

Spring 1989

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Why Systems Research?

Land grant universities have delivered information to the agricultural community for more than a century. During that time the science of agriculture has played an increasingly important role. As science progressed, the questions asked became increasingly narrow in scope. We went from the farm, to the field, to the whole plant, to part of the plant, to the cells, to the subcellular level, and finally to the molecular level. All this was in the quest to learn more about how plants and animals function. At the farm level, however, integration of science and management of the numerous individual components required to produce still is the most critical skill needed to farm successfully.

As science and statistics evolved, university research primarily adopted a reductionist, single component approach for the study of agricultural production. We looked at the kill ratio of pesticides on target organisms but we did not look at how the balance of nature was affected by these compounds. We did not do general research because more narrowly defined questions seemed more amenable to a scientific approach. Now producers and society are asking broader questions. Growers want farming systems that are more economical and yet environmentally sensitive.

The cutting edge in farming is at this agricultural-environmental boundary. To meet this challenge, we must ask a broader set of questions and change the way we organize ourselves. The major problems and breakthroughs will occur at the disciplinary boundaries, therefore we must conduct more interdisciplinary farming systems research. We will not abandon the reductionist approach, but we need to realize that there is a continuum of agricultural research and many ways to develop the information required today. We have learned that everything is connected to everything else, therefore we must find a balance between the narrow and specific, and the broad and general truths.

Increasing systems research will help accomplish this. Systems research is more difficult to organize and develop, but it has the advantage of putting all the components together so that systems knowledge is primary and components become a subset of the system. It involves more management decisions because more researchers are involved. But a project that looks at a particular agricultural problem from many different angles and disciplines is more likely to produce thorough and long-term results because it takes the entire agricultural vista into consideration.

As an example, we are frequently asked about floor management of orchards and vineyards. When you change one aspect of the floor management of an orchard or vineyard, you change the management of the entire system. If you are only evaluating one aspect of it - for example, the addition of a legume cover crop to add nitrogen to the soil - you may come away saying it had a positive effect in adding nitrogen. That is a very reductionist approach. That

approach doesn't tell you that cover crops also affect pest dynamics, in both positive and negative ways. The cover crop may mean less dust in the vineyard or orchard, which would keep mites down, but there is evidence that certain cover crops tend to harbor nematodes. Cover crops may increase water infiltration, but they also tend to cool an orchard or vineyard floor and may add to the risk of frost damage in cold weather. Reductionist solutions often unwittingly lead to the creation of other problems.

Many of the continuing problems in agriculture cannot be solved by a single discipline. We feel that embracing and nourishing multidisciplinary systems research is the best hope for agriculture today.

- **Bill Liebhardt**, *director, UC Sustainable Agriculture Research & Education Program.*

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UC SAREP Moves

The **UC SAREP** mailing address has changed to **UC Sustainable Agriculture Research and Education Program, University of California, Davis, CA 95616**. We're still housed in UC Davis Agronomy and Range Science quarters (Room 258 Hunt Hall). We appreciate UC Davis and the Agronomy & Range Science Department providing us with a home, particularly since space is very limited and we are a statewide program. Director **Bill Liebhardt** moved to 258A Hunt Hall next to his staff, which includes information analyst **Jill Auburn**, farming systems analyst **Dave Chaney**, writer **Lyra Halprin** and information assistant **Barbara Wetzel**. As a statewide program, we will continue to cooperate and communicate with other UC programs that address issues of sustainability including the new Center for Sustainable Agriculture at Davis (Montague Demment, Director), the Divisions of Biological Control at Berkeley and Riverside, the Agroecology Program at Santa Cruz, the Dry Lands Research Institute at Riverside, and the statewide Integrated Pest Management (IPM) Project located in Davis.

Sources of Funding

General Service Foundation. Robert W. Musser, president. 1445 Pearl Street, Suite 201 (P.O. Box 4659), Boulder, CO 80302. (303) 447-9541. Areas of concern are International Peace, Population, and Resources (use, management and quality of water in the United States, particularly west of the Mississippi River, or resource development on a sustainable basis in developing countries). Contributions are made to organizations tax-exempt under U.S. laws. New, demonstration, and/or research projects are preferred. Write for guidelines in each area of concern. A letter of inquiry to the Foundation is *strongly* recommended. The Board of Directors meets twice a year; deadlines for those meetings are March 1 and September 1.

