Spring 1996

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Technical Reviews:

From the Director

Long-Term Research Necessary

The legislation that authorized SAREP in 1986 states that the program should address long-term issues related to sustainable agriculture. The concept of sustainability implies a long-term view, which is necessary to evaluate many of the processes in nature and agriculture. It is important that society support long-term research so that we can see the effect of farming practices on the natural resource base. For example, the practice that led to the 1930s dust bowl-plowing the prairies-actually began about 100 years earlier.

Maintaining California's resource base is part of an intergenerational equity question: What is our generation's responsibility to the future? (See "Sharing the Cost of Land Tenure and Stewardship," p. 4.) In many areas of the world, the environment has been severely degraded because there was little or no thought about the needs of the future. Once the environment is degraded, productivity decreases, which reduces society's ability to feed itself. In his book *O*ut of the Earth-Civilization and the Life of the Soil (The Free Press, 1991), soil scientist **Daniel J. Hillel** says:

We live in an age and culture that is very sensitive to human rights, but does not grant equal weight to human responsibilities. We insist on our prerogatives, and neglect our obligations. Our attitude toward the environment is marked by careless confidence and reckless self-indulgence. These are the attitudes and actions that, in any individual, we recognize as childish. And just as a mature person must learn to consider the circumstances and needs of others, so a mature society must restrain its exploitation of resources and consider both the rights of future generations and the needs of other species.

Intermediate-length research such as that being conducted at the Sustainable Agriculture Farming Systems project at UC Davis and other sites (see Technical Reviews, p.9 and p.11) begins to address some long-term issues. Nonetheless, a commitment to real long-term research is essential to fully understand the ramifications of our farming practices. As a major research institution, it is the responsibility of the University of California to address these long-term issues. In 1990 SAREP funded a group of UC Davis researchers who initiated the first 100-year irrigated farmland research site in a Mediterranean climate anywhere in the world. SAREP provided $150,000 to begin the experiment. Since that time both the UC Division of Agriculture and Natural Resources (DANR) and the UC Davis College of Agriculture and Environmental Sciences have committed substantial resources to keep this research going. In addition to its considerable scientific value, the Long-term Research on Agricultural Systems (LTRAS) project at UCD is a very worthy effort, for it is an acknowledgment by those of us living that we have a responsibility to the next generations. The experiments are under the leadership of **Ford Denison** of the Agronomy Department at UCD. Denison and other scientists have two years experience at the site, and have made good progress in the set-up of long-term research, and in experiments that can provide information that is useful right now. Important questions relating long-term sustainability and soil, air and water quality are being examined. The effect of different levels of organic matter on soil productivity will be researched over a long time period. For example, researchers will be comparing treatments for which the amount of carbon inputs varies by seven-fold. In addition to answering specific scientific questions, this comparison may also shed light on a critical issue related to the problem of global warming. CO_2 is a greenhouse gas. If we learn how to trap or sequester this CO_2 in soil organic matter, that would help reduce atmospheric CO_2, one of the culprits implicated in global warming. The only way to identify and understand these soil processes is to study them under carefully conducted field studies over very long periods of time. Other issues that will be examined at the LTRAS are water use efficiency, nitrogen sources, organic matter management, soil health/plant health relationships, microbial dynamics in the soil, soil physical issues, and dust movement. As we have seen in the famous Rothamsted Classical Experiments in Southern England and other long-term experiments started more than 100 years ago, unforeseen issues not contemplated at the beginning of those experiments have emerged and can be understood because we have this long-term history.

The LTRAS experiments began in the early 1990s, when the state and the University of California were beginning to experience financial difficulties. It took a substantial effort by many people to negotiate the finances of this important research. The experiment has many individual investigators studying the sustainability of agricultural practices within the larger context of agricultural systems. Since contributing the initial start-up money for the overall project, SAREP has funded an additional four-year treatment in the original experiment. But long-term support cannot stop. It is important to keep this experiment well-financed, as it is the only one of its type in California. This effort must be continued so we have a sound scientific knowledge base from which to draw information about the future of agriculture. Agricultural practices will continue to evolve and change in the next century, but the basic questions addressed in this research will always be timely. Because it is important to keep this work going into the future, the UC must take the lead in securing funding sources to maintain the LTRAS project and start other long-term studies.-Bill Liebhardt, director, University of California Sustainable Agriculture Research and Education Program.

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Community Food Systems Conference:

"Sustaining Farms and People in the Emerging Economy"

Mark your calendars: UC SAREP, along with the Community Alliance with Family Farmers, the national Community Food Security Coalition, and the California Communities Program at UC Davis will host a conference **Oct. 2-3**, 1996 at UC Davis to consider the role of community food systems in relation to the global food economy and the movement for sustainable communities. Panel sessions will showcase innovative community food system projects across California, build bridges of cooperation among these allies, and share methods for developing a community food system. Pulitzer-prize winning poet Gary Snyder will read his poetry at a luncheon featuring local foods. Keynote speakers include **Daniel Kemmis**, Mayor of Missoula, Mont. and author *of The Good City and the Good Life: Renewing the Sense of Community*; and **Joan Gussow**, professor emeritus, Teacher's College, Columbia University and author *of Chicken Little, Tomato Sauce and Agriculture:Who Will Produce Tomorrow's Food?* For more information contact David Campbell, (916) 752-7541; dave.c.campbell@ucdavis.edu) or **Gail Feenstra**, (916) 752-8408; gwfeenstra@ucdavis.edu).

SAREP WEB Information

http://www.sarep.ucdavis.edu/

In addition to its print publications, UC SAREP offers access to SAREP-funded research and education projects, its quarterly newsletter, its new Progress Report 1993-1995, and information databases through its World Wide Web server.

SAREP Cover Crops Database

http://www.sarep.ucdavis.edu/ccrop/

SAREP has developed an on-line resource for cover crop information which features a searchable database, articles, and references to other sources of information on cover crops. The database contains hundreds of pages of information and color pictures of more than 40 cover crops used on farms in California. The resource page will be periodically updated as new information is developed.

SAREP Calendar

http://www.sarep.ucdavis.edu/

SAREP offers a regularly updated sustainable agriculture calendar on our World Wide Web site. You may add your own sustainable agriculture events to the SAREP Web site calendar.

Other Related Sites...

