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The Farmer's Transition

In the last issue of **Sustainable Agriculture News**, we discussed agriculture's agenda, and the precarious position growers find themselves in. As a result of changing markets, legislation and other factors, many farmers are rethinking their production and marketing structures so they can move toward more environmentally safe practices. Some are changing their production systems because they see an expanding market or a niche for food produced in a different fashion. Others will respond as legislation or other forces beyond their control require them to change to stay in business. Eventually, most growers may be faced with very significant changes in their production systems. For some, change will be an opportunity- for others, it will create problems. We have a tendency to resist change because it moves us into unknown directions - but one way or another, change is upon agriculture, and many farmers will be involved in these changes.

What Are the Options?

So the question for many is: How do we continue to produce and stay in business? What are the options for you, as a farmer, as you face a transition? Many of the decisions regarding the transition to more environmentally sound farming practices will be business decisions. If you are going to change, consider the scale of the modifications in the next few years. You may make major changes on your farm all at once, or you can take a small parcel of land and make modest changes the first year and learn about the management and environmental problems on your particular site.

Business Risks

There are risks in all business decisions, so some of you may be more comfortable with small changes the first year, while others may take higher risks and make rapid changes in production systems. You must weigh marketing and legislative factors, your management skills and farming environment before you make a judgment that is appropriate for you. No matter what your decision, however, you would be wise to start moving in the direction of change as prudently as possible.

No one has all the answers to the production and marketing problems that you will face as your farming system changes. Therefore, it is important to start and learn from your experiences. Even if you only make changes on one acre, that experience will be invaluable in the coming years as the production system changes to meet different demands and needs. Each production system, each environment, each grower will have a different set of circumstances and problems.

Where to Start

Even though there is no way to set out a complete recipe for change in this column, some general guidelines can be shared.

Analyze your current market and production systems and identify the constraints. Take a look at the most limiting factors now and think about ways in which they might be addressed if some pesticides or other tools you use are eliminated. As a general rule, inputs cannot be removed from a conventional farming system without other changes being required. Not understanding that could lead to real problems. A total systems view of your production practices must be taken. It may mean changing some production practices very significantly, or it may just mean some minor adjustments. Your first attempt at managing pesticide or fertilizer inputs might be to strictly monitor fields and gradually reduce the inputs. You might try changes in two or three different ways, in small areas, so that you can see how different management strategies work in your environment.

The main decision for you to make is to *begin* the process on your own operation. The details of what you do may not be as important in getting started. If major legislative changes take place in the next two or three years which enormously restrict your use of chemical inputs, a year or two head start on even a small part of your acreage will be very important.

What a farmer needs now is an early and flexible start on transition planning, and the ability to learn from each year's experience. If you are a farmer, you will be helping *yourself* by planning ahead. You will be setting your own agenda. - **Bill Liebhardt**, *director, UC Sustainable Agriculture Research & Education Program*

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Sustainable Agriculture Symposium March 15, 1990

Mark your calendars for the March 15-16 sustainable agriculture symposium sponsored by UC SAREP at the Sacramento Hilton.

Sustainable Agriculture in California: A Research Symposium will feature research reports funded by SAREP in the last three years, but all researchers involved in sustainable agriculture are invited to present posters and published abstracts of their work. For information on presenting a poster contact **Dave Chaney** at (916) 752-8667. For registration information contact **Dennis Pendleton** at University Extension, UC Davis, (916) 757-8899.

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New Cover Crops Bulletin

The first revision of the University of California bulletin on cover crops in 38 years is now available through the UC Division of Agriculture and Natural Resources. *Covercrops for California Agriculture* shows growers how to enhance the productivity of their land while reducing the need for synthetic fertilizers.

The 24-page bulletin outlines the benefits and costs of using cover crops, how to select appropriate cover crops for different commodities and how to manage cover crops. **Rick Miller**, a UC Davis postgraduate agronomy researcher and one of the publication's primary authors, said the bulletin can be "an important resource for farmers who want to establish a broader, more integrated method of production."

Order the bulletin by title and number (21471) from ANR Publications, Dept. NR, University of California, 6701 San Pablo Avenue, Oakland, CA 94608-1239. Enclose a check payable to UC Regents for $3.50, which includes postage, tax and handling. Call (415) 642-2431 to place orders using VISA or MasterCard

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LISA Funds California

California fared well in the second round of competitive grants funded by the USDA's new Low-Input Sustainable Agriculture (LISA) Program. **Bill Liebhardt** and **Jill Auburn** of UC SAREP, UC Davis extension weed ecologist **Tom Lanini**, and Oregon State University's **Alan Cooper** received $90,000 to develop information on cover crops. Funds will be used for regional meetings, databases, publications, and videotapes.

Ron Voss, director of UC's Small Farm Program and a UC Davis vegetable crops extension specialist, is heading a five-state project with more than a dozen investigators. The project received $112,000 to collect and disseminate information on a range of topics including farm diversification, specialty crops, marketing, sustainable organic practices, and education methods.

A farming systems comparison study involving a team of UC Davis researchers was awarded $174,311. The project is comparing conventional, low-input and organic systems and is headed by entomologists **Ted Wilson** and **Mike Hoffman**, and agronomist **Steve Temple**. (For more information on the project see **Sustainable Agriculture News**, volume 2, no.1, page 6.)

A comparison of low and high-input vegetable production systems in California, awarded $215,300 in LISA funds in 1988 for two years, is well underway. Fourteen farms growing fresh-market tomatoes in Yolo, Sutter, and Sacramento counties are being intensively monitored for their soil, plant, water, pathology, and insect effects by **Laurie Drinkwater** and **Carol Shennan** of UC Davis' vegetable crops department, UC Davis plant pathologist **Ariena van Bruggen**, UC Santa Cruz ecologist **Deborah Letourneau**, and **Phil LeVeen**, an independent economist.

Projects funded in other states in the Western Region are also of interest to California producers. **Nancy CalIan** and **Don Mathre** of Montana State University received a grant to study an alternative to chemical control of "damping-off," a seedling disease in vegetables. In their initial trials, seeds coated with a particular strain of *Pseudomonas* bacteria provided equal or better control of damping-off than did chemical treatment when seeds were planted into cold soil.

Linda Hardesty at Washington State University is joining a commercial grower in studying a "silvopastoral" system in which sheep graze in a fruit orchard.

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SAREP Expands

The UC SAREP staff increased by four this fall with the addition of a second writer, a cover crops analyst, a perennial cropping systems analyst and an administrative assistant.