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"Guide" Out of Print

"Sustainable Agriculture: A Guide to Information," a 12-page listing of literature and information sources on sustainable agriculture was produced last August by **David Bainbridge** and **Steve Mitchell** at the Dry Lands Research Institute of UC Riverside with a grant from the UC SAREP. The guide has been extremely popular, and all 5,000 copies have been distributed at no charge to anyone who requested it from Dry Lands or UC SAREP. Because requests for the guide continue to arrive at the UC SAREP office, the program may revise and reprint it if funds are available. If you have read the guide and have comments about its content or format please contact the UC Sustainable Agriculture Research and Education Program, Room 258 Hunt Hall, University of California, Davis, CA 95616, (916/752-7556).

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Conversion Booklet Available

"Switching to a Sustainable System," an 18-page booklet by Frederick Kirschenmann on strategies for converting from conventional to sustainable farming systems is available for a \$3.00 mailing charge from the Northern Plains Sustainable Agriculture Society, RR 1, Box 53, Wales, ND 58281. Although many of the models described are based on midwestern farming systems, the booklet includes much basic information on the conversion from conventional to sustainable practices. It describes requirements for a sustainable farming system including field plans, crop rotations, regenerative soil building methods, and new concepts in farm management. A limited supply of the first printing is left; a second printing is planned.

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Plant & Soil Conference Stresses Low-Input

The issue of sustainability was part of almost every session of the 1989 California Plant and Soil Conference February 1-2 in Sacramento. UC SAREP director **Bill Liebhardt** chaired a session on low-input farming, while other sessions featured biotechnology, soil fertility and plant nutrition, pesticide issues and water infiltration.

Groundwater Hazards

An afternoon session on groundwater hazards included discussions of potential contaminants, movement of hazardous materials below the root zone, municipal/industrial groundwater problems, and new regulations. California's Pesticide Contamination Prevention Act (AB 2021) is leading to stricter regulations on the use of some agricultural chemicals. **Mark Pepple** of the California Department of Food and Agriculture's Environmental Monitoring and Pest Management division discussed the department's implementation program, including the monitoring of wells, and the modified use of chemicals known to leach. Chemicals that leach in a particular soil and location will be restricted in specific pest management zones (PMZs). Permits will be required for the use of these chemicals in that PMZ, and may be applied only by pest control advisers licensed by the state under new groundwater certification training programs. There are strong indications that the number of chemicals and the scope of PMZs will be increasing as well monitoring progresses. This presents an immediate challenge to the agricultural community to develop alternatives for those cropping systems where groundwater contamination is a problem.

Walt Farmer from UC Riverside, Department of Soil and Environmental Science discussed factors that determine the movement of agricultural chemicals through soil including multiple transport processes, characteristics of the chemical in question, and soil factors like porosity, carbon content and the depth of the water table. A recent EPA report showed that 46 pesticides have been detected in groundwater nationally. **Jeremy Dyson**, also from UC Riverside, emphasized the limitations of laboratory studies on the path of agricultural chemicals and the need for more field data on the transport of pesticides through soils.

The possibility of biological contamination of groundwater increases as use of organic soil amendments increases. **Marylynn Yates** from UC Riverside discussed potential contaminants from sludge including viruses, bacteria, and protozoa. Although biological contamination of groundwater has occurred in only a few spots nationally, predicted increases in the addition

of sewage sludge to soil will require more detailed analyses of material applied, its movement through soil, and more information to farmers on correct application to prevent health hazards.

Water Infiltration

Progress reports from some of the studies of the Kearney Foundation's ongoing five-year study of water penetration problems in irrigated soils were presented in another session. Soil-water specialist **Terry Prichard** outlined the size of the problem in California: slow water infiltration affects over two million acres (23 percent of California's cropland) and costs growers from \$20 per acre in pastures to \$1200 per acre in some orchards. In almonds, for example, it reduces yield, tree vigor, nut quality, and tree longevity, increases disease susceptibility, and interferes with movement of fertilizers. Orchard floor management practices can improve water infiltration significantly, according to his research. Using a portable infiltrometer that he developed, he found that the mowed cover crop treatments (Salina strawberry clover, Blando brome, or resident vegetation) had about twice the infiltration rate of the residual herbicide treatment.

