Winter 1991

In This Issue:

From the Director

Why Change?

This issue of **Sustainable Agriculture News** is primarily about the transition facing California agricultural producers. The need to develop farming Systems that are more economically viable, environmentally sound and socially just continues to be a high priority for California farmers and ranchers. Even though the 1990 environmental initiatives did not pass, the need for California agriculture to become more environmentally sensitive is still very important in a market-driven economy. Syndicated columnist **Thomas Elias** recently wrote a column entitled "Deja Vu Surrounds Big Green." In it he discussed the defeat of the 1972 environmental initiative Proposition 9 Proponents and opponents of that initiative were the same as those who took sides on one of the 1990 environmental initiatives, Proposition 128 ("Big Green"), which would have restricted the use of many agricultural chemicals. The lesson of this clash, according to Elias, is that the battle does not end on election day. Within ten years of its defeat, almost every part of the 1972 environmental initiative was law. The measure would have banned lead in gasoline, banned DDT, mandated limits on political donations, and sought a moratorium on building nuclear power plants. Within three years lead was removed from gasoline, DDT was off the market, strict limits were put on political donations (which lasted until a judge threw them out in October 1990), and no new atomic power plants were licensed. We must remember this lesson in our agricultural planning. By making the changes society wants, agriculture is moving in the same direction as its customers. Agriculture can begin to set its own agenda, and as **Len Richardson** of **California Farmer** said, send a "we care" message. When we send a "we care" message, no public relations firm is needed to prop up agriculture's image. Farming practices take care of that, and agriculture sells itself. -*Bill Liebhardt director, UC Sustainable Agriculture Research & Education Program.*

Winter, 1991 (v3n2)

Farmers Reveal Transition Motivations

by Ann Drescher Mayse, SAREP

Editor's Note: *The following article is from a SAREP publication on making the transition to more sustainable farming practices, scheduled for release in 1991.*

According to interviews with 12 California growers from February through May 1990, growers have many motivations for changing their production systems. The motivations can be organized into the broad categories of **economics, solutions to farming problems, public policy**, and **grower attitudes**.

Economics

Lowering Inputs
The changing economics of production were often cited by growers as an important motivation. The benefits of high input/high yield agriculture have been enjoyed for more than 40 years. During the last ten years the cost of fuel, fertilizers, and pesticides has risen dramatically in relation to prices received for products. As one grower summarized, "There appears to be less room for error in farming today, with financing harder, more regulation, and profit margin lower because expenses are higher and the price received for products hasn't increased with the cost of production."

One effective strategy for reducing production costs is through careful monitoring and reduction of inputs. The exact strategy differs among farms and communities, but monitoring and input reduction have been successful in cases ranging from reduced tillage for fuel conservation, to incorporation of green manures and crop rotation for fertility, to the use of integrated pest management techniques. Economic trade-offs are clearly involved, and most growers said they tend to use more intense and creative management.

Solutions to Current Farming Problems

Many growers are making changes because of their concerns about important production problems including pest resistance, dependence upon non-renewable energy, and adverse environmental impacts of their farming systems.

Biological Factors
A tree fruit grower noted that if two or three major pests in each of his crops could be controlled through non-disruptive methods, he would not use pesticides, which cause secondary pest outbreaks and other problems. The same grower is also exploring ways to reduce cultivation to preserve a surface mulch and active biological layer.

A rice and row crop grower developed a different strategy. He reported finding rotations and cultural practices that actually use some weeds to an advantage to provide biomass and organic matter. His techniques came after several years of experimentation with crops and rotations, and involved a desire to modify his farming practices.

Environmental Degradation
Agriculture's impact on the surrounding environment also affects farmers, their families, and their land. The need to address problems of soil erosion, ground and surface water pollution, and air quality are clearly important for the well-being of the agricultural community.

A coastal grape grower reported that her objective was to reduce both soil erosion and dust. She planted a fescue cover, converted to drip irrigation, and didn't "try to have the most beautiful, weed-free vineyard" anymore. She said she has reduced erosion, saved water, and reduced electrical energy use while preserving yield and quality.

Although soil quality was seldom cited during interviews as a primary motivation for changing production systems, it was a common secondary benefit that later became extremely important. A highly successful Central Valley grape producer switched from commercial fertilizer to legumes, compost, and other mineral soil amendments. He made these changes to increase vine health through what he described as the proper balance of nutrients in the soil, including trace elements.

Public Policy

While many farmers are reluctant to make changes because of real and perceived risks, virtually all California farmers are feeling pressures. Many of the pressures come from outside the farm. Several interviewed growers felt they were actually reducing economic risk by making limited changes in production practices in order to gain experience.

Increased Regulation
Concerns about environmental quality continue to influence agriculture. Several growers said that regulations would soon force them to find alternatives, and they would prefer to make some changes now. A rancher explained that making a transition strictly motivated by compliance with regulations is very stressful.

A Merced County grower saw the trend coming six years ago and decided to experiment. First attracted by the organic food premium, his interest in new production systems was further fueled by restrictions on pesticides. He said if materials now under scrutiny are further restricted, he believes his several years of experimentation have given him the knowledge to succeed without these materials. A Glenn County rice grower has similar motivations as he experiments with alternatives to rice burning.

Consumer Pressure
Although advances in food technology have provided high quality, readily available and affordable food, many consumers are concerned about the potential residues of fertilizers, pesticides, hormones, antibiotics, and heavy metals. Markets are often consumer-driven, and while it is important to avoid

passing fads, farmers may find it profitable to use consumer preferences to their advantage.

Attitude Changes

Growers interested in modifying their farming practices often start by reading scientific, technical and anecdotal information, talking with other farmers, and attending meetings. An agricultural consultant said, "Changing farming practices is by no means a snap. Sometimes it is difficult to figure out solutions, or there may not be direct solutions. But we know benign neglect [is not a solution]."

Observation reveals that fertility, diversity, and pest/predator balances are all common to naturally occurring systems. As suggested by a couple who farm in the San Joaquin Valley, it is not the farm that first changes, but rather the farmer who begins to see fields differently. Another grower pointed out that "the farm does not work like a factory, but instead as a living, breathing and reproducing entity."

Conclusions

This brief summary of motivating influences in California agriculture includes some situations that may be familiar, and others that may simply raise interesting questions. Factors that stimulate change, like solutions to agricultural problems, vary among individual growers. While innovation is a time-honored tradition in agriculture, a rapidly changing and complex set of motivational factors are affecting California farming today.