Gail Feenstra, who has a doctorate in nutrition education from Columbia University is a new half-time program writer. She has worked in sustainable food and agriculture research for eight years.

Robert Bugg joined the staff as a cover crops analyst and writer. He came to SAREP from the University of Georgia where he was a post-doctoral fellow and a research associate. His research specialty is the role of cover crops in soil fertility. Bugg has a Ph.D. in entomology from UC Davis and has worked in sustainable agriculture systems for ten years. His position is funded by the USDA's Low-Input Sustainable Agriculture (LISA) Program.

Chuck Ingels is the perennial cropping systems analyst and writer. He has a master's degree in pomology from UC Davis, where he worked in the walnut improvement program. He has done research on brown rot control and plum salt tolerance at the Kearney Agricultural Center in Parlier.

Pam Palaima is the program's new three-quarter-time administrative assistant. She has worked at UC Davis for seven years, most recently in the botany department.

These new staff members join **Bill Liebhardt**, SAREP director; *Jill Auburn*, information systems manager; **Dave Chaney**, annual cropping systems analyst and writer; **Lyra Halprin**, half-time program writer and editor of Sustainable Agriculture News; **Ray Wennig**, half-time staff research associate for field work; **Barbara Wetzel**, half-time program information assistant and publications coordinator; and **Robert Zomer**, one-quarter-time staff researcher.

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Water Board Funds Cover Crops

UC SAREP received a $25,000 contract from the State of California Water Resources Control Board for work demonstrating the role of cover crops in improving water quality. In the next 16 months, SAREP staff members will develop a manual based on the program's rapidly expanding database of cover crop characteristics. Information gathered from two demonstration projects in the Central Valley will also be included in the manual, which is receiving additional funding from a USDA Low-Input Sustainable Agriculture (LISA) Program grant (see LISA, page 2.)

Terry Prichard, a UC Davis water management extension specialist, and **Lonnie Hendricks**, a Merced County farm advisor are coordinating a demonstration project comparing different grasses in an almond orchard for their ability to improve water infiltration and reduce the need for herbicides. Tulare County farm advisors **Neil O'Connell** and **Michelle LeStrange** and Extension Specialist **John Pehrson** are examining winter legumes for their ability to provide nutrients and other benefits to a block of organically managed citrus.

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Free Ag Hotline

SAREP's **Jill Auburn** participated in a September 1989 two-day review of Appropriate Technology Transfer for Rural America (ATTRA), a toll-free hotline (800-346-9140) sponsored by the USDA Extension Service and operated by the National Center for Appropriate Technology. Ten reviewers from throughout the U.S. worked to clarify ATTRA's role as it relates to local Cooperative Extension. ATTRA specialists answer telephone inquiries from individuals throughout the country and respond with individually tailored letters, plus related articles and contacts for further information. Unlike Cooperative Extension, ATTRA does not give immediate recommendations for solving a particular problem.

ATTRA is a resource for specialists, farm advisors and farmers, who want more background on a topic. The review group agreed that extension personnel should be encouraged to call ATTRA if they are looking for information in sustainable agriculture. Reviewers offered to be conduits through which ATTRA could periodically update Cooperative Extension personnel on the kinds of questions received from each state, and the information provided by ATTRA in response.

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Beneficials Pamphlet

A recent update of the California Department of Food and Agriculture's pamphlet *1989 Suppliers of Beneficial Organisms in North America*, lists 60 companies selling predatory mites, fly parasites, parasitic nematodes, or other biocontrol organisms. Addresses, telephones, type of business (mail order, phone order, retail, or wholesale) and availability of literature and consulting are noted.

Written by **Larry G. Bezark**, the 12-page pamphlet is dedicated to the 100th anniversary of the release of the Vedalia beetle for controlling cottony cushion scale in California citrus. Copies are free from Biological Control Services Program, 3288 Meadowview Road, Sacramento, CA 95832, (916) 427-4590.

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500 Attend Low-Input Grape Meetings

The success of a December 1988 reduced input grape meeting in Visalia prompted the presentation of three similar meetings in the fall of 1989. Each program was sponsored in part by UC Cooperative Extension and the UC SAREP. The October 24 meeting at Kearney Agricultural Center in Parlier, moderated by **Bob Sheesley**, Fresno County Cooperative Extension director, was attended by approximately 250 people. The meeting in Stockton on November 7, co-sponsored by the UC Statewide IPM Project and the Lodi District Grape Growers, was led by Stanislaus County Farm Advisor **Kathy Kelley** and drew about 90 people. The November 14 Santa Rosa meeting was co-sponsored by University Extension and moderated by **Jim Wolpert**, viticulture extension specialist at UC Davis and was attended by 190 people.

New Vineyard Considerations

Most of the presentations addressed practices which can reduce chemical inputs in *existing* vineyards. **Paul Verdegaal**, San Joaquin County viticulture advisor, and Jim Wolpert, however, discussed the importance of site and variety considerations in the *initial establishment* of a vineyard, and how their careful consideration can lead to reduced inputs later. Verdegaal spoke at the Stockton meeting, while Wolpert spoke at the Santa Rosa meeting. They identified three site characteristics which influence pest management strategies: soil type and depth, previous crop history, and location. Grape variety choices will in most cases be determined by overall market demand and/or buyer needs. When a choice exists, however, the use of certain varieties can mitigate potential insect, disease and nutritional problems, they said.

Nutrition, Vine Management

"The key to vine management is to adequately fill the trellis system without creating excessive vigor," said **Pete Christensen**, extension viticulture specialist, at the Kearney and Stockton meetings. Christensen said the rate of nitrogen (N) applied should be adjusted to account for potential vigor. He noted that recent research has shown maximum N uptake is during late spring or summer, rather than in winter or early spring. Postharvest applications have been shown to provide high levels of stored N at dormancy, supplying the N needs of early spring growth. Split fertilizations at these times have resulted in nearly a 50% decrease in N applied per acre in the southern San Joaquin Valley due to the increased efficiency of uptake, he said. Cover crops can be used either to add N (legumes) when deficient, or to compete with vines during the summer to control excessive vine vigor, according to Christensen. For maximum N availability, the legume should be incorporated

in the spring just before it blooms, he said. Excessive vigor can be controlled by allowing a cover of Blando brome grass to mature (mowing before the frost period) and reseed. This practice will tie up N, delaying and extending its availability, he said. The use of a summer grass cover will also help control vigor due to increased competition for water and nutrients, and the cover will also reduce dust problems, Christensen said.