In another study, vegetative cover was not helpful in improving water infiltration in a Butte County prune orchard with a history of crusting problems, studied by UC Davis researchers **Daniel Moore, Michael Singer,** and **M. Shannon Sadler**. Disking helped in the short-term, but contributes to the plow pan which is a problem in this orchard. Gypsum appeared to make an improvement, but it was not long-lasting. In contrast, gypsum improved infiltration for four to five irrigations in a vineyard under drip irrigation, studied by Tulare County farm advisor **Bill Peacock** and UCD specialist **Bill Wildman**.

When the five-year study is completed in 1991, these and other results will be integrated into a management guide by the Kearney Foundation of Soil Science, a research unit of the University of California. There were eighteen projects in this area in 1987-88 involving 85 researchers.

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Farm Conference, Direct Marketing Association Meet

February's 1989 Farm Conference and National Direct Marketing Conference in Oakland brought together a large and diverse group for 80 workshops over three days. Featured speakers included **Paul Hawken**, author of "Grow Your Own Business", writer and editor **Richard Smoley**, produce specialists **Sibella Kraus** and **Frieda Caplan**, and **Ralph Grossi**, president of American Farmland Trust.

The former managing editor of "California Farmer" magazine, Richard Smoley discussed four major issues he said the farm media does not address well: urbanization, air pollution, organic farming and animal welfare. Smoley encouraged the audience to let farm publications know what readers want.

Land Use

Many workshop sessions addressed public policy issues. Urbanization and farmland preservation was the focus of "Getting Involved with Land Use Issues" led by Sonoma County farm advisor **Rick Bennett**. Farmers **Elizabeth Kaminaka** of San Luis Obispo County, **Dwight Caswell**, Sonoma County, and **Al Courchesne**, Contra Costa County, discussed different approaches to these challenges. Some of the crucial issues covered in the workshop included dealing with local bureaucracy and politics, how to organize and build coalitions, working with diverse attitudes and goals in the farming community, communicating with developers, and the creation of "agricultural parks". The panel noted that most members of county boards, who affect many land use issues, are trained in urban planning. Zoning laws usually reflect this bias and the challenge is to come up with mechanisms to cut through the laws. Suggested strategies include focusing efforts around open space, wildlife, and groundwater protection.

Imports

The effect of imports on California agriculture continues to be an issue of concern. The workshop "Imports: Impact on California Producers and Consumers" was well attended and generated intense discussion. **Cathy Krause**, consultant for the California assembly sub-committee on international trade said the state focuses very little on imports compared to its \$5 million export promotion budget. Pesticide residue on imported produce and the negative publicity it creates for California growers' and their use of pesticides makes imports a very touchy subject. Krause, however, pointed out that California views itself as a free trade body and

operates foreign trade and investment offices in London, Tokyo, Mexico City, Hong Kong, and Frankfurt. Demographics and ethnicity, the growing

presence and influence of multi-national corporations in the United States, consumer demand, and seasonal availability of certain products are also reasons for the increasing level of imports in the state. **Ted Batkin**, chairman of several California commodity boards, noted that most imports into California come from Mexico, Canada, and Central America, but that they arrive mainly during the non-producing period (December-February) and have minimal impact on California agriculture. Batkin suggested that imported commodities including tomatoes, lettuce, squash, strawberries, peppers, broccoli, and cauliflower during the off-season may actually be beneficial to California growers: they fill a need for the consumer, and generate a year-round desire for fresh produce. Batkin also predicted that imports will increase as other environmental and political concerns arise including urbanization, the need for reduction in pesticide use, and the development of free trade agreements with Canada and Mexico.

Production Practices

Although the focus of the conference was on marketing, many sessions addressed more sustainable production practices. UC farm advisors, specialists and faculty were involved in many of these sessions. UC IPM advisor **Jim Stapleton** and Winters tree fruit grower **Alex Hogstrom** led a session on minimum use and maximum efficiency of pesticides. UC farm advisors **Craig Weakley** and **Manuel Jimenez** described current research on pheromones and trap crops for insect control in vegetables and fruit trees. UC Berkeley professor **Ken Hagen** and private consultant **Larry Bowen** shared a session on biological control. UC SAREP director **Bill Liebhardt** joined growers **Ed Sills** and **Paul Buxinan** in a session on low-input agriculture.