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4 Years, 52 Projects: UC SAREP Progress Report Now Available

A progress report documenting the work of SAREP is now available. The report includes detailed summaries of the 52 projects SAREP has funded for more than $1.35 million in its first four years. SAREP was established in 1986 at the request of the California Legislature in response to grower and consumer concerns about agriculture's effect on the environment, rural communities, worker health, food safety, and producer profitability.

"Farmers are at the crossroads," said **Bill Liebhardt**, extension specialist and SAREP director. "Society wants agriculture to produce abundant and nutritious food and fiber, while maintaining the resource base. Farmers, however, need to be able to continue to produce in a way that allows them to remain economically viable. As a result of these forces, agriculture and the state of California find themselves in a major transition."

The progress report represents four years of work by SAREP to help address concerns about the long-term viability of California agriculture, Liebhardt said.

Those interested can examine the 127-page report at any UC Cooperative Extension office. Free copies may be requested from SAREP, University of California, Davis, CA 95616, (916) 752-7556.

Sources of Funding

LISA. The deadline for submission of preproposals to the USDA Western Region LISA (Low-Input Sustainable Agriculture) grants program has been extended to January 31, 1991. The goals are to develop economically, environmentally, and socially viable whole-farm crop or livestock systems, facilitate technology adoption in sustainable farming systems, or analyze the effects of public policies on farmer incentives to adopt sustainable farming methods. For more information on the preproposals contact Denise Bodie, University of California, Division of Agriculture and Natural Resources, 300 Lakeside Dr., 6th Floor, Oakland, CA 94612-3560, (415) 987-0033.

SAREP. SAREP will not offer a Request for Proposals (RFP) in 1991, as grant money is currently committed to multiple year projects. When funding is available for another round of grants, it will be announced in **Sustainable Agriculture News**, and a copy of the RFP will be mailed to everyone on the newsletter's mailing list. (Remember to fill out the mail purge form on page 17 or you will be dropped from the mailing list.)

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Sustainable Ag Summer Course

Reservations are now being accepted for an annual summer course at UC Davis exploring technical, economic, social, political and philosophical aspects of agricultural sustainability.

Introduction to Sustainable Agricultural Systems, will be offered June 24-Aug. 16, 1991. The intensive (25-30 hour/week) class includes lectures, labs, discussion, field trips, and 12 hours per week of practical, in-field education. The anticipated fee is $450. Contact Mark Van Horn, Student Experimental Farm, Dept. of Agronomy, University of California, Davis, CA 95616, (916) 752-7645.

Winter, 1991 (v3n2)

Organic Agriculture Requires Certification, Marketing

by Mark Van Horn, program director, UC Davis Student Experimental Farm

Organic farming and alternative farming practices have moved from the outer fringes of agriculture to the mainstream in the last ten years. Although concepts such as integrated pest management have been generally accepted, until recently the agricultural establishment was skeptical of organic farming, which lacked technical and financial support from public and private institutions.

The 1980s brought many changes to agriculture. In the last five years particularly, economic, social, political and environmental factors have increased support for organic farming. Although still a relatively small part of California agriculture, organic acreage and sales have increased at annual rates exceeding 50 percent since 1986. California farmgate sales of organic products were estimated at $100 million in 1989.

Positive, Negative Influences

Many factors are contributing to the rapid increase in organic production. Positive factors include increased consumer demand, a larger more effective marketing and distribution system, new opportunities for processing raw organic commodities, and the premiums frequently paid to growers for organic products.

Additionally, growers have found many agricultural chemicals less attractive because of their effects on the environment and health, increased regulation, and removal of some of these products from the market. Certain chemicals have been less useful due to the development of pesticide resistant pest populations, pest resurgence and secondary pest outbreaks. Growers also have access to more and better information about non-chemical farming.

Growers contemplating a switch to organic farming should be aware that there is more to successful organic production methods than throwing away pesticides and labeling products "organic". Production practices, marketing, and regulatory requirements are different for organic farming. California law requires that any product labeled or sold as organic must meet specific requirements. In general, the law prohibits the use of synthetic materials in the production, handling or processing of organic crops. It places restrictions and prohibitions on the use of drugs, hormones, feed additives, and preservatives used in connection with organic livestock products.

The California Organic Foods Act, originally enacted in 1979, was revised and expanded in 1990. The new law retains many of the restrictions on materials and production practices, but also includes important changes. The most significant changes relate to the length of time that a crop, field or animal must be managed consistent with the law before it can be considered organic. Under the old law, an annual crop could be considered organic if the field in which it was planted had been managed organically for 12 months prior to planting. The current law changes that waiting period to 24 months in 1995 and 36 months in 1996. The change will make California standards more consistent with other laws in the United States, most of which require a three-year waiting period. The federal 1990 Farm Bill included the Organic Production Act which requires a three-year transition period effective October 1, 1993.

Another major change in the California law requires that all organic producers register their operations with the county agricultural commissioner. Registration requirements will include a registration fee, precise maps of production areas, and records of production inputs. Third party certification, including independent inspections by California Certified Organic Farmers (CCOF) or other organizations to confirm that farming practices meet organic standards will still be optional, although requirements for certification will be more elaborate than for registration, and all certification organizations will need state approval of their registration procedures.

Marketing

Marketing considerations are important for organic growers. Stories of growers receiving large premiums for organic products have heightened producers' interest in the organic market. Although an "organic premium" is still common, economic planning based upon the assumption of hearty premiums is risky. The organic premium fluctuates significantly between crops, seasons, and specific markets, and may not be available if the organic market for a commodity is saturated. The organic market for most commodities is still very small, and it may be flooded easily by a relatively small amount of product. Additionally, the large premiums that some organic growers receive is at least partly due to other factors, including the use of special crop varieties, or harvesting and handling practices (e.g. tree- or vine-ripened produce).

Even when no other special practices are employed, organic products are specialty items and require special marketing. Producers not accustomed to the time and energy required for marketing may have difficulty adjusting to the organic market, or recognizing the critical importance of marketing in successful organic operations. Producers must research potential markets for size, consistency, and competition. They must match their production to their market. The small-scale (health food stores, restaurants) and large-scale (super market chains) organic markets are distinct, and variability exists within these markets. Targeting and developing markets prior to the start of production can prevent expensive mistakes.

The conversion to organic farming is not a matter of trading the pesticide rig for a manure spreader. The word "organic" implies thinking of the whole farming system. Production practices, marketing, regulatory considerations, and philosophy are important parts of any farming operation. Those farmers interested in organic farming will probably be most successful if they consider all its implications.

