitate adoption of information generated by this project to all interested parties as it becomes available.

### Summary

The Sustainable Agriculture Farming Systems (SAFS) project was established to study the transition from conventional to low-input and organic practices. Treatments include three, four-year rotations under conventional (conv-4), low-input, and organic management and a conventionally-managed, two-year rotation (conv-2). Comparing 1996 values with base line data taken in 1988, the organic system showed a greater increase in selected soil fertility variables than the other systems. In 1996, the organic system, on average, had 91 percent greater soluble phosphorous (P), 21.5 percent greater soluble potassium (K), and 14.1 percent greater soil organic matter (SOM) than in 1988. Additional positive effects on soil quality resulting from low-input and organic management include higher microbial biomass and activity, increase in mobile humic acids, increased water infiltration rates, and soil water-holding capacity. Pesticide use in the low-input cropping system is less than 50 percent of that used in the conventional systems.

The most profitable farming system continues to be the conv-2 system due to the greater frequency of tomato in that rotation. Among the four-year rotations, the organic system with price premiums is the most profitable while the organic system without premiums is the least profitable. New research efforts are underway to quantify the contribution of cover crop nitrogen (N) to the following cash crop in the low-input and organic systems and to measure the impact of farming system management on soil biota and the associated effects on soil fertility and pest management.

Information generated from SAFS research has been disseminated through a video highlighting the project results, workshops, annual field days, field tours, educational materials, peer-reviewed articles, and an Internet homepage. The project was the host site for AgTech98, the annual UC Davis showcase of important research and technology. Interest in the findings of the SAFS project by farmers, industry, researchers, and the general public continues to increase, and the SAFS plots serve as a living laboratory for graduate and undergraduate students, and provide samples for a number of soil and agronomic courses on campus.

The complete report of this project is available on SAREP's Web page at:  
[www.sarep.ucdavis.edu/grants/Reports](http://www.sarep.ucdavis.edu/grants/Reports)

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