Weeds

UC Davis weed ecologist **Tom Lanini** and Brentwood grower **Rick Knoll** shared a session on non-chemical weed management. Lanini described some of his recent research, which includes experiments with irrigation and tillage for weed control in vegetables. Sprinklers cause the most weed problems, he said, while buried drip (10 inches deep, so it can be disked on top) is very good for annual weeds except for large-seeded ones. Buried drip doesn't help control perennial weeds, however. He also conducted experiments to find out how close and how frequently cultivation is necessary if the farmer is relying on mechanical control of weeds in vegetables. In tomatoes, cultivating very close to the row is important: even one inch unweeded next to the crop depressed yield and slowed maturation. In tomatoes and cucumbers, the first cultivation should be by about two weeks from emergence. If it was delayed any longer in these experiments, yield declined due to "cultivator blight" or damage to the crop, such as when field bindweed wraps around the tomatoes and the cultivator then disturbs the tomatoes as it pulls out the bindweed. Cultivation for another six weeks was needed to maintain yields in both tomatoes and cucumbers. Further cultivation (up to eight weeks weed-free) improved tomato quality (brix, or percent solids) but hurt cucumber yields. In slower-growing bell peppers, a yield decline was seen from weeds in even the first two weeks, so cultivation should begin sooner. Maintaining the field weed-free for a longer time (8-10 weeks) was judged cost-effective in peppers. Lanini is also conducting similar experiments in lettuce. Rick Knoll drew upon ten years experience farming without any chemicals, even plant-

derived ones, as the basis for his 'community-derived' approach, in which he views weeds as a part of his very diverse ecological system, rather than just as pests. The audience was very interested in his experience with Chinese weeder geese. They disturb the Soil much less than mechanical mowing, he said, but require close supervision and training to be most effective.

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"Transition" Conference

Making the transition to low or non-chemical farming was the topic of a one-day meeting attended by 120 people in Chico February 11. The morning session stressed the wide array of state government, university, and private organizations available as resources to growers. A panel of growers, retailers, wholesalers and manufacturers described marketing opportunities available to low-input farmers. Four separate afternoon sessions focused on fruit crops, nut crops, field crops, and vegetable and specialty crops. In each of these sessions UC researchers and farm advisors, private consultants and experienced growers addressed topics in soil and pest management. The conference was co-sponsored by California State University at Chico, California Certified Organic Farmers, Committee for Sustainable Agriculture and UC SAREP.

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Future Directions: Views on Sustainable Ag

It is encouraging to see the research establishment of the USDA, the University of California and Cooperative Extension strongly support research-based sustainable solutions to agricultural problems.

At the national level, US Secretary of Agriculture **Clayton Yeutter** told US senators in January that "low-input, sustainable agriculture is an area that has sparked my personal interest." He said he is aware of "successful farmers, full-time farmers, with efficient operations beginning to embark upon programs that one would define in this category" and sees a need to "follow through on this as a serious research and development endeavor."

At the state level, **Kenneth Farrell**, vice-president of the UC Division of Agriculture and Natural Resources gave his thoughts on food production in a changing world in the March 1989 issue of "California Agriculture". "To me," he wrote, "sustainable agriculture is a necessary goal, the production of healthy food and fiber by methods that are economically viable and environmentally sound. Sustainable production systems involve balancing, to the maximum extent possible, on-farm and off-farm inputs to maintain long-term viability of agriculture and natural resources, considering both ecological and economic criteria... Our multidisciplinary approach to agriculture's problems seeks to find solutions that will both ensure the long-term health of the environment and help farmers retain their financial health."

UC Davis faculty member **William Rains**, professor of agronomy and range science and chair of the UC SAREP Technical Advisory Committee, recently wrote that "it is essential that we take a holistic view of agriculture and consider it as a complex, multifaceted system requiring an increasingly sophisticated approach to the analysis of resources, to the understanding of environmental issues and to the management of highly complex farming systems."