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Field Day Showcases Sills' Sutter County Transition Farm

by Dave Chaney, SAREP

Farmers developing systems of low or non-chemical agriculture need both time and creativity. This was the message at a Committee for Sustainable Agriculture (CSA) field day August 29, 1990 at **Ed** and **Wynette Sills'** Pleasant Grove Farms in Sutter County. Since 1985, the Sills have been refining their organic production practices on numerous crops. They farm about 2,000 acres of almonds, rice, popcorn, oats, and vetch seed. About 1,500 acres are certified by California Certified Organic Farmers (CCOF). The 50 individuals who attended the field day toured the operation and heard Ed Sills and farm foreman **Peter Brostrom** present some of their ideas and experiences with rice, corn, popcorn, and almond production systems.

Almonds

Sills' goal with his 100 acres of almonds is to establish an orchard that can take care of itself. Key practices helping to achieve this goal include planting trees on berms to improve drainage, and maintaining a good clover cover crop on the orchard floor. Sills said the cover crop, mown periodically throughout the season, not only helps improve soil quality by increasing organic matter and water infiltration rates, but also helps to establish adequate populations of beneficial organisms that can control pests like the peach twig borer (PTB) and navel orangeworm. **George Post**, Ag Advisors, Yuba City, arrived early and scouted the orchard for signs of PTB damage: He could not find any.

A major challenge for Sills and Brostrom has been designing a harvest system that is compatible with these floor management practices. Brostrom said that rather than using standard mechanical harvesting and sweeping practices, the trees are knocked manually with mallets. The almonds fall onto a tarp and are rolled into the middles to dry. Nuts are then swept conventionally. Managing the cover crop presents some conflicts with these harvesting procedures, but the kinks are being worked out slowly, he said. Brostrom said it remains to be seen whether the harvest method continues to be economical as the trees grow and produce more nuts.

Popcorn, Rice

Rotations are the cornerstone of Sills' rice and popcorn production systems. Both crops are rotated in alternate years with seed crops of vetch or oats and vetch. In addition, a vetch cover crop during the fall and winter improves soil physical properties and supplies nitrogen for the following crop. All crop residue at Pleasant Grove Farms is incorporated into the soil; no straw is burned. This added residue increases organic matter and enhances soil tilth, Sills said.

The greatest problem in Sills' rice and popcorn production systems has been weed control. There are a few weed species that have adapted to the timing and environmental conditions created by several years of a particular crop rotation. Brostrom briefly described some of the modifications they are making to address these problems. He said rice may be grown the year following popcorn to control the broadleaf weeds that have appeared in the corn and oat rotations. They have also tried planting Sudan grass, a summer cover crop, in a field that had been plagued with barnyard grass, a warm season weed that builds up in corn. The irrigation of Sudan grass forced the barnyard grass to germinate. Both the Sudan grass crop and the barnyard grass were plowed down prior to planting the fall cover crop.

Unusual weather conditions have added a complicating factor in weed control. Cool weather in the spring of 1990 resulted in a severe infestation of mustard and wild radish in newly planted popcorn, Brostrom said. Most growers would have disked in the crop; Sills and Brostrom decided to use their cultivation skill, and experience with various pieces of equipment to clean out the weeds as soon as soil conditions allowed. Two or three passes with a Lilliston cultivator proved to be adequate and the popcorn crop pulled through, Brostrom said.

On-Farm Residue Research

The field day also included reports from researchers working with a 25-acre cooperative experiment partially supported by SAREP at Pleasant Grove Farms**. Stuart Pettygrove**, UC Davis land, air and water resources department extension specialist; **Carl Wick** and **Jack Williams**, Butte and Sutter county farm advisors; and **Deng Jiayou**, UCD Davis land, air and water resources researcher, are looking at rice-straw management in a continuous rice-winter green manure rotation. As they address questions about burning vs. incorporating residue, their objectives are to investigate: 1) The compatibility of straw incorporation with vetch (winter green manure) production; 2) The effect of green manure and rice straw incorporation on crop nitrogen response; 3) Soil tilth effects; and 4) Stem rot effects.

No conclusive results or data are available yet, but researchers made several observations that may be relevant to rice farmers considering using a cover crop:

- Seed bed preparation is very important in establishing a good cover crop. Purple vetch broad-cast in late November on a rough field containing a large amount of rice harvest residue resulted in a non-uniform stand and very poor growth during the winter months. Rolling, flailing and/ or disking rice straw after harvest may be necessary to ensure best vetch growth.

- Soil pH and phosphorus content made a difference in how well the cover crop grew. These parameters should be matched prior to planting to the cover crop species selected.

Data collected over the next two years will identify conflicts between rice straw management strategies and the use of cover crops as a source of nitrogen for rice production.

Controversy

In the meantime, rice straw burning continues to be a controversial health and environmental issue in the Sacramento Valley. Jack Williams outlined some of the pros and cons in an afternoon workshop. Rice straw incorporation has two other benefits besides the improvement of air quality. It adds valuable organic matter to the soil and, by incorporating the straw, some nutrients are returned to the production system. Williams said farmers continue to burn rice straw in spite of these benefits because of its enormous quantity, and the fact that it takes longer to break down when it is incorporated into the soil. Nutrients may also be tied up during the process of straw decomposition. Additionally, there are added time and energy costs related to incorporating residue, and stem rot disease may overwinter on rice straw.

Otis Wollan, CSA executive director, reminded the audience that the 1990-1991 burn plan recently approved by the California State Air Resources Board for the Sacramento Valley Basinwide Air Pollution Control District, allows fewer acres to be burned on agricultural burn days. Concurrently, strict "no burn" regulations will be in force on days with poor air quality conditions, further restricting regional rice growers. Also, a rice burning lawsuit is pending in which both the Air Resources Board are named, Wollan said. The outcome of this suit may establish even tighter regulations on agricultural burning in the area. Ed Sills put the controversy into perspective by challenging the audience to be prepared for the time when burning is not allowed. Telling the public that there is "no problem" simply won't work. Instead, Sills said, it is important to work on alternative residue management strategies that address the restrictions rice growers face.

CSA Farm Field Days

The farm field days detailed on these two pages, and a field day at Lundberg Family Farm in Richvale September 15, 1990 were sponsored by the Committee for Sustainable Agriculture (CSA) with a grant from SAREP. CSA is an eight-year-old non-profit organization aimed at promoting sustainable agriculture in California.

In 1991 CSA is the primary sponsor, in association with the UC Cooperative Extension, of the following transition conferences (see **CALENDAR**, p.20 for more details):

Jan. 23, Kearney Agricultural Center, Parlier. Grapes, stone fruits. Technical assistance programs.

Mar. 12, California State University, Chico. Grain crops, orchard crops, livestock, specialty vegetables. Technical assistance programs. (Tentative)

Mar. 26, Salinas Community Center, Salinas. Strawberries, vegetables, fruit crops. Farm field day, technical assistance programs.