Northwest Coalition for Alternatives to Pesticides (NCAP)

http://www.efn.org/~ncap

NCAP helps develop policies to protect groundwater, food supplies and forest watersheds from pesticide contamination; provides model pest management policies for schoolgrounds, roadsides, national forests and other locations; information on pesticide alternatives for pest problems; updates on citizen reform efforts and policy initiatives in North America through its *Journal of Pesticide Reform*; assistance and referrals for pesticide exposure victims; and organizing assistance for community policy reform.

California Environmental Resources Evaluation System (CERES)

http://ceres.ca.gov

CERES is the California Resources Agency's data and information base on natural resources. It facilitates access to electronic data describing California's resources, including physical environments, living creatures and their habitats, and environmental impact reports and studies. In addition to such basic data as up-to-date flood and snow conditions, the CERES Web site offers information on natural resource planning and stewardship, research and education for individuals, schools, community groups, and government agencies. The California Resource Agency includes the departments of boating and waterways, conservation, fish and game, forestry and fire protection, parks and recreation, water resources and others; the California

Conservation Corps; many commissions, including coastal, energy, and state lands; boards (mining and geology, fish and game, parks and recreation and others); conservancies (Tahoe, coastal), and special programs (Biodiversity Council, Rivers Assessment, Wetlands Information System).

NOTE: To receive print copies of SAREP documents, write UC SAREP, University of California, Davis, CA 95616; Tel: (916) 752-7556; Fax: (916) 754-8550; e-mail: sarep@ucdavis.edu

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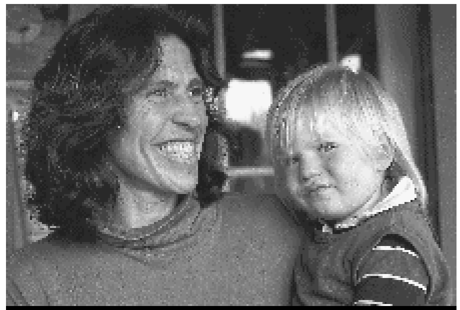
Sharing the Cost of Land Tenure and Stewardship

By Luanne Warnock, SAREP

Standing at the edge of a field looking far across an expanse of corn to the horizon, the question of ownership arises: Can what is mortal "own" that which is perpetual? Many believe that the responsibility of stewardship outweighs the power of ownership. While ownership confers the right to do as one pleases with what one owns, stewardship suggests that despite ownership rights there is an incumbent duty to temper one's pleasure with a consideration for others-both those present and those yet to come.

In 1994 SAREP funded a project based on ideas such as these, designed by a group in Covelo, Mendocino County. which want-ed to create a model for conserving and protecting agricultural land. Specific issues the project aimed to address were:
1) the preservation of farmland from conversion to non-agricultural development and housing uses; 2) the promotion of biological/sustainable farming practices that would enhance biological life and the integrity of agricultural soils; and 3) eliminating the speculative value of farmland so that it becomes and remains affordable for farming. The model that emerged was an innovative arrangement where the farmer owns the productive agricultural value of the land while a nonprofit organization owns all the land's additional speculative or market value.

Although not the first open space conservation easement plan, this new model, based on the concept of shared-equity, was developed to more fully



Gloria and Nicolas Decater

address agricultural issues in the preservation of land. In fact, unique to this approach are the legally binding deed restrictions that ensure the land will be kept in active farming use; that it will be farmed with either organic or biodynamic methods; and that the resale value is based solely on the land's agricultural value. Steve and Gloria Decater of Live Power Community Farm and members of their community, notably the Live Power Community Farm CSA (community supported agriculture project or subscription farm), worked for four years to turn these concepts into a reality that would secure the integrity and agricultural future of their farm. Through donations, $81,000 was raised for the land trust's equity, while the Decaters purchased the agricultural value of the land and the building improvements for $69,000. The progressive public and private partnership in Live Power Community Farm became official in the summer of 1995 when the sale was completed.

SAREP's involvement with the project began in October 1994. A $5,000 grant was awarded to the proposal Sharing the Costs of Land Tenure and Stewardship, which outlined the preparation of a manual on shared-equity.

"It is critical that the process as experienced by the Decaters be documented in order to establish precedent, enabling other communities and farmers to pursue similar actions," says **Jered Lawson**, principal investigator of the project.

The manual is intended to be a tool of empowerment and introduction to shared-equity, with particular emphasis on the elements developed by the people of Live Power Community Farm. Specifics such as where to find a nonprofit partner, how to go about raising necessary funds, and drafting the Easement or Option are covered in practical "how to" instructions. With enough information to allow the methods to be adapted to individual needs, the manual is a handbook for farmers, landowners and investors who have at heart a concern for the future existence of family farms and the promotion of farming methods that will sustain the integrity and productivity of the land.

A draft of the manual will be available at a workshop on the legal and financial mechanics of land tenure options for community supported projects May 3-5 at the Headlands Institute in Sausalito, Calif. For more information, contact Jered Lawson at CSA West, 1156 High Street, Santa Cruz, CA 95064; Tel: (408) 459-3964.

New SAREP Progress Report Details Research

UC SAREP has released its new 60-page Progress Report 1993-1995, which details recent SAREP-funded competitive grants for production, community development and public policy research, meetings, and graduate student research. The report elaborates on SAREP's information, education and outreach efforts, updates long-term farmland research, and presents the new Biologically Integrated Farming Systems (BIFS) projects. The progress report is accessible through SAREP's World Wide Web server located at http://www.sarep.ucdavis.edu/ Print copies (free, but donations of $5, checks payable to "UC Regents" greatly appreciated) are available while supplies last by contacting SAREP, University of California, Davis, CA 95616; Tel: (916) 752-7556; e-mail: sarep@ucdavis.edu

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Resources

Regional UC Cooperative Extension Newsletter Debuts

Four UC Cooperative Extension livestock, dairy and range management farm advisors in a 16-county area are spending part of their time working as a team to develop and deliver educational programs and conduct research on a regional basis. The team includes **Gary Veserat**, beef cattle, headquartered in Woodland, Yolo County, (916) 666-8143, e-mail: gmveserat@ucdavis.edu; **Marit Arana**, dairy technology and ruminant nutrition, based in Stockton, San Joaquin County, (209) 468-2085, e-mail: marana@ucdavis.edu; **Dave Pratt**, pasture, rangelands, grazing and economics, headquartered in Fairfield, Solano County, (707) 421-6790 7#, e-mail: dwpratt@ucdavis.edu; and **Stephanie Larson**, sheep, water quality and conflict resolution, based in Santa Rosa, Sonoma County, (707) 527-2621, e-mail: slarson@ucdavis.edu. They are collaborating on a quarterly newsletter, *The North Central Region Livestock, Dairy & Pasture Report*. The 16-county region ranges from Marin County in the west to Alpine County in the east, and from Yolo County in the North to Santa Clara County in the south. Contact Larson to subscribe to the free regional newsletter, or contact specific farm advisors to find out about their individual publications.