Soil, Water Management

Bill Liebhardt, SAREP director, reviewed the pros and cons of manures and composts at the Santa Rosa meeting. He discussed the process of organic matter decomposition. While both manures and composts improve soil tilth and add essential nutrients, nutrients in compost are more concentrated and are biologically more stable, he said.

Terry Prichard, water management extension specialist at UC Davis, discussed his research at the Santa Rosa meeting. His work in almonds showed that when a cover crop of Blando brome grass is mowed in the spring, the clippings protect the soil surface, impede moisture loss, and act as a mulch to prevent weed seed germination. A residual herbicide treatment also resulted in low water use, but increased soil compaction, he said.

Non-chemical weed control was UC Davis Extension Weed Specialist **Clyde Elmore's** topic at the Santa Rosa meeting. He said growers face two major weed management issues: *any* weeds in the vine rows of young vineyards, and *perennial* weeds in established vineyards. Elmore said various kinds of natural and synthetic mulches look promising, although some are very expensive. He said cover crops may out compete problem weeds with proper management, noting that Elka ryegrass has been shown to suppress 96% of other weeds.

Grape IPM

Bill Barnett, area Integrated Pest Management (IPM) advisor at Kearney, presented an overview of IPM principles in grape production at the Kearney meeting. He stressed the importance of cultural and biological control methods, but he said that chemical pesticides, with all their drawbacks, will continue to be a tool in pest management. He talked about the need to get off the "pesticide treadmill" by timing their applications to minimize the effect on non-target organisms, and by spot-treating problem areas which have been identified through extensive monitoring.

Leaf Removal

At the Kearney and Stockton meetings, **Jim Stapleton**, area IPM advisor in Stanislaus County, presented results from studies on wine grapes which indicated that selective leaf removal vastly reduces bunch rots, especially *Botrytis.* Stapleton recommended evaluating the effects of leaf removal on a small portion of acreage before using this technique on an entire vineyard. Mechanical leaf removal on wine grapes may become more cost effective and replace removal by hand, he said. **Jim Marois**, a plant pathology associate professor at UC Davis, continued the discussion of leaf removal at the Santa Rosa meeting. *Botrytis* stops growing beyond a certain "evaporation potential,"

and wind speed is the factor which most affects evaporation of moisture off grapes. The major effect of leaf removal is to keep grape clusters and the air surrounding them drier, which stops the spread of *Botrytis,* Marois noted. Cluster tightness is a more important factor in disease incidence than is individual berry susceptibility, he said. Further research may show that cluster manipulation may help prevent bunch rots, he said.

Kenneth Hagen, a UC Berkeley entomology professor, spoke about insect predators and explained how leaf removal for control of bunch rots reduces the number of leaves which predators and parasites have to cover in search of prey, increasing their effectiveness. He said predators may play a strong role in vineyards, and should be encouraged by pollen, nectar and habitats provided by cover crops.

Leafhoppers

Leafhopper management was discussed at all three meetings. "The grape and variegated leafhoppers are the most important pests of grapevines in the San Joaquin Valley," according to Tulare County Farm Advisor **Bill Peacock**, who spoke at the Kearney meeting. He said that vine vigor is essential to reduce leafhopper populations. The parasitic wasp, *Anagrus epos,* is an effective natural enemy of the grape leafhopper, but only about 30% control of variegated leafhoppers can be expected, he said. Peacock emphasized that it is important to avoid using chemical insecticides unless absolutely necessary, due to mites' increased resistance to them, and to the disruptive effect insecticides have on mite predators. This requires knowing both the economic level of leafhopper populations and the amount of egg parasitism, especially during the first brood, he said. Control of these first brood nymphs is important and can be done using soaps or summer oils; leaf removal has also been shown to be effective.

Bill Barnett discussed leafhopper management at the Stockton and Santa Rosa meetings. He said vineyards in the Stockton/Lodi area nearly always have *Anagrus* parasites due to the large number of riparian areas containing blackberry vines. Blackberries, as well as prunes and possibly almonds act as alternate hosts of the parasite during the winter. The variegated leafhopper, however, has recently moved into the northern San Joaquin Valley and is moving toward northern coastal areas. New *Anagrus* parasites from Mexico, Arizona and Colorado have been introduced into California in an attempt to provide increased biological control. Barnett also stressed that general predators, especially spiders, can be important in leafhopper control, and that cover crops will greatly increase the population of such predators.

Mites, Mealybugs

The management of mites, a pest which often flares up after insecticidal applications for leafhoppers, was addressed at the Kearney meeting by **Harry Andris**, Fresno County farm advisor. He said cultural considerations that help reduce mite damage include avoiding water stress to the vines, reducing dusty conditions, and providing a habitat for mite predators. Summer cover crops or a native weed cover provide such an habitat and are gaining in popularity.

Don Flaherty, entomology farm advisor in Tulare County, discussed mealybug management at the Kearney meeting. Mealybugs overwinter on old wood under loose bark and readily infest bunches which later touch the cordons (woody part of grape plant). Some growers are using arbors, allowing the clusters to hang free from old wood. If spraying must be done, spot-spraying can minimize damage to parasites, he noted.

Spray Oils

New approaches to pest control were addressed at the Kearney meeting by **Jack Dibble**, entomology specialist at Kearney. He said that narrow range spray oils that are effective against certain insect and mite pests of tree and vine crops, are inexpensive and very safe. Because the mode of action is through suffocation, thorough spray coverage is important, he said. Soaps are also quite safe and show effectiveness on mites and both species of leafhoppers, Dibble said. Vacuum machines have recently received attention and some growers have reported 40-50% control of leafhoppers, he added.

Nematodes

Mike McKenry, extension nematologist at Kearney Agricultural Center, talked about nematode management at the Stockton and Santa Rosa meetings. He noted that many commercial nematicides may soon become unavailable, and discussed alternatives including resistant rootstocks, more frequent irrigation, manuring, cover crops, and soil amendments. Each of these may have drawbacks and some are expensive, he said. Many plant extracts are toxic to nematodes, but have also been found to be toxic to plant roots, he said. Finally, while some cover crops have been found to restrict vine growth, McKenry said the following three winter covers seem to be compatible with grapevines and do not harbor nematodes: Cahaba white vetch, barley, and Blando brome grass.