Apr. 17, Santa Rosa. Grapes, vegetables, fruit livestock. Emphasis on farms using cover crops. Farm field day, technical assistance programs.

SAREP is the primary sponsor, m association with CSA and UC Cooperative Extension, of a transition conference for the Sierra Foothills Mar. 13 in Placerville. Emphasis will be on stone fruits, pome fruits, grapes and vegetables. (See **CALENDAR**, p.20) The transition conferences are designed to give growers technical assistance and up-to-date information on sustainable farming practices.

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Ferrari Farm: Successful Transition Agriculture in Linden

by Chuck Ingels, SAREP

Ferrari Farm, a highly diversified farm near Linden, San Joaquin County, attracted 65 people to a farm tour and field day sponsored by the Committee for Sustainable Agriculture Aug.22, 1990. The 223 acre farm includes 75 acres of fruit trees, 126 acres of nuts, and 22 acres of fresh market vegetables. A total of 136 acres are certified by California Certified Organic Farmers (CCOF). Ferrari employs 12 to 14 people all year, and twice that number during picking and packing seasons. The Ferrari farm was selected as a case study in **Alternative Agriculture** (National Research Council, 1989).

Wayne Ferrari discussed his farm management with tour participants. "Over the years, we have tried a lot of things and we have made many mistakes, but it is an ongoing process to keep on top of the operation," he said.

Marketing Key

Ferrari noted that the success of the operation has been largely due to the diversity of crops, the price premiums obtained for organic produce, and the fact that they market produce themselves. "My dad always said, 'If we can grow it ourselves, we can sell it ourselves.'" Ferrari said much of the produce is sold to wholesale firms, and a significant amount is sold at the San Francisco farmers' market. The Ferraris have been selling produce in the San Francisco Bay Area for about 30 years, and have an established reputation and numerous repeat customers, he said.

To maintain soil fertility on the organic acreage, Ferrari said he uses a cover crop of purple vetch to supply nitrogen and add organic matter to the soil. In addition, nearly three tons per acre of composted steer manure are used; in 1990 more than 450 tons were applied on the farm.

Pest Control

Ferrari also discussed insect pest management in his organic apple orchard. He is involved in the experimental use of the granulosis virus to control codling moth larvae. He said that one drawback to its use is the number of sprays required per season - he had just applied his 12th spray (four sprays per generation). Scheduling irrigations around sprays is difficult, Ferrari said. He noted that an advantage of the virus is that it is nontoxic and can be used right up to the day of harvest. It could be useful as the final spray in a conventional spray program because no post -application interval before harvest would be required, as is the case with most chemical insecticides. Ferrari has had excellent success controlling oriental fruit moth on peaches using a mating disruption technique. A synthetic female insect sex pheromone (scent) is released from dispensers, confusing the males and preventing mating. "Many of our pest management problems will be solved when the pheromone disruption technique is perfected for codling moth and peach twig borer," he said.

"But the most difficult pest management problem to overcome in the organic acreage is the lack of fungicides," Ferrari said. He has had a major brown rot problem, as the only organically-acceptable fungicides available are calcium sulfate and lime sulfur, which did not provide adequate control.

Researchers Present

The afternoon portion of the field day included presentations of sustainable agriculture techniques used by Ferrari and other growers. Of particular interest was "Alternative Agricultural Methods for Controlling Codling Moth." **Lou Falcon**, professor and insect pathologist, UC Berkeley Entomology Department, discussed the use and status of the granulosis virus, which is currently in the testing phase (see article in SAREP technical newsletter **Components**, Vol.1, No.4, Fall 1990).

A review of codling moth mating disruption was presented by **Phil Kirsch**, general manager and entomologist, Biocontrol Limited, Davis. Kirsch has worked on codling moth mating disruption studies since 1987. In field trials performed in Sutter, El Dorado, and Lake counties, codling moth damage in pears was held to one percent or less using mating disruption compared to 30 percent or more for untreated trees, Kirsch said. He said that 400 pheromone dispensers per acre used two times per season was found to be the most effective application rate. The cost of using mating disruption is similar to a conventional spray program, about $100-120 per acre, according to Kirsch. He noted that the dispensers should be commercially available for the 1991 season, pending EPA approval.

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Soil Management: Critical Key to Transition

by Bill Liebhardt, SAREP & Matthew Werner, UC Santa Cruz Agroecology Program

The transition to more sustainable farming practices should be thought of as a farming system level change that includes markets, people, attitudes, management and those physical, chemical and biological processes that affect the behavior of organisms. An important part of the transition involves soil management. It is not inert material which holds up plants or something that we must drive tractors over. It is true that soil has a certain percent of sand, silt and clay which by themselves, are biologically inert. However, all soils have organic matter, made of material that was once living or is living, which supports a complex biological system.

Homeland

The soil is home to a diverse array of organisms. Some soil microorganisms make their own food (as do crop plants), others obtain nourishment directly from the products of organic breakdown and decay, while others are predators, parasites, or live in a symbiotic relationship with another organism. The soil microorganisms include bacteria, fungi (including yeasts), algae, and protozoans. The soil animal community is dominated by invertebrates including nematodes, mites, collembola (springtails), other insects, and earthworms. Nematodes are commonly known as plant root parasites, but most soil-dwelling species participate in organic matter decomposition. Non-parasitic nematodes are especially abundant when organic matter levels are high. Soil arthropods (primarily mites and collembola) influence microbes, nematodes, and other invertebrates by feeding on them, incorporating organic residues into the soil, and by inoculating fresh residues with decomposer organisms. Earthworms and other larger invertebrates influence decomposition processes, and also have significant effects on soil structural development.

Soil Building

Biological activity helps create stable aggregates which result in soils with better tilth and physical condition. How do we get soil aggregates? Soil polysaccharides and iron oxides are binding agents that cause soil mineral particles and organic matter to adhere together as an aggregate. Polysaccharides are simply carbohydrate materials produced by soil organisms. We increase polysaccharide content by adding organic carbon (organic matter) to the soil. It is thought that when we add organic matter to the soil, microbial processes and spontaneous chemical reactions produce humus. We are adding complex organic material which microbes break down to simple materials, and then further re-synthesize these to complex materials. It has been theorized that in this process random non-ordered materials are produced in the humus-building process that microbes cannot attack. This may account for the longevity of some fractions or parts of soil organic matter. It also supports the contention that it is more than a microbial process, because a rule of biochemistry is "What microbes can build, they can break down."