Small Ranch Manual

Small Ranch Manual: A Guide to Management for Green Pastures and Clean Water, by **John Cobourn** and **Susan Donaldson**, University of Nevada Cooperative Extension, 1995, $2.00. University of Nevada extension water resource and water quality specialists received an Environmental Protection Agency Clean Water Act grant to write this guide because small ranchers are converting a significant amount of commercial agricultural land in the West to non-commercial uses. The manual covers pasture management; irrigation; creek, pond and ditch management; erosion control; animal waste management; wells, septic tank systems; underground fuel storage tanks; pest management; and residential landscape (environmentally sound, low-water use plants). To order, mail a $2 check (postage/handling) payable to "Board of Regents" to Cooperative Extension, PO Box 11130, Reno, NV 89520-2893. Call (702) 784-4848 for quantity rates.

Pesticide Report

Pesticide-Induced Disruptions of Agricultural Ecosystems, by **Kathleen Walker, James Liebman**, and **William Pease**, 51 pages, 1995, California Policy Seminar. This is the fourth report of the Environmental Health Policy Program of the University of California Center for Occupational and Environmental Health, School of Public Health, University of California, Berkeley. It describes the ecological disruptions resulting from pesticide applications (the creation of "super bugs" and the loss of beneficial organisms), and examines management programs that address these problems. Free to California government offices, $12 to general public (checks payable to "UC Regents"). Contact: California Policy Seminar, 2020 Milvia, Suite 412, Berkeley, CA 94704; Tel: (510) 642-5514.

CSA Information

Community supported agriculture (CSA) is a rapidly growing concept/method of organizing smaller farming operations. In CSA projects, consumers buy "subscriptions" to local farms, allowing farmers to plan ahead with prepaid customers. A growing number of resources are available to interested farmers and consumers, including:

- *Community Supported Agriculture*…Making the Connection, 198 pages, binder format, UC Cooperative Extension, Placer County and UC Small Farm Center, 1995. A comprehensive manual on CSAs. $25 plus $5 shipping/handling (Calif. residents add 7.25 % tax). Checks payable to "UC Regents," UCCE, 11477 E Ave., Auburn, CA 95603; Tel: (916) 889-7385.

- *Community Supported Agriculture Conference*, Publication SA-002, 1994, edited by Gerry Cohn , 37 pages. $8. Proceedings from a December 1993 UC SAREP-Small Farm Center CSA conference. Available from UC Agricultural Publications, 6701 San Pablo Ave., Oakland, CA 94608-1239; Tel: in Calif. (800) 994-8849, outside Calif. (510) 642-2431. Checks payable to "UC Regents," Visa/MasterCard.

- *Community Supported Agriculture: The Producer/Consumer Partnership*, a ten-page booklet (XCM-189) introducing the CSA concept, available for $2 (postage/handling) from the Colorado State University Cooperative Extension Resource Center. Send check payable to "CSU" to CERC, Colorado State University, 115 General Services Bldg., Ft. Collins, CO 80523-4061.

For the following three CSA resources, send checks payable to "CSA of North America" to CSA of North America, c/o Indian Line Farm, RR3, Box 85, Great Barrington, MA 01230:

- *Basic Formula to Create Community Supported Agriculture*, a 64-page handbook including budgets, job descriptions, outreach tactics, bibliography, list of projects. $10.

- *Directory* listing many currently active CSA projects by state, including information on number of shares, variety of production, period of distribution, $5.

- *It's Not Just About Vegetables*, an 18-minute video about the core group of the first season at Indian Line Farm. Used to visually introduce the CSA concept to an interested community. $35.

- The e-mail list "csa-l@prairienet.org" for networking on community supported agriculture is now available. The listowners are **John Barclay** (jbarclay@prairienet.org) and **Sarah Milstein** (milstein@pipeline.com). Send an e-mail to either Barclay or Milstein to subscribe.

Additionally, the Bio-Dynamic Farming and Gardening Association, Box 550, Kimberton, PA 19442, offers the following publication on CSAs:

Farms of Tomorrow: Community Supported Farms, Farm Supported Communities, by **Trauger Groh** and **Steve McFadden**. 176-page paperback discusses the CSA philosophy and includes seven case studies. $14.

Farm Video

Pleasant Grove Farms: A Case Study, V94-Z, 22 minutes, **Jan** and **Glenn McGourty** and the UC Small Farm Program, $10. Interviews with **Ed** and **Wynette Sills** of Pleasant Grove Farms in Sutter County, Calif. Covers family goals, the meaning of sustainability, production practices, marketing, community/land use issues. Make checks payable to "UC Regents" and send to DANR Communications Services, University of California, Davis, CA 95616. Visa and MasterCard orders available by telephone: (916) 757-8980.

Sources of Funding

Organic Research Grants

The Organic Farming Research Foundation is offering funds for organic farming research, dissemination of research results to organic farmers and growers interested in making the transition to organic production, and consumer education on organic farming issues. Projects should involve farmers in design and execution, and take place on working farms when possible. Proposals of $3,000-$5,000 are encouraged. Matching funds and/or in-kind contributions are recommended. Proposals are considered twice a year; the next round of proposals must be received by **July 15, 1996**. To receive copies of grant application procedures and the OFRF Research and Education Priorities describing target areas, write Grants Program, Organic Farming Research Foundation, PO Box 440, Santa Cruz, CA 95061; Tel: (408) 426-6606.