The Stockton meeting also included a panel discussion with two local growers. **John Tecklenburg**, from Lodi, became frustrated with the excessive use of Furadan and the buildup of root knot nematodes in his farming operation. He explained how implementing IPM techniques helped him reduce mite buildup while improving his general farm management practices. **Joe Cotta**, whose family has been farming since 1966, noted that their operation started without a spray rig. He said they eventually joined most growers on the "pesticide treadmill." When problems arose with the use of the pesticide Metasystox-R (MSR) on grapes, they began to examine their farming techniques. They now successfully farm a portion of their vineyard with no chemical sprays.

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Improving Soil Quality in Annual Crops = Better Production

A group of 40 row and field crop farmers met with extension specialists at the Kearney Agricultural Center in Parlier November 28 to discuss current information on ecologically sound soil management for annual cropping systems. The theme was *Enhancing Soil Quality for Successful Production.*

Soil quality characteristics addressed at the workshop included: structure, tilth, soil-water relationships, weed management, and soil fertility. Highlights of the meeting follow.

Organic Matter

Tillage and crop residue management were highlighted in presentations by **Lloyd Elliott**, director of the USDA Cotton Research Station, Shafter and **Jim Rumsey**, assistant professor of agricultural engineering at UC Davis. Elliott emphasized the importance of increasing organic matter content and enhancing the activity of beneficial microorganisms that break down organic matter. He said they are the keys to improving water infiltration and nutrient cycling. High levels of soil organic matter have also been shown to improve the crop's ability to resist various pest problems, Elliot said. Two major factors may limit row and field crop production under higher organic matter levels: 1) the lack of environmentally sound weed control methods; and 2) the need for better equipment and implements that allow for planting into crop residues and a rougher seed bed.

Low-Till

Minimum tillage is a specific practice that has been show to enhance soil organic matter levels and soil tilth. Rumsey defined it as the minimum soil manipulation necessary for crop production or for meeting tillage requirements under the existing soil conditions. Some of the primary reasons farmers make use of minimum tillage include: 1) reducing runoff and soil erosion; 2) conserving soil moisture; and 3) saving money through reduction of energy and/or labor inputs in tillage. Rumsey said research on field corn and processing tomatoes at the UC Davis Student Experimental Farm is developing useful information for row crop farmers. The number of field operations were reduced from eight to two in field corn, and from eight to three in processing tomatoes. Some of the preliminary conclusions drawn from two years of data are shown in the following table. More information is required in order to assess the effects of minimum tillage on insects, diseases, and soil fertility, Rumsey said.

Generic comparison of tillage systems	

	Conventional Minimum	
Consideration	Tillage	Tillage
crop yield	best	close
crop quality	same	same
weed control	best	problem
stand establishment	best	problem
soil compaction	least	variable
water infiltration	OK	best
soil moisture	OK	best
labor	most	least
operating costs	most	least
capital requirement	most	less

Water-Soil Balance

Research has shown that irrigation practices must be adapted to the changing soil conditions as growers work to modify soil structure and improve infiltration rates. **Blaine Hanson**, a UC Davis extension irrigation specialist, presented some of the key principles in improving irrigation efficiency in annual cropping systems. Irrigation efficiency is defined as the beneficial use of water divided by the applied water. A high irrigation efficiency means that losses of water are minimal. The resulting benefits of high irrigation efficiencies include: 1) reduced water costs; 2) reduced pumping costs; 3) better retention of mobile plant nutrients within the root zone; and 4) protection of ground water supplies due to less deep percolation of chemicals through soil profile.

In practical terms, the key to high irrigation efficiencies is *uniformity* of water application, Hanson said. Uniformity refers to the evenness with which water is applied throughout a field. The uniformity of surface irrigation systems can be improved by: 1) reducing the length of the irrigation run; 2) adjusting the furrow inflow rate; 3) creating a smoother furrow surface for water to move along; and 4) implementing a surge flow program whereby the flow of water at a particular furrow is intermittent instead of continuous. Knowing application and infiltration rates for a particular field are essential for obtaining highest efficiencies. The best technology available to growers for determining appropriate application rates is to manually probe the soil to monitor what is happening in the soil profile, Hanson said.

The uniformity of sprinkler irrigation systems can be improved by: 1) maintaining uniform pressure throughout the sprinkler system; 2) repairing all leaks; 3) maintaining a uniform nozzle size; and 4) avoiding irrigation on windy days.

Subsurface Drip Irrigation

Larry Schwankl, a UC Davis extension irrigation specialist, discussed subsurface drip irrigation in row crop production. A summary of advantages and disadvantages follows.

Advantages. 1) Uniform water application when properly designed and maintained. 2) Reduced labor requirements compared to conventional surface irrigation system. 3) Increased efficiency of water and chemical use due to direct delivery to crop root zone. 4) Maintenance of a dry soil surface allows for access to field at all times and reduced weed growth. *5)* Irrigation effectiveness is not influenced by poor surface infiltration characteristics. 6) Documented yield increases for some crops and locations.

Disadvantages. 1) Installation and removal of buried drip systems can be both difficult and expensive (reported costs as high as $400/acre.) 2) Depending on water quality, proper maintenance and operation of a subsurface drip system may require sophisticated filtration systems plus chlorine and/or acid treatments to prevent clogging of drip lines. 3) Difficult to detect and repair leaks and clogging. 4) Subsurface drip systems require qualified and extensive management. *5)* Potential problems with germination and stand establishment for some crops. 6) Initially high capital costs ($1,000/acre or more depending on manufacturer) may prohibit use in some crops.

An economic assessment should also take into account the life of the lateral drip lines, usually about five to seven years. Most California growers, however, feel they would need to get back into the field within three to five years for deep ripping, Schwankl noted.

Weed Control

Weeds are one potentially limiting factor for growers making use of minimum tillage and other low-input practices to enhance soil quality. **Tom Lanini**, a UC Davis extension weed ecologist, presented several low-input and non-chemical options for vegetable crop growers. Lanini stressed the importance of balancing a number of weed control practices rather than relying on one single control method. General approaches should include cultivation, biological control, mulches of various kinds, and capitalizing on the crop's ability to compete, he said.

Living mulches block light, compete directly with weeds and may be allelopathic (suppress weeds with release of toxic substances) depending on the particular species used. Lanini summarized recently published work on subclover and other living mulches (see *California Agriculture,* November/December 1989).