At the county level, Kern County Cooperative Extension farm advisor **Mario Viveros** feels that "we have to be ready to accept the challenge that the public wants a product that is pesticide free. We may not be able to produce entirely without pesticides, but we are certainly moving in that direction." He gave examples from UC's integrated pest management work in almonds: some pests, like the insect navel orangeworm, are best controlled through sanitation and other non-chemical means; others, such as the fungal disease shot hole, require chemical control, but research is being done to identify when sprays are NOT necessary, which can save growers a lot of money. These alternatives are necessary, he said, because "no business can survive by not listening to what the customer wants."

It is important for consumers and producers to know that the University of California research and extension personnel are attempting to address their concerns regarding the issues of food safety, environmental quality and

economically viable production systems.

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Reduced-Input Almond Meeting

Reduced-input practices were the topic of a Modesto meeting attended by more than 180 people, sponsored by UC Cooperative Extension advisors in Stanislaus, Merced and San Joaquin counties February 28. Stanislaus county farm advisor **Wes Asai** began the morning meeting with a discussion of native and planted groundcovers. In a five-year study comparing Blando brome, strawberry clover, native cover, "chem mow" and total herbicide treatments, pest populations differed more than tree growth or yield. Soil compaction was greater in the total herbicide treatment, according to **Terry Prichard**, irrigation and soils specialist for UC in San Joaquin County. Water penetration was better in all the mowed cover crops than in the "chem mow" or herbicide treatments. Extension specialist **Rollie Meyer** discussed legumes and manure as nutrient sources. Both materials improve water penetration as well as providing nutrients he said, but they must be managed with their variable nutrient content and slow-release nature in mind.

According to area IPM advisor **Bill Barnett**, irrigation and encouraging beneficials are the most effective techniques for controlling spider mites. Barnett also described recent research showing that trap counts for peach twig borer are not a good indicator of egg-laying, so growers should not spray when they see increased trap activity near 600 degree days. UCD researcher **Dennis Meal** discussed sanitation, timing of harvest, the parasites *Pentalitomastix* and *Goniozus* and other controls for navel orangeworm. Merced county farm advisor **Lonnie Hendricks** began the final talk with a discussion of the need to change attitudes. He showed a slide of what many people might consider a poorly-tended orchard (tall, messy-looking cover crop) and a slide of a perfectly clean orchard. Pointing to the clean orchard he said, "This looks neat and tidy, but where's the habitat for beneficials?"

Hendricks also described an ongoing study where he is comparing two almond orchards, one managed with no insect or mite sprays, and one managed conventionally (see p.7 for more information on this study). Both orchards had similar levels of total worm damage, although the two orchards had very different levels of pests and beneficials. More research is needed to explain these kinds of differences and to understand all the aspects of managing a low-input system. Meanwhile, this meeting demonstrated that much information is currently available from UC farm advisors. It was planned by Wes Asai, Lonnie Hendricks and San Joaquin County farm advisor **Paul Verdegaal**, who moderated the meeting.

Results Arriving from UC SAREP Grants

Progress reports from the research, demonstration and education grants funded by **UC SAREP** have just arrived in the program's office. Summaries and full reports will be distributed to UC departments, county extension offices and other locations. Availability will be announced in the next newsletter. Here are highlights from a few of the reports:

Cotton-Soil Study

In their study of soil and plant interactions in the potassium deficiency/disease syndrome of cotton (PDDS), UC Davis faculty **Ken Cassman** and **Jim Marois** and Kings County farm advisor **Bruce Roberts** found that cotton response to applied potassium (K) is cumulative, and massive rates of K addition are required to replenish soil K supply. Additions of fertilizer K stay mostly in the plow layer, and have little effect below the surface where cotton root development is best. Loss of soil organic matter (12% in surface soil in two years) from growing cotton without rotation also appears to make K less available for plant uptake. A winter barley cover crop grown between cotton crops did not produce well enough to cause detectable changes in soil properties or cotton growth. Manure will be tried this year.

Cover crops for Vegetable Systems

A two-year-old study of the effects of winter cover crops on soil nitrogen availability and soil structure by assistant professor **Carol Shennan** and graduate student **Lee Stivers** of UCD's Vegetable Crops department, found that Lana (woollypod) vetch produced the most above-ground biomass of all legumes tested (bell beans, berseem clover, Austrian winter peas, oats, and an oats/vetch mixture) and fixed up to 230 pounds per acre of nitrogen under favorable conditions in Davis. Cover cropping improved soil structure, but dried out the soil by an amount equivalent to 0.4-0.8 inches of water down to a depth of 24 inches, relative to a winter fallow. Processing tomato yields following a winter legume were as high as those in plots fertilized with 200 pounds per acre of fertilizer. Soil ammonium levels rose rapidly after incorporation of the vetch, indicating that the nitrogen from the legume was available about as rapidly as from the chemical fertilizer.