Lindbergh Grants

The Charles A. and Anne Morrow Lindbergh Foundation provides approximately ten grants of up to $10,580 each (the 1927 cost of the "Spirit of St. Louis") to individuals whose work furthers the balance between the environment and technological progress. Award categories include agriculture, aviation/aerospace, conservation of natural resources (animal, plant, water, land, air, energy), education (humanities, the arts, intercultural communication), exploration, health (biomedical research, health and population sciences, adaptive technology), and waste minimization and management. Grants are directed at individuals rather than institutional programs. Application materials for the 1997 grants must be postmarked by **June 11, 1996**. For an application, send a self-addressed, stamped business-size envelope to the Charles A. and Anne Morrow Lindbergh Foundation office, 708 South 3rd Street, Suite 110, Minneapolis, MN 55415-1141; (612) 338-1703; Fax: (612) 338-6826; e-mail: lindfdtn@mtn.org or access the Foundation's World Wide Web site at http://www.mtn.org/lindfdtn.

Fertilizer Research Awards

The California Department of Food and Agriculture's Fertilizer Research and Education Program is requesting grant proposals for research and education projects aimed at improving fertilizer use efficiency and preventing groundwater contamination. Proposals must be submitted to the California Department of Food and Agriculture, 1220 N Street, Sacramento, CA 95814 by **April 17, 1996**. For more information and to receive a copy of the Request for Proposals, contact **Casey Walsh-Cady** or **Kertrina Anderson** at CDFA, (916) 653-5340; e-mail: lwcady@ucdavis.edu or jrfranco@ucdavis.edu n

IPM Funding

The California Department of Pesticide Regulation (DPR) is requesting proposals from California groups interested in adopting innovative pest management practices that will lead to the development of reduced-risk pest management systems. The program will provide support for groups of innovators to work with university researchers, private industry, and consultants to set up demonstration projects of new integrated pest management (IPM) systems. Proposals will be accepted until 4:30 p.m. on **November 29, 1996**. For more information and to get a complete Request for Proposals, contact **Jenny Broome** at DPR, Tel: (916) 324-4100; FAX: (916) 324-4088; e-mail: jbroome@cdpr.ca.gov

Funding Resource Note:

Funding-seekers may want to investigate *Environmental Grantmaking Funding 1995 Directory* (March 1995), published by Environmental Research Institute, 1655 Elmwood Ave., Suite 225, Rochester, NY 14620, Tel: (800) 724-1857; Fax: (716) 473-0968. The 700-page directory with information on 600 grantmaking foundations is available for $70 plus $5 shipping and handling.

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The good city and the good life: Renewing the sense of community.

Daniel Kemmis

Houghton Mifflin Company, New York, NY. 1995

Daniel Kemmis, mayor of Missoula, Montana, is one of the nation's most astute interpreters of civic life and the practice of citizenship. This book, based on his experiences as mayor and his travels to communities around the word, documents the small, patient and encouraging steps by which citizens are reviving democracy and building more sustainable communities. Two of the book's primary arguments bear directly on the concerns of sustainable agriculture: 1) the idea that direct marketing arrangements, particularly farmers' markets, are critical not merely for promoting local commercial activity but also as vehicles for civic renewal, and 2) the view that 'citistates' (i.e. cities and their surrounding region) are and should be replacing the nation-state as the proper frame for political and economic life as we head into the next century.

Kemmis begins his investigation of 'the good city' in what might at first seem an unlikely place: the Missoula Farmers' Market. Like many others, Kemmis admires the market as a center of commercial activity which supports nearby farms, including those begun only recently by Hmong residents. But he sees more as well. Amidst the bustle and activity of the market, Kemmis sees the organic creation of a new civility in the city's life; civility which is making possible a renewed and deeper sense of citizenship in the community:

I believe that the way people carry themselves at the Farmers' Market is essentially the way of citizens, and that referring to the market as civilized is an implicit recognition of this fact. . . We know that most cities through most of history have grown up around markets. We know that people needed gathering places in order to exchange material surplus for deficiency, but also to exchange news, stories, joy, and grief. . . . As Steve weighs my broccoli and Lucy counts out my change, the whole history of their farm and of our friendship is part and parcel of what we exchange. Moving back through the market, back to the spot where I'm to meet Abe, I see in dozens of conversations around me an interweaving of these life stories, and I find delight and security in realizing once again that this fabric is Missoula, my home, my city. (p. 5, 11)

Kemmis believes that the cynicism and despair which mark today's politics are a reflection of the lack of occasions for people to be present with one another in ways that acknowledge their wholeness as human beings, and their common dependence on particular places on the earth. Obscured by the groundcover of a more cynical politics, human scale institutions like farmers' markets are quietly but successfully reviving the civic sensitivities required for democratic politics to thrive.

Drawing on the economic thought of Jane Jacobs, and the recent political analysis of Neil Peirce, Kemmis suggests that the economic and political viability of cities and their surrounding regions is increasingly tied to how creatively they develop self-conscious and self-reliant regional economies. Kemmis argues forcefully against government policies that segment urban and rural interests. Not only have these policies allowed suburban sprawl and interests to spread unchecked, they have created the illusion that the economic health of farmers and the economic health of urban centers can be pursued independently:

Throughout history, the role of cities has been precisely to focus, organize, and multiply the resources of the surrounding regions to which they are organically connected. In the era of the nation-state, we had not only lost sight of this role, but what is worse, national policy has misled both cities and their rural surroundings into believing that they could prosper independently of one another, especially if each could open a wide enough pipeline to Washington... One of the best ways for the Agriculture Department to help its rural constituents would be to insist upon a rigorous review of the long list of national policies that have exploded the natural integrity of city-regions, deluding city centers, suburbs, and rural surroundings into ignoring their mutual dependency. (p.119-120)

Reviewer's Comments

Kemmis is correct in suggesting that support for sustainable agriculture and rural development requires more than aggressive lobbying for increased funding of these programs by the USDA. Indeed, he raises a larger question: On whom will farmers and rural residents choose to be dependent? In an age where federal expenditures continue to shrink, and global corporations often exploit communities to benefit stockholders, wouldn't the interests of farmers and rural residents be better served by increasing their links and ties to nearby cities? From this perspective, it appears that the work of building a more sustainable agriculture is inseparable from the work of building more self-reliant regional economies suited to particular places.