Transition

Transition to more sustainable farming practices is the basis of good pest and crop stress management. It is a preventive management strategy that may help avoid these problems. It is the start of a management strategy to improve production and potentially reduce chemical input costs and increase the efficiency of both internal and external inputs. A question that might arise is "What and how do we change if we want to change?" We need to find a way to manage crops so that soil biological activity is enhanced. Ways to do so include returning organic matter to soil, minimized disturbance through tillage, reduced synthetic chemical use, crop rotation, and the use of animal manures.

Organic Matter Management

Organic matter management is a major part of our strategy. We can return organic matter to the soil by incorporating green manure cover crops, manure, compost or crop residues. Does organic matter management change soil behavior in California? We believe we can say, "Yes it does." Farmers and researchers have examples and data to demonstrate that effect. Researchers studying the connection between cover crops and water infiltration include Pete Christensen, Terry Prichard, D.W. Grimes, D.A. Goldhamer, Daniel Munk and W.A. Williams. Other work has shown that a cover crop of vetch also reduces crusting which aids seed germination and emergence (Groody & Singer, SAREP RFP87.077/Shennan). Research in progress is showing that organic matter is very important in maintenance of soil potassium availability (SAREP RFP87.094/Cassman & Roberts). A fertile soil in this sense then is a soil which supplies adequate nutrients and has both biological and physical characteristics that produce healthy plants. It is also clear that fertile soil is not just a pile of inert material with sufficient N, P & K. For example, we could fertilize concrete pavement perfectly and still not produce anything.

Tillage

Physical disturbance of the soil caused by tillage is a crucial factor in determining structure and function of biological communities in agroecosystems. Tillage disturbs the top six to ten inches of soil, and a more or less homogeneous plow zone replaces differentiated surface soil horizons. Frequent disturbance of the topsoil causes a decrease in the diversity of species that can in-habit the soil ecosystem. Various methods of tillage cause different degrees of disturbance. Many organic production systems do not differ from conventional practices in terms of the degree of disturbance caused by tillage. It is helpful to think in terms of what practices contribute to a food production system that is sustainable over the long-term.

The effects of tillage are often relative to the size of soil organisms. Single-cell microbes may respond positively to aeration and increased food availability, while large invertebrates may be selected against by the disruption of their habitats and direct physical injury.

Populations of most soil animals are initially reduced by tillage. Nematodes may recover the most rapidly of any group, while springtail communities are not changed greatly by cultivation. Tillage favors organisms with short life cycles, rapid dispersal, and small body size, and species with these characteristics may actually benefit from mechanical disturbance, in much the same way that weedy plant species flourish in agricultural or other disturbed ecosystems. The most successful groups in plowed soils may be those with a resistant life stage.

Earthworms, however, are usually harmed by tillage. In general, the greater the intensity and frequency of disturbance, the lower their population density. Lowered soil moisture caused by cultivation tends to hurt them.

Synthetic Chemical Use

Management practices that add nutrients to the soil tend to enhance soil biological activity. However, any positive effects of synthetic fertilizers occur indirectly, through the stimulation of plant growth which then provides a food source for soil animals. Application of fertilizers such as ammonium nitrate, urea, or super-phosphate have demonstrated toxic effects on soil animals. The application of inorganic fertilizers to experimental plots at the Rothamstead Experiment Station in England for 118 years caused decreases in earthworms and microarthropods.

In the past several decades an enormous array of biocide formulations have been produced and applied in attempts to control key pests in agricultural systems. Many of the fungicide, insecticide, and fumigant formulations are very toxic to soil organisms. Herbicides are generally the least toxic, although direct toxic effects of some herbicides on soil invertebrates have been demonstrated in the lab.

In field studies, direct toxic effects of herbicides on soil organisms have not been convincingly demonstrated, yet reports of problems are common. Direct toxicological effects may play a role, but most researchers conclude that reductions in soil organisms or activity are mainly due to indirect effects caused by a loss in primary productivity, lowered organic matter, and the loss of vegetative and litter cover. Earthworms and other organisms need habitat and a food source.

Application methods may have unique effects on soil animals. Surface feeding earthworms are most susceptible to surface applications of the fungicide benomyl, and are less affected by incorporation of the biocide into the soil. Species like nightcrawlers *(Lumbricus terrestris)* form permanent burrows, and do not come into contact with subsurface soil beyond their burrow. However, deeper-dwelling species which continuously extend their burrows as they feed in the subsurface soil, are most susceptible when benomyl is incorporated. Surface dwelling springtails may be more affected by herbicides than species that live in mineral soil layers.

Crop Rotation

Increasing the diversity of plants in an agroecosystem tends to prevent the build up of crop-specific pests above economically damaging threshold levels. Diversity within a single field can be created by growing crop mixtures (polycultures or intercrops), or by tolerating some weed growth. Diversity over time is created by growing different crops in succession following a regular sequence (crop rotations). Crop mixtures are likely to increase soil animal diversity.

Each plant species influences the soil ecosystem in unique ways, through the type and amount of organic matter released by roots, the type and amount of litter contributed to the soil, growth cycles, effects on soil microclimate, and the way it interacts with beneficial microbes. These plant influences on soil habitats do have repercussions on the decomposer community (organisms that break down organic matter). Although choice of crop species probably has less effect on soil organisms than plowing or soil type, rotation does add to the level of disturbance in soil ecosystems. In some cases crop rotation has a greater impact on microarthropods than insecticide use.

Management plans for transitional production systems generally include legume crops or green manures in a crop rotation as a way to maintain soil fertility. Legumes as an organic matter and nitrogen source support larger numbers and greater activity of soil microbes compared to inorganic nitrogen sources.

Animal Manures

The application of animal manures and composts as nutrient sources generally increases the abundance and activity of soil plant and animal life. Microbial and protozoan activity is highest in organically fertilized soils. Manure causes increases of microbial predators, while decreasing the abundance of plant parasites. Collembolas, earthworms, and some predatory mites increase in abundance when manure is added to crop soils, and manure may help to control nematode populations.

Strawberry Transition Studies

Because of the complexity and interactions of soil processes, it is important they be examined in concert in studies of farms and fields making the transition. The

UC Santa Cruz Agroecology Program, with partial funding from SAREP, has been studying the transition on a one-third acre site on a strawberry farm on the north coast of Santa Cruz County since September 1987 (Gliessman et al., California Agriculture, July-Aug. 1990). Chandler strawberries were winter-planted in a replicated randomized block design. Experimental treatments include conventionally-farmed strawberry plots with normal inputs, and plots farmed organically and planted to strawberries during the first year of conversion and thereafter. In the experiments, changes in the soil during transition to organic management practices have been due in large part to the removal of chemical stress, especially the removal of fumigation as a preplanting soil treatment. The addition of organic matter is also important in determining soil biological function. A shift has been observed in the abundance and diversity of rhizosphere fungi, including those fungi suspected of being antagonistic towards the pathogenic fungi that are present in low numbers. after three years of transition there is no evidence of fungal disease outbreaks in the organic plots. Estimates of microbial biomass have also been higher in the transitional organic soils. It is suspected that increasing the diversity and activity of soil organisms is the key to preventing disease outbreaks in organically managed systems.