Cultivation is probably the most widely used method of weed control, Lanini noted. It is possible to enhance the effectiveness of cultivation by scheduling cultivations according to the crop's ability to compete with problem weeds. Lanini said studies conducted over the past three years showed that field bindweed could be effectively controlled in processing tomatoes with two cultivations conducted at approximately three and six weeks from planting. A general rule of thumb for controlling annual weeds in vegetable crops is to insure two to ten weeks of weed-free conditions after crop emergence to obtain profitable yields, he said. The specific length of time depends on the rate of crop growth and the time of year. Lanini described the lengths of time for weed-free conditions required by several other vegetable crops. Times are shown below:

Crop	Required weed-free period
cucumber	2 - 4 weeks
bell pepper	8-10
lettuce	4 - 6
cauliflower	4 - 6

Soil Fertility

As growers look at alternative soil management strategies, some of the key questions they ask center on soil fertility: How can farmers maintain adequate levels of soil fertility? Are organic sources of nutrients sufficient to meet the nutrient needs of their specific crops? Are cover crops or green manures really feasible for individual farmers' production systems? Can an individual farmer maintain adequate fertility levels in his/her soil and not contaminate groundwater?

These were some of the questions addressed by three speakers at the workshop. **Stuart Pettygrove**, UC Davis extension soils specialist, presented important principles for using manure and compost. The cumulative effects of manure applications on soil properties include: 1) improved permeability; 2) resistance to compaction; 3) increased water holding capacity; and 4) decreased surface crusting. It is difficult to assign a dollar value to these particular benefits, Pettygrove said. Nutrient values are easier to assign, but there are a number of considerations that complicate the actual management of nutrients, particularly nitrogen. Pettygrove said the four compounding factors are: 1) the water content of the manure; 2) the actual nitrogen content of the material; 3) the nitrogen availability; and 4) the method of application. All these will ultimately influence the nitrogen contribution made by the manure, he said. Though the decay series (nitrogen release rates over time) is an important concept for manure management, it should not be regarded as an accurate management tool, Pettygrove said. The biological process of organic matter breakdown makes nitrogen rates too variable and unpredictable, he said. Tighter nutrient management can be achieved through the use of compost containing more stable nitrogen compounds available to the crop over time, he added.

Cover Crops

Growers heard **Rick Miller**, a UC Davis postgraduate agronomy researcher, discuss the use of cover crops in annual production systems. He talked about four years use of cover crops at the UC Davis Student Experimental Farm where he has been growing them in conjunction with field corn and processing tomatoes. Cover crop selection and management in annual cropping systems is described extensively by Miller in *Covercrops for California Agriculture*, published by the UC Division of Agriculture and Natural Resources (publication 21471, see **Cover Crops**, p.2 to order.)

UC Davis extension soils specialist **Roland Meyer** said sufficient levels of nitrogen can be supplied to crops while maintaining groundwater quality. Accomplishing this requires an approach to fertility management that combines: 1) knowing the amount of nitrogen removed in the harvested portion of the crop being grown; 2) an assessment of the nitrogen supply

capabilities of an individual farmer's soil; and 3) appropriate applications of fertilizer nitrogen where needed along with sound irrigation management practices.

Gabe Bethlenfalvay, a soil ecologist with the USDA-Agricultural Research Service in Albany, presented soil quality issues at a more technical level. Research by Bethlenfalvay and others shows the importance of beneficial soil fungi (mycorrhizae) in enhancing soil structure and improving nutrient and water transfer from the soil solution to the growing crop. Though the significance of mycorrhizae is well-known, there is still much to be done to improve them and their management in an agricultural setting, Bethlenfalvay said.

Allan Fulton, Kings County farm advisor, reminded the audience that information discussed at the workshop can be used to help solve specific San Joaquin Valley soil problems including clay pans, hard pans, saline soils, wind erosion, nutritional problems, water infiltration, perched (high) water tables, pathogens, and nematodes. Fulton said the challenge to San Joaquin Valley farmers and researchers is determining how to integrate different soil management practices, and understanding the ramifications of *any* changes to other aspects of a cropping system.

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Hopland Pasture Management Meeting

New developments in pasture management were presented to an overflow audience of ranchers at UC's Hopland Field Station October 21. The meeting was co-sponsored by Mendocino County Cooperative Extension and the Mendocino County Farm Bureau.

Improvements Save $

Sonoma County Farm Advisor **Stephanie Larson** demonstrated that "spending money to make money" by improving pasture through seeding, and fertilizing with phosphorus and possibly sulfur can be more cost-effective than buying hay.

Hopland agronomist **Milt Jones** emphasized the importance of using freshly inoculated seed when planting a legume such as a clover.

Controlled Grazing

Several presentations focused on controlled grazing, a management technique that limits the length of time fields are grazed, allowing time for pasture to recover. Conventional grazing methods allow animals to graze continuously throughout fields. Controlled grazing requires planning, flexibility, and a holistic view of the ranch, according to **Dave Pratt**, Napa and Solano counties farm advisor.

Milt Jones presented preliminary results from the first year of a study funded by UC SAREP at Hopland comparing controlled and continuous grazing. Pratt and Larson demonstrated training sheep to electric fencing.

Plant, Animal Pests

Mendocino County Farm Advisor **Glenn McGourty** reviewed the successes and failures in biological control of weeds. "Biocontrol will usually not eradicate weeds, but may keep them at low levels," he said. Other tools are usually still needed, he added.

Controlling vertebrate pests is a constant challenge, as described by Hopland Superintendent **Bob Timm**, who has experimented with several breeds of guard dogs in the last two years with wildly varying results.

Hopland is one of nine University of California agricultural field stations and centers located throughout the state. They include Deciduous Fruit Field Station in San Jose, Imperial Valley Agricultural Center in El Centro,

Kearney Agricultural Center in Parlier, Lindcove Field Station in Exeter, Sierra Foothill Range Field Station in Browns Valley, South Coast Field Station in Irvine, Tulelake Field Station in Tulelake, and West Side Field Station in Five Points.

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Cover Crops: The Sequel

Editor's note: *This article is a continued summary of the July 1989 cover crops meeting at UC Davis, sponsored by UC SAREP with funding from the USDA's Alternative Agricultural Opportunities program. The purpose of the meeting of 50 researchers, educators and growers was to stimulate interaction among people with both research and practical experience. Information presented at the meeting is being compiled by SAREP for publication. Similar meetings in other states within the western US are planned as part of a two-year grant from the USDA's Low-Input Sustainable Agriculture Program (LISA).*

Organic Field Crops

Dan Cohen, director of the California Organic Field Crops Association, stressed the importance of fieldscale trials to demonstrate soil-improving properties of cover crops. Farmers are seldom persuaded by trials that rely on small experimental plots, he said. Nitrogen cost is a significant concern to his growers, who farm a total of 500,000 acres. They are also interested in the development of rotational schemes that take into account nematodes and other pests, Cohen said.