As the concept of sustainable agriculture continues to evolve, greater attention is being directed to linking urban and rural interests and building tangible connections between those who grow food and those who eat it. The principle of "systems thinking" has expanded well beyond the farm gate, giving rise to a concern for the "urban-rural interface." In large measure this new emphasis grows from the quite tangible economic stakes that farmers have in developing more beneficial and direct marketing relationships with consumers. But in a larger sense, the new concern speaks to a growing understanding that without shared stewardship of our resources it will be impossible to sustain either the agricultural economy or the quality of life we wish for our cities.

The efforts of individuals to shape a political economy that allows a city and its surrounding countryside to thrive and prosper can be summed up in a too often neglected word. That word is citizenship. In fact, citizenship is the proper name and rightful home of systems thinking applied to public problems. The hallmark of such thought is the effort to attend to the particular needs of citizens without losing sight of the common good, and attend to the whole without losing sight of the value of each particular citizen. It is perhaps not too surprising that farmers devoted to whole systems approaches on their farms are among the nation's most inspiring leaders in sparking a renewed emphasis on citizenship, community building, and civic literacy.

The Good City and the Good Life can be purchased from your local bookseller for $22.95. For more information about farmers' markets and community revitalization in California, contact the reviewer, David Campbell, UC Sustainable Agriculture Research and Education Program, University of California, Davis, CA 95616.

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Contributed by David Campbell

Prospects for a sustainable agriculture in the Northeast's rural/urban fringe.

Pfeffer, Max J. and Mark B. Lapping

Research in Rural Sociology and Development, Volume 6:67-93. 1995

This paper critically evaluates the recent developments of sustainable agriculture at the rural/urban fringe in the Northeast U.S. From the authors' perspective, sustainability relates mainly to diversification of production, pursuit of new markets and a greater local and regional self-sufficiency in food production. The authors present specific agricultural trends for the Northeast in the 1980s and then report how farmland preservation planners see these changes playing out in the future. The authors identify some problems that must be dealt with if agriculture is to survive in the Northeast and policies that have already been implemented to address these problems. They conclude with an assessment of the possibilities for sustainable agriculture in the Northeast's rural/urban fringe.

Background

In response to the farm crisis of the 1980s, many farmers across the nation have begun developing alternative production systems and farm enterprises that are less dependent on the highly specialized, government-supported agricultural system. At one level, these alternative systems are more risky than conventional operations, but a greater diversity of products that take advantage of market niches and that offer premium prices helps compensate for the risks. Such strategies have been particularly successful in rural/urban fringe areas where producers have direct access to urban consumers.

As a result of the successful adaptation of farmers to these new markets and the stabilization of the farmland base near some cities, say the authors, agriculture at the rural/urban fringe is becoming a dynamic sector of the economy, and in fact, may represent a "harbinger of some types of activity that will inhabit these areas in the future" (p. 70). According to the authors, the literature on rural/urban fringe agriculture consistently attributes this dynamism to the spread of residential development into agricultural areas that emerged in the 1970s. Although this phenomenon has created well-documented problems, including cropland losses, complaints about farming practices and loss of farm support businesses, residents also value local agriculture as part of the ambiance they seek.

Farms that have flourished in rural/urban fringe areas have done so largely because they cater to the preferences of nearby residents. They tend to be more specialized in producing high value crops, sell more products directly to consumers, are smaller and make more efficient use of resources. Policies to support these farms have been adopted throughout the Northeast, including right-to-farm ordinances, preferential assessment of farmland, agricultural zoning and purchase of land or development rights. The authors of this paper have two primary concerns: 1) What type of agriculture do these policies aim to preserve? And 2) Will they be successful at sustaining agriculture in the Northeast urban fringe areas for years to come?

Methods

To address these questions, the authors used two main data sources. First, changes in northeastern agriculture were observed using county Census of Agriculture data for 1978 and 1987, the most recent information available. Metropolitan counties in 11 states (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island and Vermont) were identified using the U.S. Census Bureau designation for 1983. The second data source was a survey of professional planners currently involved in land use planning in the Northeast's rural/urban fringe. A mail survey of 259 planners working in the public sector, in private non-governmental organizations (NGOs) and as consultants to public and private agencies, was conducted in the latter half of 1992. The 210 responses returned represented an 81 percent response rate. In addition to fixed-response questions on local planning issues, respondents were asked two open-ended questions about the future of agriculture in their area. These views, along with salient agricultural changes and local farm preservation policies were then evaluated in terms of four criteria for sustainability: emphasis on production for local markets, crop diversity, maintenance of small communities, and the adoption of farming methods that minimize the disruption of ecosystems.

Agricultural Trends in the Northeast's Rural/Urban Fringe

Census data showed that farm numbers and farmland acres in the rural/urban fringe remained relatively stable in the 1980s, although small farms increased and middle-sized farms declined. The largest average percentage declines were in poultry and dairy farms. The largest proportional increase was in farms specializing in animal products. Data and interviews suggested horse farms were the main source of this increase. The authors suggest that the rural/urban fringe may be changing from a locus of production to one of leisure pursuits. In contrast, numbers of farms specializing in field crops, horticultural specialties and vegetables remained the same.

Planners' Visions

Survey results found that planners expressed positive opinions about the prospects for agriculture in their areas. The minority that had negative assessments were mostly from the New England states and felt that urban expansion and farmland conversion would continue and drive up the costs of production, making small-scale production unprofitable. These planners held out some hope for pasture-based animal production on marginal lands.

Those expressing the majority opinion emphasized the importance of market opportunities associated with access to urban markets. They felt that local agriculture was competitive with other regions, given a situation where producers are treated equally in terms of various government subsidies. Most still admitted that farms directly on the urban periphery would be converted to other uses, yet they also saw urban development creating new market opportunities for produce and nursery products through local outlets. These views run counter to dominant development trends in the U.S. which have led to increasing regional concentration.

Planners do not envision a type of agriculture at the rural/urban fringe that will be oriented toward self-sufficiency in food, but that will exploit diverse, lucrative specialty niche markets in the region. These markets include a variety of nontraditional commodities such as the growing ethnic demand for sheep and goat products and "boutique" farm specialties, as well as farm involvement in services such as tourism, recreation and education. These activities are expected to become an important income source and contribute to the economic development of the region.