The population levels of mycorrhizal fungi have also been monitored, beneficial organisms that assist the host plant in nutrient and water uptake. Mycorrhizal colonization of strawberry roots in organically managed plots increases during the course of transition, while fumigation and use of fungicides reduces levels in conventional plots. Strawberries left for a second year in this experiment showed higher levels of colonization at the beginning of the second production year.

In the conventional strawberry production system being studied, population levels of decomposer invertebrates periodically become very high, possibly due to the removal of predators by miticide and insecticide sprays. In the organically-managed strawberry production system, population levels tend to stay more consistent through the year.

Management Approaches

Let's look at some specific problems in the transition to more sustainable farming practices.

If you want to increase nitrogen management efficiency, consider all sources of nitrogen in your farming system. If there are legume cover crops, or if manure or compost are used, consider them sources of nitrogen. Look at nitrogen in irrigation water, and carry-over nitrogen in the soil profile from previous years. Some California growers are finding there is sufficient carry-over nitrogen in the top three to five feet of soil to meet crop nitrogen needs.

A major soil management problem in much of the United States is herbicide build up. If herbicides have been used in your farming system, it is important to consider the possibility of carry-over problems. This can be checked by filling a pot with soil from a field and planting seeds in it. If the seeds germinate and grow, there is no problem with that species and the soil. If they do not germinate, you may have identified a problem with that species and a carry-over herbicide. You will need to find a crop that will tolerate that herbicide for a short time (one to three years).

Weed control is best achieved with a preventive management approach. This can include the use of competitive crops, cover crops, allelopathic crops (plants that release toxins which suppress weeds), rotations, good cultivation and irrigation management, and reduced use of herbicides. In a row crop you can band herbicides and potentially reduce herbicide use by 60 to 70 percent. This technique combined with other strategies can reduce herbicide input substantially. With perennials, the management of cover crops alone may eliminate weed competition.

Soil is Dynamic

To summarize, soil management during the period of transition to more sustainable farming practices means looking at our soil resource as part of a dynamic system, and managing that resource. This approach may require changes in attitude and management. Soil is a very complex system, which is still not completely understood. We do know that there are both short and long-term benefits to farms and farmers in soil management techniques that look at the soil as a dynamic living entity.

Winter, 1991 (v3n2)

On-farm Research & the Transition

by Jill Shore Auburn & Robert Bugg SAREP

Many growers and researchers are frustrated that the University of California isn't able to answer all of their questions about how to make the transition to more sustainable farming practices. California agriculture is being asked to change so quickly and so dramatically, that there isn't time for researchers to study every question scientifically. What's a farmer to do?

The most successful farmers carefully observe differences among fields and patches on their own farms, and continually experiment with different methods in small plots before adopting them on a whole field. They usually don't need complicated experimental designs and sophisticated statistics to tell them what works for them. Some attention to plot layout according to the basic principles of experimental design can often be helpful, however.

The Three R's of On-Farm Research

Experimental design and statistics are often presented as something only academics understand and care about. The terms for different designs (randomized complete block, split-plot, Latin Square) and the alphabet soup of statistical formulas (t's, R-squared's, F's, and p's) sometimes seem more important than the reasons we use them.

There are three basic concepts of experimental design that everyone should use in even the most casual on-farm experiments: *replication, randomization, and reasonableness.*

Replication

No one looks at a particularly lush field and draws conclusions about its management without considering background factors such as soil, water and local climate. Whenever you try a new method on a single plot, and draw a conclusion by comparing that single plot with its neighbor, you are running the risk of being fooled. If you have several experimental plots treated the same (replicates), interspersed with other plots treated differently, you can gauge how much of the difference in a single plot is due to the treatment, as opposed to inherent variability among plots. Of course, each of several treatments must be represented by multiple plots (replicates). For example, if you wanted to compare the effect of cover crops vs. manure on soil, you would need several plots treated with cover crops and several plots treated with manure. Most statistical formulas compare variability within treatments (that is, among plots treated the same) to variability among

treatments (plots treated differently). Even without a statistical measure, you can tell a lot by looking at replicated plots: If plots with the same treatment are very different from one another, you'd want to see a much bigger difference between them and your "conventional" plots before concluding that the treatment made a difference. There is no way you can make this judgment with a single plot. The lack of replication is one of the reasons that the conclusions of older studies are often called into question.

Randomization

If you lay out several plots of each treatment, you should do so in a way that doesn't influence the results. Particularly if there is (or might be) an environmental gradient of some sort, such as changing soil type or a row of trees that shades one end of the plots more than another, you should lay out the plots in a way that spreads them out over the gradient, rather than having all of one type of treatment near one end of the gradient. Breaking the entire area into several blocks, and then assigning one treatment to a plot in each of the blocks by flipping a coin, drawing straws, or some other randomization procedure, is the safest way to proceed. Randomization ensures that the plots will be interspersed in a way that removes the influence of any gradients.

Example of poor (unrandomized) and better (randomized) experimental plot layout with three treatments, A, B, and C. (Jill Shore Auburn)

Reasonableness

Randomization and replication are the basics of experimental design, but they don't substitute for evaluating the reasonableness of the result before "betting the farm" on it. If something seems to have worked, are there other possible explanations? Is there anything else that you did inadvertently to make the treated plots work but differently from the others? Repeating an experiment in a different field, and/or next year, can help to ensure that you're not misled by circumstances that year, or conditions in that field.

Besides using these principles of experimental design in your own on-farm research, you can use them to evaluate the claims of consultants, salespeople, and neighbors. Someone may try to sell you on a practice or a product based on positive results elsewhere. You can ask questions about how well the results were replicated, and whether the conclusions being drawn are reasonable or likely to be the result of conditions peculiar to another farm or situation. If the results weren't based on a replicated trial and repeated from one year to the next, it doesn't necessarily mean that they're wrong. It means you should use caution and preferably experiment on a small scale with some replication before you believe the results.

Basic Statistics

In most cases, on-farm studies involve one or more in-dependent variables, and one or more dependent variables. The independent variables are the factors that the experimenter applies (at various levels) to determine whether any of the independent variables causes a significant effect on the dependent variable. Variables can be either qualitative or quantitative. For example, if compost is applied to an orchard at ten different rates, that is a quantitative variable. If one is comparing conventional to organic production systems, this variable is qualitative. Different species of cover crops are also distinguished qualitatively. Most dependent variables of interest to farmers can be measured quantitatively. For example, yield, cull rates, pest incidence, insect or earthworm densities, and soil organic matter can usually be assessed as quantitative variables.