High vs. Low-Input Vegetables

Laurie Drinkwater, a UC Davis vegetable crops department researcher, gave a preliminary report on an interdisciplinary study funded by LISA. Drinkwater, UC Davis Vegetable Crops Assistant Professor **Carol Shennan**, UC Davis Plant Pathology Assistant Professor **Ariena van Bruggen**, UC Santa Cruz ecologist **Deborah Letourneau**, and **Phil LeVeen**, an independent economist, are assessing soil, water, insect, cost, and yield parameters for fresh-market tomato production. The study is being conducted at 14 sites with one tomato variety and horticultural practices varying from organic to conventional. Three of the farms used cover crops in the past year.

Ecological Roots

Rob Klusen, a UC Santa Cruz agroecology graduate student, discussed the ecology of the root-zone and how it relates to nutrient cycling. When a root tip penetrates and fractures a soil aggregate (cluster of soil grains bound by organic matter), organic matter is exposed, fueling an explosion of soil bacteria, KIusen said. Amoebae in turn attack the bacteria and release nitrogen compounds that plants absorb, he said. As roots continue to grow, reaggregation of soil particles occurs due to polysaccharides coming from both the plant root and associated microbes, Klusen said. Organic matter encased by beneficial fungi (mycorrhizae) may be protected from decomposition until penetration by another root, he noted.

KIusen is collaborating with **Rick Knoll**, an organic farmer from Brentwood. The two are particularly interested in promoting root growth by having weeder geese graze cover crops. When shoot material is removed, plants invest more of their resources in root growth, Knoll said. The plan is to contrast soil dynamics in a grazed no-till cover crop versus a cover crop that is simply disked under, he said. Klusen and Knoll are also exploring the use of cover crops to encourage the growth of mycorrhizae which will colonize the roots of vegetable crops. The fungi will help improve nutrient-uptake efficiency, and reduce transplant shock.

Potassium Deficiency

Ken Cassman, an assistant professor in the UC Davis agronomy department, has been using barley and wheat as winter cover crops to enhance potassium (K) availability to cotton. Extensive areas of the San Joaquin Valley contain vermiculite in the soil, a mineral that absorbs great amounts of K added as fertilizer, making the K unavailable to cotton, Cassman said. There is some evidence that added organic matter is gradually improving the K-response of cotton at the field site, he noted. Humic acid, the largest component of stable humus in soil also appears to be important in maintaining K in a form available to plants, he said. Work in progress is attempting to define this mechanism, Cassman said. The limited window for cover-crop use (December to early March) means that cool-season grasses cannot contribute much biomass, Cassman said. Because of this, he plans to use composted animal manure to add organic matter, and contrast the cotton yields to those obtained with fertilizers having the same nutrient value. He expects plots with added manure to have higher yields of cotton.

Orchards Under Cover

Cover crops can reduce compaction, and improve infiltration and retention of water, but some covers may increase total water use in almond orchards, according to **Terry Prichard**, a UC Davis water management extension specialist. Prichard is evaluating different cover crops and management practices in one mature and one young almond orchard. The treatments were: 1) chemical mowing (partial suppression of cover crop by herbicide); 2) solid coverage residual herbicide; 3) uncontrolled resident weedy vegetation; 4) Blando brome grass planted as a cover crop; and 5) Salina strawberry clover planted as a cover crop. Chemically-mowed resident cover and Blando brome showed less water use and soil compaction, and with increased water infiltration. Both resident cover and Salina strawberry clover used more water, and solid coverage herbicide reduced water infiltration.

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New Advisory Group Focuses on Labor, Rural Issues

UC SAREP convened the first meeting of its Economic and Public Policy Advisory Group in Oakland October 26, 1989. The purpose of the group is to define a research and education agenda for economic and public policy issues as they affect the sustainability of California agriculture, provide a forum for discussion, and plan research and education programs.

The group is made up of University of California and California State University faculty, extension personnel, UC SAREP technical and public advisory committee members, and private agricultural consultants. The first meeting began with the identification of three areas in which economics and public policy have a significant impact on sustainability: 1) production practices, 2) labor, and 3) rural/community development. Three subgroups discussed these topics in greater detail and reconvened to hear presentations from each work group.

Presented here are abbreviated summaries from each of the three work groups.

Production Practices Group

Participants in this group included **Leslie "Bees" Butler**, UC Davis extension agricultural marketing economist; **Bob Cantisano, Fran DuBois, Bruce Jennings, Jack Pandol, Jr.** and **Steve Pavich**, UC SAREP Public Advisory Committee members; **Bill Liebhardt**, UC SAREP director; and **Rex Woods** of the university-wide Water Resources Center based at UC Riverside.

The group began by identifying guiding principles for production practices research. They concluded that this research should 1) focus on preventive practices vs. "curative ones"; 2) be more systems-oriented with a long-term focus; 3) be ecologically sound; and 4) include a focus on the way systems interact. The group suggested specific areas for research including soil building, weed control, pests/pathogens, breeding, non-tillage/minimum tillage, mechanical aids, biological controls, biotechnology, human and animal nutrition using alternative practices, composting and water use/quality. Members agreed that the next step is to identify economic and public policy research related to these practices.

Labor Group

Participants in the labor group included **Franz Kegel**, San Joaquin County farm advisor; **Robert Peyton**, UC Division of Agriculture and Natural

Resources analyst; **Howard Rosenberg**, UC Berkeley Agricultural Personnel Management Program extension specialist; **Kay**

Thomley, UC SAREP Public Advisory Committee member; **Suzanne Vaupel**, agricultural consultant; **Don Villarejo**, Institute for Rural Studies executive director; and **Jill Auburn** and **Gail Feenstra** of UC SAREP.