Planners expect to meet regional food demands in two ways: 1) through the strong rise in direct marketing to consumers (e.g., farm stands, U-pick operations, local farmers' markets and 2) by supplying larger regional markets in nearby large urban centers. On the other hand, planners disagree about the likely future structure of agriculture in the region. About half expect farm consolidation and the other half feel deconcentration will occur. In both cases, according to the authors, we can expect more diversification on farms as well as a more diverse farm sector within local areas.

Although planners devoted much attention to the economic aspects of local agriculture, very little concern was directed toward the environment. Few thought problems such as soil erosion, pesticide drift, or water pollution would be problems in the future and that local agriculture, in general, is environmentally friendly and a preferred use of the land. They expected that local agriculture will be more important as dwindling energy supplies make local food sources more attractive to urban populations.

Even though the Northeast rural/urban fringe agriculture may be important for meeting future food needs, planners identified several problems that threaten farm survival. It is most threatened by development pressures and farmland conversion to non-farm uses. Related problems include the "parcelization" of farmland as a result of poor zoning regulations, and the decreased opportunities for young people to enter farming because they can't compete with developers for valuable land.

There are some policies to preserve agriculture in rural/urban fringe areas and these are strongly supported by planners. Preferential farmland tax assessment is the most common measure found in all states of the region. Purchase of development rights (PDR) programs were also fairly common (in 60 percent of the counties studied) and were enthusiastically endorsed by planners. Under PDR programs, farmers voluntarily sell their development rights and receive payment for development restrictions through public funds. Although popular, PDR programs are expensive and the demand for them often exceeds the funds available. Other policies have also been enacted to preserve farm enterprises, such as zoning for roadside stands, farmers' markets, housing for farm labor, etc. Planners indicate these policies are not as important as farmland preservation. They view farmland preservation as more of "a means to promote an orderly and efficient pattern of growth" vs.

"a limit to overall growth."

Conclusion

From this evidence, the authors conclude that farm enterprises must increasingly orient their production toward alternative markets. Farmers in rural/urban fringe areas are successfully taking advantage of the demand for local, specialty food and farm products. The dominant sentiment from planners is that local agriculture is desirable and should be encouraged through local policies. This type of agriculture is consistent with the bioregional approach articulated by environmentalists and others, which emphasizes the consumption of food produced locally within a particular region. However, the capacity of local agriculture to sustain the natural resource base in these areas is limited in scope. Planners expect an emphasis on high value commodity production, marketed mainly to affluent consumers. Development pressures will continue to pose serious threats to farmland preservation. Given this scenario, the authors suggest that efforts are needed to intervene in land markets and to enhance the viability of existing farms. The effectiveness of these efforts hinges on three critical areas of public support: 1) the demand for regional farm products and services, 2) farmland protection, and 3) continued willingness of the public to provide financial support for acquisition of farmland. Although a strong base of support for rural/urban fringe agriculture and its products and services has been established, this trend will need to continue lest farmland preservation become narrowly defined as open space protection. The extent of the public's investment and sacrifice in an era of tight budgets will ultimately determine the future of agriculture in the northeast.

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(GWF.196)

Contributed by Gail Feenstra

Organic and conventional management effects on biologically active soil organic matter pools.

M.M. Wander, S.J. Traina, B.R. Stinner and S.E. Peters

Soil Science Society of America Journal 58:1130-1139. 1994

Five years ago, we reviewed a research paper detailing the results of the first phase of a cropping systems experiment conducted at the Rodale Research Center in east-central Pennsylvania [Liebhardt et al. (1989), reviewed in Components 2(2):2-3]. Three different farming systems were compared (Table 1): low-input/livestock, low-input/cash grain and conventional. Each system was monitored for: 1) grain and hay yields, 2) corn dry matter production, 3) leaf tissue nutrient concentrations of corn, soybean, small grains, 4) green manure biomass and nutrient content, 5) animal manure nutrient content and quantity applied, and 6) weed biomass in both corn and soybean. The experiment underwent a typical conversion scenario where the productivity of the land converted from conventional to low-input management was suppressed for a few years, after which yields rebounded to equal or exceed those in conventionally managed plots. Results of this study pointed to three principles that growers could use as they planned for conversion from conventional to lower-input or organic systems.

1) Begin with crops that have a low nitrogen requirement or that fix their own nitrogen. Initial crops should also be able to compete against the weeds present in the field.

2) Shift between warm- and cool-season crops in the rotation. This practice disrupts the life cycles of various weeds and reduces competition in alternating crops.

3) Facilitate the transition period by gradually reducing fertilizer and pesticide inputs. Herbicides can be banded and used in conjunction with cultivation; nitrogen fertilizers can be used to supplement nutrients added from animal or green manures.

The current article examines the role that organic matter plays in how the different farming systems function. In fact, total soil organic matter as measured over the course of the experiment was not particularly useful in monitoring soil quality or predicting the effects of various management practices. However, the transition effect (rebounding productivity after a period of several years) may actually be associated with more subtle beneficial changes in the biologically active fraction of soil organic matter, according to the authors. The overall objective of their research was to investigate the popular concept that "sustainable" management practices enhance that particular fraction of soil organic matter which is biologically active. This hypothesis was addressed by measuring soil biological activity (soil respiration), soil nitrogen supply capacity (available inorganic and mineralized nitrogen), water-dispersible organic matter pools, and particulate soil organic matter pools in the three farming systems.

Table 1. Crop sequences for three farming systems studied in the Rodale experiment.

Table 1. Crop sequences for three farming systems studied in the Rodale experiment.

		-- ROTATION --				
Farm System	**Entry Point**	**1981**	**1982**	**1983**	**1984**	**1985**
Low-Input/ Livestock	1	oat + clover	clover (yr.2)	corn	soyb	corn (feed)
	2	corn	soyb	corn (feed)	wheat clover	clover (yr. 2)
	3	corn (feed)	wheat clover	clover (yr. 2)	corn	soyb
Low-Input Cash Grain (Cover Cropped)	1	oat + clover	corn	oat + clover	corn	soyb
	2	soyb	oat + clover	corn	wheat	corn
	3	corn	soyb	oat + clover	corn	oat + clover
Conventional	1	corn	corn	soyb	corn	soyb
	2	soyb	corn	corn	soyb	corn
	3	corn	soyb	corn	corn	soyb

Rotations in the livestock-based and conventional systems for 1986 to 1990 were nearly identical to those shown for 1981 to 1985; in the cover cropped system, various intercepts of barley, wheat and or soybeans were substituted for species cropping.