Nematodes and Cover Crops

Nematologist **Mike McKenry**, based at UC's Kearney Agricultural Center, continues to study the effects of cover crops on the build-up of harmful nematodes in the soil. He is concerned that the increased popularity of cover crops may cause problems since many cover crops, particularly legumes, are hosts to nematodes. He planted small plots of different cover crops and a grapevine in either sandy soil or sandy loam soil, and inoculated them with various nematodes. In sandy loam soil he found that Cahaba white vetch,

Hubam sweet clover, and barley improved vine growth in the presence of nematodes, while other cover crops did not. In sandy soil, Cahaba white vetch, Blando brome, and barley improved vine growth whether nematodes were present or not. The summer cover crops that were tested appeared to be less beneficial. Measurements of nematode build-up in the soil and on plant roots showed that native weeds, Nimblewill and NemaGold were poor summer covers, but Elka rye/Chewing fescue was a non-host for root knot nematode. Of the winter cover crops, Cahaba white vetch and barley were the best; Hubam sweet clover is apparently a host to some root knot nematode species although it had a favorable effect on the vines.

Almond Orchard Comparison

Merced county farm advisor **Lonnie Hendricks** has monitored two almond orchards for the last year: **Glenn Anderson** uses no insecticides or fungicides and grows a vetch cover crop which he tills into the soil, while his brother and next-door neighbor **Ron Anderson** uses more conventional methods including pesticides and mowed native cover. Hand-harvested samples of 800 nuts (Nonpareil variety) from each orchard showed similar acceptable levels of worm damage in the two orchards: 2.8% in the unsprayed orchard and 2.7% in the sprayed orchard. Spider mites were not a problem in the unsprayed orchard, while there was an outbreak in the sprayed orchard (after a May spray of insecticide) which was satisfactorily treated with a miticide. General predator and parasite levels were higher in the unsprayed orchard with the tall vetch cover crop, especially spiders and parasitic wasps. Soil properties and soil and tissue nutrients are also being monitored. This study of existing orchards, while not providing definitive answers through replicated research, is quickly and cost-effectively identifying key factors in the functioning of alternative systems.

Strawberries

The several large-scale, whole-system research projects which first received funding from **UC SAREP** in 1988 have not been underway a complete season and have few results to report yet. In a two-year-old study, **Jim Cochran** of Swanton Berry Farms and **Steve Gliessman** of UC Santa Cruz are comparing organic and conventional strawberry production in replicated plots on Cochran's farm. Yields were lower in the organic plots in the first season, but organic berries had a higher market value. Yield-limiting factors have been determined including lower soil temperatures, less available nutrients, higher weed populations, and possible impacts of different pests and diseases. Steps are being taken to lessen these problems during the second cropping season. Detailed soil and crop measurements are being taken, including the fate of pesticide residues.

Organic Beef Symposium

Organic beef was the topic of a March 16 Symposium attended by 60 people in Ukiah. Organized by Mendocino County farm advisor **Rod Shippey**, the symposium was designed to address the growing interest in organic certification among California livestock producers. Currently the market for organic beef is quite small, but producers see great potential for an expanding clientele in the United States.

Like growers of food crops, organic livestock producers are continually developing the system which works best for them. According to **Cathy and Ralph Rittenhouse**, Humboldt County ranchers, these systems will include some kind of rotational grazing combined with specialized feeding of organically produced forages. The California Health and Safety code and the California Certified Organic Growers production guide detail more specific requirements for "organic" livestock.

The real crunch for producers comes in the area of marketing. California certification allows organic producers to market their meat only within state boundaries. Anything marketed outside California requires USDA certification. The USDA has no definition of "organic", and therefore will not permit the use of that term on meat marketed across state lines. Producers are concerned that the USDA's inaction on this issue will hinder the development of a national or international market in organic meat.

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