The aim of most statistical tests is to judge whether the independent variables do a better job of predicting the dependent variables than does the overall average. The type of test that is generally used to make this judgment depends on whether the independent variable is quantitative or qualitative.

If both the dependent and independent variables are quantitative, the appropriate type of statistical test is called regression analysis. This does not mean a "Shirley MacLaine-like" reading of your past lives. What it does mean is a test for some type of linear relationship between the variables, in which the slope is significantly different from zero. For example, increasing levels of fertilizer might cause increased yields.

If the independent variables are qualitative and the dependent variable is quantitative, the appropriate type of statistical test is analysis of variance, abbreviated ANOVA. ANOVA tests whether the individual levels of each independent variable do a significantly better job of predicting the observed data than would the overall average.

Whether regression or ANOVA is used, the resulting statistic is interpreted using p-values: p is the probability that the observed differences in means are due to chance. Therefore, a low value of p indicates a high likelihood that there is a real effect (more than just chance) of the independent variable on the dependent variable. If p is less than or equal to 0.05 (5 percent probability that the results are due just to chance), the result is usually called "statistically significant."

Calculation Aids

Suitable statistical software is available for both MSDOS and Macintosh computers that make the calculation of these statistics much easier, so that grower-users can be free to concentrate on the meaning of the statistics rather than on how to calculate them. Reviews of statistical software are available in computer journals.

There are few examples of California farmers conducting on-farm research that would satisfy university scientists. An organization called Practical Farmers of Iowa founded by **Richard and Sharon Thompson**, however, does promote on-farm research. This organization has produced a primer offering guidelines for other growers to do simple but effective research design. (To obtain a copy of "A Farmer's Guide to On-Farm Research" send $4.50 [includes postage and handling], to Richard and Sharon Thompson, Rural Route 2, Box 132, Boone, IA, 50036-9632.)

Winter, 1991 (v3n2)

SAREP Project Updates

by Lyra Halprin, SAREP

Two years after the alar apple scare, three SAREP projects are comparing organic and conventional apple production systems. Farm advisors in Santa Cruz, Contra Costa and Sonoma counties are working with researchers and farmers to find out what is required of farmers in the transition from conventional to organic production systems. "Three projects in three geographic areas will give us some sense of grower and climatic variability in dealing with this crop," said **Bill Liebhardt**, SAREP director.

Santa Cruz

Sean Swezey, UC Santa Cruz Agroecology Program, is coordinating a project in Watsonville in a Granny Smith orchard. He said first year results have shown that growers should have a very good idea of their soil and climate conditions before starting the conversion to organic production. His group found that organic growers must pay even more attention to accurate integrated pest management forecasting indicators (orchard traps, degree day dates) than conventional growers, in order to make cost-effective use of non-chemical pest control methods like granulosis virus to combat codling moth. Swezey also said there is much to learn about tree growth, nutrient supply and weed suppression in certified organic production.

Sonoma

Farm Advisor **Paul Vossen** is coordinating the Sonoma County project, which had higher levels of codling moth damage than did Swezey's cooler-climate experiment. Codling moths have three flights (generations) in warmer Sonoma County compared to two in Watsonville, which makes a big difference in control, Vossen said. Vossen noted that fruit size and yields were about the same in organic and conventional test plots that did not have major codling moth damage. Vossen said limited use of pheromone (sex hormone) confusants proved to be a more effective codling moth control technique than oil and *Bacillus thuringiensis* (Bt) and will be more widely used in the next growing season.

Contra Costa

Janet Caprile, Contra Costa County farm advisor, reiterated what Swezey said about the need to carefully observe biological indicators. "It's so important to time exactly," she said. "We found three-week discrepancies in monitoring techniques, which is not acceptable. It makes it difficult to use the products effectively." The

Contra Costa County orchard was hit by four moth flights. The Contra Costa

County researchers have seen differences m organic sprays. The most effective biological control organism for them was the granulosis virus, with the Bt and oil combination second most-effective. Ryania spray (a ground-up root) was less effective than either granulosis or Bt and oil, but more effective than nothing, Caprile said. She is doing the comparison study on 30 acres of Granny Smith and Fuji apples, in an orchard of 250 acres of conventional production. She said it is hard to tell if the biological controls will have a cumulative positive effect on the apple trees, and will be looking for indications in the coming growing season. She noted that when there is an untreated control section in the middle of an orchard it increases codling moth pressure throughout the orchard.

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Biocontrol in the Transition

Jill Auburn, SAREP & Lynne Kennedy, UC Agricultural Issues Center

Editor's Note: *Six growers, three pest control advisers, an agricultural chemical representative, and a bank loan officer met with UC Biocontrol Specialist* **Kent Daane** *at Kearney Agricultural Center, Parlier recently to discuss their experiences in moving toward more biologically-based pest management methods. The meeting was organized by* **Lynne Kennedy** *of UC's Agricultural Issues Center (AIC) to provide information for a publication on biological approaches to pest management coordinated by the AIC. The publication, coordinated by* **Patrick Madden** *and several study teams of UC research and extension staff is planned for Spring 1991 release to policy-makers and other interested readers.*

Q: Is information on biological pest management available and affordable?

A: (Paraphrased participant responses)

Some information is available, but a lot more research needs to be done, particularly in foreign exploration/importation of natural enemies, and understanding life cycles of pests and beneficials. There is a lag time between when the problem arises and when the answers become available. We stop researching an insect when the problem goes away, so we don't learn everything we should. Usually research that is done doesn't apply to a grower's exact situation, so there is still a need for growers and their pest control advisers (PCAs) to work out their own methodologies. Growers get ideas and intermediate results at update meetings, but express some trouble getting conclusive end results of research.

Q: We have consensus that existing information is incomplete, but how do we make what does exist more available?

A: Monthly meetings of farmers, PCAs and farm advisors are useful. Farm advisors can't come out and diagnose problems quickly; we need more people who can do this. The private sector, state universities, retired experienced farmers all might help. Bold farmers who experiment are a good source of information: They may do things for the wrong reasons, but they often work. Not everything has to be understood scientifically in order to work.

Q: What are the risks as you move away from pesticides?

A: Cosmetic damage, such as light scarring of the rind on melons and oranges, or russeting on plums, will usually be rejected, even if no pesticides were used on the product. Early-maturing varieties of stone fruits hold up well, but later varieties do not without conventional fungicides. Biological sprays such as the bacteria "Bt" may have to be used very frequently, whereas the real goal is a stable system that doesn't need frequent intervention. Transitional and organic farms are more management-intensive. Additionally, infestations from neighbors can upset the system.