Results and Discussion

After ten years, net changes in total soil organic matter were small (Table 2). Increases in the animal-based system, for example, averaged only a few tenths of a percent between 1981 and 1991. But this bulk measurement does not adequately represent the important changes and dynamics involved in other soil organic matter characteristics. Results of this experiment show that two kinds of organic matter change were at work in the alternative systems: 1) accumulation of biologically active soil organic matter; and 2) accumulation of more stable, yet still labile, soil organic matter.

Table 2 Changes in total soil carbon and nitrogen between 1981 and

1990.				
	Carbon		**Nitrogen**	
Farming System	1981	1990	1981	1990
Livestock-based	22.7a(1)	23.4ab	3.31ab	3.5a
Cover Cropped	23.6a	24.5	2.87b	3.42ab
Conventional	22.31	21.3b	3.41a	3.25b
(1) Treatment means within columns followed by different letters are significantly different based on Fisher's protected LSDs (P<0.05).				

Biologically active soil organic matter was most closely associated with measurements of soil nitrogen supply and soil biological activity. The animal-based rotation improved this organic matter fraction the most, based on the apparent rates of soil organic matter turnover and biological activity, which were greater in this treatment than in the other two treatments (Figure 1).

The more stable (but still labile) organic matter pool, on the other hand, was more closely associated with the particulate soil organic matter fraction, and showed greatest accumulations in the cover cropped plots (Figure 2). Even though respiration rates were greater in the cover cropped soil than in the conventionally managed soil, and even though the cover cropped soil received the least total carbon (based on inputs of aboveground residues), it was still a better net carbon sink than the other systems. The reason for this phenomenon appears to be that this particulate, or LF (light fraction), organic matter is stabilized or protected to some degree in the soil matrix. Therefore, although the LF organic matter is accessible to microorganisms, it metabolizes more slowly than the active fraction. One study has shown it has an intermediate turnover rate averaging about 2.31 years (Jenkinson and Rayner, 1977). Additionally, Rodale researchers report that the LF or particulate organic matter in their experiment had roughly three times more nitrogen than the surrounding soil solution. Under these conditions, the moderately stable organic matter that can accumulate in legume cover cropped systems is reported to adequately meet nutrient supply demands of most agricultural systems.

In summary,

…accumulated organic matter in the manure-amended soil was the most labile whereas the cover cropped soil accumulated the most organic matter overall. In the cover cropped soil, higher total carbon and nitrogen, particulate soil organic matter, and reduced water-dispersible organic matter indicated that its soil organic matter was more stable than organic matter in the other two treatment soils. The conventionally managed soil had the lowest biological activity (nitrogen supply and soil respiration rates) and did not accumulate soil organic matter during the 10-year experiment.

From these results, the authors conclude that the LF organic matter is a functionally important soil organic matter pool, and that assays of the particulate residues that make up this fraction may provide the best characterization of the quality and quantity of organic matter in agricultural soils and, ultimately, the performance of cropping systems based on those soils.

Click here to view figures

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(DEC.536)

Contributed by David Chaney

A comparison of conventional, low-input and organic farming systems: The transition phase and long-term viability.

David Chaney

Adapted from UC SAREP Progress Report 1993-1995. UC Sustainable Agriculture Research and Education Program, Davis, CA. 1996

Editor's note: This research summary is based in part on a series of articles featured in California Agriculture, Volume 48, Number 5, 1994, University of California, Division of Agriculture and Natural Resources, Oakland, CA. The project is supported primarily by the USDA's Western Sustainable Agriculture Research and Education (SARE) program and UC SAREP. Additional funds have also come from the California Department of Food and Agriculture's Fertilizer Research and Education Program and the H.J. Heinz Foundation.

This review summarizes some of the latest information coming out of a long-term research project at the University of California, Davis. The project, now entering its ninth year of operation, has been set up to describe and quantify the environmental, agronomic and economic consequences of the transition from conventional farming systems to systems that are less dependent on synthetic fertilizers and pesticides. The focus is on cropping systems typical of the southern Sacramento Valley in California. The research team is multidisciplinary, and participating farmers and UC Cooperative Extension farm advisors play a key role in guiding the management decisions applied to the various production systems. By broadening and integrating the scope of investigation, researchers have been able to critically evaluate the success of different farming practices and their effects on the environment, as well as the special requirements for adapting alternative practices to farms in other locations.

Rotations and Experimental Design

The project was initiated in 1988, and is located on 28 acres at the UC Davis Agronomy Farm. The main experiment occupies about 20 acres and compares four cropping systems: 1) a conventional two-year rotation; 2) a conventional four-year rotation; 3) a low-input four-year rotation; and 4) an organic four-year rotation. The four systems are arranged in a split-plot design with four replicates of each system. All the cropping systems include processing tomatoes, a high-value commodity grown on approximately 310,000 acres in California (1990 data). Other cash crops grown include wheat, safflower, field corn, and beans. In addition, winter-spring cover crops are grown in the low-input and organic systems. The specific rotations used in the different management systems are shown in Table 1. Each replicate of the four systems started the rotation in 1989 with a different entry point in the sequence of crops.

Observations and Results

Researchers have been collecting data on: crop growth, yield and quality; soil biology; soil fertility; soil organic matter levels; soil water infiltration rates; weeds, pest and beneficial insect populations and disease levels; and economic performance. Some of the key findings and questions for future research are summarized below.

Crop growth and yield. Soil fertility and weed management have been identified as the most important factors limiting yields in the organic and low-input systems. Project managers have altered production practices to address these constraints. Organic and low-input tomatoes, for example, are now transplanted instead of direct seeded. This practice leaves more time for cover crop growth, gives tomatoes a head start in competing against weeds and allows for the use of efficient mechanical cultivation techniques. Manure fertilizers and foliar sprays have also improved yields in the organic systems. Nonetheless, it has been difficult to obtain the high quality transplants necessary for optimal growth and yield. In the 1994 growing season, for example, researchers found that transplants in the organic and low-input systems were infected with a virus. Symptoms became apparent four to six weeks after transplanting, and yields in the organic and low-input systems were lower than in the conventional systems.