The group began by defining sustainable agriculture as "economically viable, ecologically sound, socially just and humane." Group members agreed to direct the attention of SAREP and the university to the needs of California's agricultural laborers. The group noted that agricultural labor conditions should meet accepted social standards for workers in other types of employment, and suggested new community education and research areas that would improve social and work conditions for agricultural laborers. These include: 1) research and education to achieve stable, year-round employment at a liveable wage; 2) improvement of the availability and affordability of housing; 3) improvement of information dissemination to workers and employers regarding worker rights, pesticide and workplace safety; and 4) the establishment of baseline data to determine residential conditions, and needs for community services.

The labor group's statement also included questions about how labor should interact with sustainable production systems, including: How much labor will be required? When and where is it needed? What mix of skills will be required? and, What are the preferences of the people who do and could supply this needed labor? Finally, the group noted that people involved in farm labor should have a voice in the political processes affecting them, as well as in setting priorities for agricultural research.

Rural Community Development

Participants in this group included **Isao Fujimoto**, UC Davis Department of Applied Behavioral Sciences rural communities researcher; **Stan Dundon, Tom Haller, Debra Jones**, and **George Work**, UC SAREP Public Advisory Committee members; **Desmond Jolly**, UC Davis agricultural economist, **Lynne Kennedy**, UC Agricultural Issues Center; **Jerry Moles**, agricultural consultant; **Ron Voss**, UC SAREP Technical Advisory Committee member; and **Barbara Wetzel**, UC SAREP.

The group began by looking at ways in which the University of California could assist rural residents and communities in achieving sustainability. They concluded that the most effective way of doing this may be to become involved in "action-oriented" research which enables communities to form their own institutions and policies.

Group members noted that rural community problems involve the economic and environmental deterioration of the land and its residents, characterized by a flow of resources away from the communities. This results in a loss of population and human resources. Research programs to address these problems must be defined by the communities themselves, group members concluded. Generally, the goal of these research programs is the attainment and preservation of a permanent quality of life which is high enough to cause people to stay in the community, and desirable enough to attract others to reside there. Criteria include permanent and equitable access to social,

intellectual, economic and spiritual resources; harmonious interaction with the environment; use of renewable energy; and the use of democratic planning and decision-making processes.

Group members noted that each community is unique and will define its own sustainable quality of life differently, and research conducted by outside groups will need to be somewhat non-traditional. The work group noted that action research is what rural communities need now, rather than traditional, publishable research aimed at peers. The group emphasized that action research has concrete change as its goal. This change is characterized by a long-term connection between the community and the assisting agency. The assisting agency might be a more typical research group *or* a teaching program, that would place students in observational relationships with communities, farmers and rural residents. An example of a research topic might be how new ethnic groups can be sustainably blended into rural communities.

The rural communities group ended its discussion by noting that the current university system presents difficulties for researchers doing action research because of strict publishing requirements, lack of acceptance of this less common research by colleagues, and the inadequacy of community-building inherent in the present methods of doing research.

The UC SAREP Economic and Public Policy Advisory Group will meet January 11 in Santa Cruz.

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Clover Cover Shows Promise in Orchard

A workshop demonstrating the conversion of grass and broadleaf weeds to clovers in a foothill orchard attracted 45 people November 11 to Penryn. The clover demonstration project in the Pilz' Hillcrest Orchards began in the spring of 1989 and is a cooperative effort between Hillcrest Orchards, UC Cooperative Extension and the California Energy Commission (CEC). The CEC provided a grant for the study in an effort to find ways to reduce dependence on fuel and synthetic fertilizers. The workshop was also co-sponsored by Placer Farm Supply.

Garth Veerkamp, Placer/Nevada counties farm advisor, and grower **Steve Pilz** planted a cover of white Dutch-O'Connor strawberry clover mix into the ten-acre hillside citrus orchard. It is still too early to determine if the clovers will provide the entire nitrogen needs of the orchard, according to Veerkamp. He said the literature indicates an annual nitrogen fixation rate of 30-200 lbs/acre for these clovers, and Pilz predicted it may be as much as 150 lbs/acre in this orchard. Summer soil samples in fact showed a sharp increase in nitrate-nitrogen, according to Veerkamp. However, he attributed this increase to the release of nitrogen from the stubble mowed off before planting, since perennial clovers require about 18 months before fixed nitrogen will be released. Mowing time has been reduced since the cover was planted, he said.

Planting Procedure

Veerkamp and Pilz said the procedure they used in converting the orchard floor to perennial clovers has included both successes and setbacks. In order to increase the pH of the soil, acidified by years of commercial nitrogen fertilizers, 25 tons of beet lime were added along with 5,000 pounds of 0-20-7 fertilizer to the 10 acre site. The orchard sod was sprayed with glyphosate in early April and mowed close to the ground two weeks later, according to Veerkamp. Pilz noted that while several methods of cultivation were attempted on the steep terrain, harrowing proved to be the most effective. In early May they sowed 150 pounds of the inoculated clover seed with a "belly grinder" (hand-seeder) and later ring-rolled the soil and sprinkled it every two days until it became established.

Veerkamp explained how the clovers could be planted from spring through fall with proper irrigation. The late spring planting was successful in part because the trees shaded the seedlings from heat damage, he said. He also advised using caution if seeding in the fall to allow about a month of growth, or until the clover has three true leaves, before the danger of frost.

In any case, "mowing is critical before seeding in order to maximize the light received by the clover," Veerkamp noted. He said there are no selective herbicides registered for bearing citrus, so the weeds must be mowed to the height of the clover as it grows. He said most weed seeds will not germinate through a thick stand of clover. Pilz estimates they should be able to reduce orchard mowings by four per year.

System Changes

Pilz and Veerkamp noted that their cover crop strategy didn't solve all their problems, and they are learning that an orchard is a dynamic system. Veerkamp said that introducing this new component, clover, has resulted in several other changes in the system including an initial increase in thrips and aphids on the trees after the sod died. Pilz noted that the use of cover crops is not a new idea; their goal is to see if this older strategy will fit current needs. He said their plan is one step in reducing the use of conventional energy for food production.

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Apple Transition Meeting

A one-day meeting in Watsonville November 17 presented growers with production and marketing information for making the transition to certified organic apple production. The meeting was sponsored by the Committee for Sustainable Agriculture, California Certified Organic Farmers (CCOF), Santa Cruz County Cooperative Extension, and the Agroecology Program of UC Santa Cruz.

Prevention

Steve Gliessman of the Agroecology Program began the morning with an overview of the transition process. "Organic tools for cleaning up problems don't work as well as conventional tools," he said, "so preventive measures are much more important." Establishing a cover crop to compete with weeds and to provide habitat for beneficial insects is one important preventive strategy.