Q: Aren't there several costs involved in a transition?

A: In crops like cotton, almonds, corn, alfalfa, it actually becomes cheaper and easier to farm using biological approaches. For other crops, such as fruits, the transition is more costly. Integrated pest management (IPM) definitely drops costs, but going completely organic may raise them.

Q: What are some of the greatest problems?

A: Education and attitudes of growers, marketers and consumers. Centralized and industrialized approach to food production and marketing. Increased monitoring and consulting needed. Not enough research being done. Costs, supply and effectiveness of botanicals. Re-establishing natural enemies. Uncertainty: Will the transition work? Will consumers pay for it, and accept trade-offs? Will it be profitable? There's a premium for organic produce, but no premium for something that's "pretty safe" but the grower had to use one pesticide at one point. The incentive has to be there for growers to switch.

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***Farmer Profile*:**

Porterville Farmers Make the Transition

by Robert Bugg SAREP

An increasing number of California farmers are making the shift from what has been considered conventional agriculture, to biologically-based farming systems. There were times when successful organic farmers were accused of spraying synthetic pesticides at night. But data show that a growing number of farmers are profitably using organic farming methods in California.

Family Operation

Two such farmers are **John** and **Cindy France**, a husband-and wife team who operate a diversified farm in Porterville. They farm oranges, olives, prunes, Thompson Seedless grapes for juice, Ruby Seedless table grapes, apricots, walnuts and row crops. In addition to raising seven perennial crops and three children, they also operate France Spreading, a business devoted to spreading fertilizers and bulk soil amendments (e.g., manure, compost, lime, gypsum, and sulfur) for growers throughout Kern and Tulare Counties.

Three years ago, the Frances began instituting major changes in soil management. An incentive for the transition to biologically-based farming was the looming likelihood of pesticide restrictions. Several of their spreading operation clients were successful organic growers. Other customers relied heavily on applications of animal manures or compost, or used cover crops, while minimizing most synthetic inputs. The fact that various farmers were having economic success with organic and transitional agriculture gave credibility to these concepts, and inspired the Frances with confidence that a transition would be possible. (During the transition, key information was provided by Ralph Jurgens of New Era Farm Service, Tulare and Bob Cantisano of Organic Ag Advisors, Colfax.)

Switch to Compost

The first step in the conversion process was made partly out of necessity: the Frances switched from applying animal manure to compost because of the scarcity of good-quality manure in 1986. Some consultants in the field of sustainable agriculture believe that compost is a superior soil amendment because of the high concentration of humus. John points out that in a perfect soil environment, manure would also break down to yield humus, but that composting leads more reliably to formation of humus. (Gershuny, G. & J. Smillie. 1986. *The Soul of Soil: A Guide to Ecological Soil Management.* 2nd edition. GAIA Services, St. Johnsbury, VT. 125 pp.)

The next major step, undertaken in 1989, was to begin cover cropping in the orchards and vineyards. In prunes, perennial clovers (Salina strawberry and New Zealand white clovers) are used. In the other crops, a mix of winter annuals is used, including oats, hairy vetch, common vetch, and Austrian winter pea. These must be reseeded each year.

Soil Organic Matter

Since the conversion began in 1986, laboratory tests have indicated a dramatic rise in soil organic matter in all crops. For example, in the upper six inches of soil, organic matter has risen from 0.5 to a high of 1.4 percent in the oranges, from 0.5 to a high of 1.8 percent in prunes, and from 0.7 to a high of 1.9 percent in olives. John attributes this rise mainly to the application of compost, which has been underway for several years. Most research indicates that cover cropping alone does not lead to net gains in soil organic matter (MacRae, R.J. & G.R. Mehuys. 1985. The Effect of Green Manuring on the Physical Properties of Temperate-Area Soils. Advances in Soil Science. 3:71-94.) However, cover crops are used in vineyards to increase the uptake of irrigation water. This effect was a major incentive for the Frances, whose soils were prone to crusting. In fact, the improvement in water absorption has been so great that in some cases it is difficult to get water to the ends of the rows, John reports.

No Frost Damage

Frosts can be made worse in cover-cropped citrus groves, because bare ground is better at storing solar heat and re-radiating this heat on cold nights. But frost has not proven to be a problem for the Frances, although their navel orange trees are located in a low-lying area. The lack of frost damage probably relates to the cover crop's late sowing date (November), which means that it grows no more than a few inches high and covers only a low proportion of the soil during the times of principal frost danger. The groves are tilled, which incorporates most prunings, leaving more exposed soil. The Frances also use furrow irrigation, which enables them to apply substantial amounts of warm irrigation water during times of frost.

One difficulty with the cover crop has been that the mixture of oats, vetch, and Austrian winter pea has not supplied sufficient nitrogen to the citrus, at least as currently managed. The Frances had record orange yields in 1990, but added supplemental synthetic nitrogen fertilizer (50 pounds/acre as UN-32) because leaf-tissue analyses indicated a nitrogen deficiency, and nitrogen would not be as readily available from manure as from a synthetic source. This application has postponed organic certification of the oranges.

An unexpected benefit of the cover crop may be the encouragement of a predatory mite, *Euseius tularensis*, that has been exceptionally abundant in the cover-cropped orange grove. These mites are important generalist predators of citrus pests, and benefit from sources of windblown pollen that the oats in the cover crop may have provided. This question is now being addressed by University of California researcher Beth Grafton-Cardwell, Kearney Agricultural Center, Parlier.

Record Harvest

In 1990, the Frances set all-time records for their farm in production and quality for citrus (894 field boxes picked; 1,167 40-pound cartons packed per acre, with excellent size, peaking in 72s and 88s) and Hartley walnuts (2.84 dry tons per acre, lots ranged from 0-2.5 percent insect damage, well under the 5 percent limit on insect damage for in-shell walnuts).

The Frances believe that soil amendments, including those added to regulate soil acidity, are the most important considerations in transforming a conventional operation to an organic one. They view cover crops as the next most important consideration. John says if the pest-management potential of cover cropping pans out, cover crops could be the primary consideration.

The Frances say their transition is going successfully, and that their soil quality and economic position are both improving. They also believe that the new approaches have lessened their economic risks by better insulating them from fluctuations in petrochemical prices. For people considering transition, the Frances recommend examining agricultural practices as soberly as they would any other investment, and suggest in-field experiments and long-range thinking. Bottom-line benefits in production can come quickly, but it is important to plan ahead, they say. The soil is a conservative system with much inertia, and full benefits from so-called organic practices may not become apparent for five years.