Bob Cantisano of Organic Ag Advisers discussed soil fertility from non-synthetic sources. Organic matter is the key, he said, and earthworms are the physical evidence of a biologically active soil. Purchased organic materials may be useful during the transition (based on a tissue analysis), but after two or three years the most cost-effective system is to "grow your own" nutrients with a nitrogen-fixing cover crop, he said.

Richard Smith, San Benito County farm advisor, elaborated on the topic of cover crops. According to Smith, cover crop benefits include improved water infiltration, erosion and insect control, weed suppression, and nematode inhibition. Potential drawbacks include competition for water and nutrients, increased pests of some kinds (e.g. rodents, ants), difficulty of controlling noxious weeds, and increased frost risk, he said. Cereals provide good growth in cool weather, but residue may be a problem if they are not mowed or incorporated early. Properly inoculated legumes provide nitrogen and decompose quickly when turned under, but put on growth mainly in the warmer weather of spring, he added. Mustards put on rapid, early growth and are easily incorporated, but are not recommended for apples because they harbor orange tortrix (apple skinworm).

Insect Pests

Insects pests were discussed first by **Sean Swezey** of the Agroecology Program. He is comparing conventional and transitional management in replicated plots in a commercial orchard of Granny Smiths. The orchard is in its first year of transition. The Pajaro Valley study site has low codling moth pressure due to its cool, maritime climate, Swezey said. After one year, the conventional and transitional plots have approximately the same leaf area and

leaf and fruit damage from codling moth or other insects, he said. The organic plots had a somewhat heavier crop made up of a greater number of smaller apples, since chemical thinning was not used.

IPM Area Advisor **Carolyn Pickel** described control measures for several insect pests. Codling moth and apple scab are usually the worst pests in organic apple orchards, she said, while orange tortrix is often the biggest problem in conventional orchards. Monitoring is the key to codling moth control, so that treatment with a narrow-range oil can be timed exactly at egg laying, Pickel said. The Environmental Protection Agency will likely restrict the use of oil for air pollution reasons, however, so growers should be cautiously experimenting with natural oils such as cottonseed oil, she noted. Because cottonseed oil can be phytotoxic (harmful to plants), growers should experiment to find out safe levels for their particular varieties and conditions, Pickel said. Frequent, aggressive codling moth control is important in the early years of transition because once it builds to high levels it can be difficult or impossible to control organically, she said. **Lyn Garling** of the Agroecology Program, described various monitoring methods for codling moth, including cardboard bands around tree trunks in conjunction with two kinds of experiments: male confusion with pheromones (not very successful in their first trial) and parasitic nematodes (very successful).

Management Timing

Santa Cruz County Director **Ron Tyler** gave an overview of orchard management by seasons. After harvest, organic fertilizers should be applied (if used), and cover crops should be planted. Apples need only about 60 lbs/acre/year of nitrogen fertilizer, although growers may want to apply somewhat more in the first few years of transition to account for the slower release from organic sources, Tyler said. He said research is needed to provide better information on the degradation of organic materials under California conditions, noting that too much nitrogen will cause bitter pit. A cover crop can supply all the nitrogen that is needed; Tyler recommends a barley/vetch mixture, or any similar legume and grass. He said he would like to see CCOF allow zinc sulfate treatment without prior leaf analysis, because it often shows up visually in tree tops but not in leaf samples from lower leaves. Winter pruning can aid in thinning and help to prevent alternate bearing: Prune lightly after a heavy crop, and heavily after a light crop. Tyler said thinning is the most costly operation for organic growers, especially for fresh market. At green tip stage, he suggested using lime sulfur for scab and mildew, and begin pest monitoring. At pinkbud stage, Tyler recommended applying the second lime sulfur treatment and, if the cover crop is blooming, mowing or disking it so that it won't compete with the trees for bees. Thinning is important to control crop size, and also helps with worm control, since codling moth and apple skinworm like spots between two apples, he said. Unless growers are trying to avoid tillage, Tyler said summer irrigation and disking are important. Rototilling is less desirable than disking, as it causes a very severe plow pan if soils are wet, he noted. Leaf analysis from non-fruiting spurs in July or early August is mainly to determine nitrogen and potassium levels. Harvest offers a second chance (after thinning) to sort for quality, Tyler said. Rapid cooling of harvested fruit (not to be confused with cold storage which is too slow) can help reduce postharvest bitter pit, he noted.

Growers Talk Transition

Growers **Jim Rider, Bill Denevan,** and **Robert Stephens** described their experiences with the transition process. They agreed that organic production was very difficult in areas of high codling moth pressure, and that maintaining a clean orchard with a strong program is easier than rehabilitating an abandoned orchard. A strong pest management program may be expensive, however, cautioned Denevan, who has been able to grow organically for ten years because he's "always looking at the bottom line."

Tony Scherer of Ocean Organics, and **John Battendieri** of Santa Cruz Natural Company, discussed marketing. The Alar crisis last spring created product shortage and skyrocketing prices which have not been maintained, they said, but the trend in both fresh and processed organic is rising. Organic prices are generally more stable than conventional, according to Scherer. The future looks very good, he said, even though it may be rocky in the short term: The forecast of a million boxes of organic apples from Washington looks like a lot in the traditionally small organic marketplace, but it is a "drop in the bucket" in the overall marketplace, and organic growers need to supply large, reliable volumes in order to convince chain stores to carry their produce.

Betty Emlen, the local CCOF certification chair, ended the day with a description of the certification process. CCOF Executive Director **Bob Scowcroft** described the political scene for organic production, including organic legislation being developed at both state and national levels.

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Pest Management Seminars

The fourth annual *Pest Management Seminar Series* is scheduled during January and February. It is sponsored by the UC Statewide Integrated Pest Management (IPM) Project, in cooperation with local Cooperative Extension offices, the California Agricultural Production Consultants Association (CAPCA), and the Association of Applied Insect Ecologists (AAIE).

Eight all-day seminars are scheduled throughout the state. Programs will highlight important pest management information for pest control advisers, growers and others. The morning program theme is. *Myths and Realities of Controlling Pests without Pesticides*, and will include five topics developed by teams of researchers from the Berkeley, Riverside and Davis UC campuses, as well as the California Department of Food and Agriculture. Afternoon sessions will include topics of local interest.

Advance registration is $35; registration at the door is $45. For dates, locations and registration information contact **Gale Chun** at (916) 752-7691.

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