Soil biology and fertility. Nitrogen availability appears to be an important factor determining tomato yields during the transition to organic production. Prior to 1992, tomato plants in the organic system were stunted and yellow early in the season, did not compete well with weeds, and had yields lower than tomatoes grown under conventional methods. These results were despite the fact that soil nitrate levels in the organic tomatoes in 1990 and 1991 were actually higher than or equivalent to levels in the conventional system. The reason for this phenomenon is probably related to the importance of microbial activity in an organic system. Unlike the conventional system where plants obtain nutrients from highly soluble chemical sources, the organic and low-input systems rely on microorganisms to make nutrients available for plant uptake. Through the first four years of the rotation, it has been determined that the low-input and organic systems derived 85 percent of their nitrogen from the vetch cover crop that was incorporated into the soil and broken down by microbes.

Table 1. Summary of crop rotations used in four management systems.

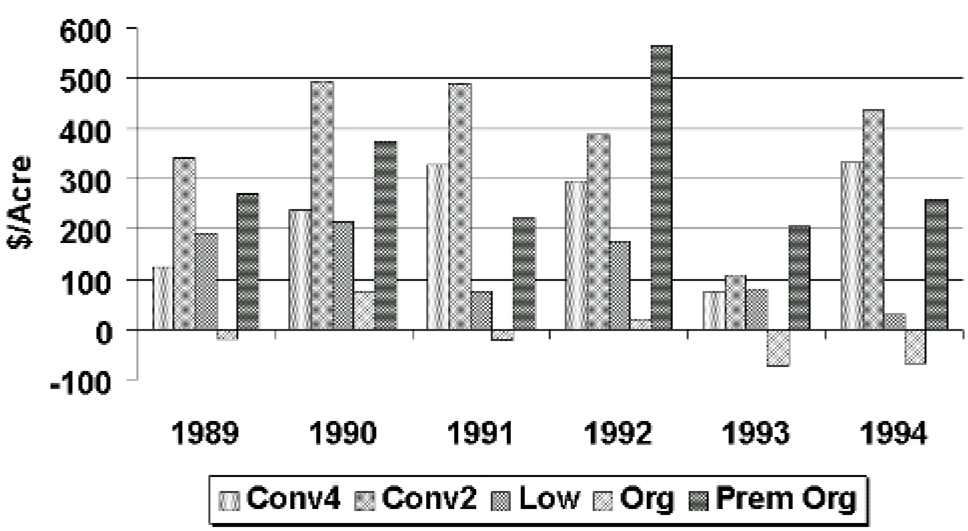
	Year 1		Year 2		Year 3		Year 4	
Mgmnt. System	**Fall**	**Spring**	**Fall**	**Spring**	**Fall**	**Spring**	**Fall**	**Spring**
Conventional (2yr)	fallow	tomato	wheat		fallow	tomato	wheat	
Conventional (4yr)	fallow	tomato	fallow	safflwr	fallow	corn	wheat	beans
Low-Input	cover**	tomato	cover	safflwr	cover	corn	oat+ vetch	beans

Organic	cover	tomato	cover	safflwr	cover	corn	oat+ vetch	beans
**Cover crop used have included vetch, oats, cowpeas, solely or in mixtures. Other species are currently being evaluated.								

To measure the importance of soil microbial activity, researchers looked closely at changes in microbial biomass carbon over the growing season. Microbial biomass carbon is an estimate of both the size of the total microbial community and the mass of potential plant nutrients contained within the cells of the microorganisms. This variable was measured in tomato plots four times between March and September in both 1990 and 1992. Levels of microbial biomass carbon fluctuated similarly in all systems over the growing season. In 1990 the only significant differences among the four farming systems occurred following the early April incorporation of the cover crop, at which time the microbial biomass carbon was higher in the organic and low-input systems. In 1992 microbial biomass carbon was higher in the organic and low-input systems throughout the growing season.

Related studies have shown some interesting differences in nematode populations among the four farming systems. Nematodes can be classified by what they feed on: bacteria, fungi, plants, or other nematodes. In the two conventional systems, the total numbers of all nematodes in the soil (to 30 cm depth) did not change significantly between 1988 and 1992. In contrast, during the same period, there were significant decreases in the total number of nematodes in the low-input and organic systems. Bacterial feeding nematodes are of particular interest because of their role in mineralizing nitrogen. Thirteen of these species have been identified in this research site. The proportion of all nematodes that are bacterial feeders declined over the four years in the two conventional systems, increased in the low-input system and declined in the organic system. The decline in the organic system is surprising given the high levels of microbial biomass measured in those plots. Researchers suggest that the late sampling date for nematodes may have been responsible for this discrepancy.

Figure 1. Whole Farm Profits per Acre



Insects, Weeds and Diseases. The shift from conventional to low-input or organic pest control did not result in large increases in relative abundance of most pest species over the period of this study. However, there were some significant short-term problems in individual farming systems. Significantly greater damage occurred in organic and low-input plots due to tomato fruitworm in 1989 and stink bugs in 1992, while insecticides prevented damage to conventional plots. Similarly, the cover crop residue appeared to increase damage by seed corn maggot to safflower and corn in two consecutive years. Verticillium increased in soils on the conventional two-year plots, probably because of the increased frequency of tomato plantings in this system. The presence of the disease organism, however, does not seem to have affected yields in those plots. Bacterial spot of processing tomato was severe in the spring of 1993, due to rain and a hailstorm. Aerial treatments were not practical for the small plots in this study, but by the time the fields had dried sufficiently for ground application, the weather was hot and dry, stopping the epidemic. Rust occurred every year on all safflower plots. However, it was not observed to cause yield loss. Corn smut was observed in all plots, but the level of its incidence remained below the treatment threshold.

Weeds were a problem in all systems, but the different control methods employed in each system favored the growth of several key species. In the low-input and organic systems, barnyardgrass has become a significant problem. In the conventional systems, field bindweed and nightshade have been more problematic. The shift to these weed species has resulted in modifications to the control strategies, including herbicide changes or increased cultivation frequency, but there has been little or no change in total weed cover. The vagaries of the weather presented an added challenge in low-input and organic systems. For example, the wet spring in 1993 prevented timely cultivation and resulted in increased weed competition in the organic corn where herbicides were not used.

Economics. Results to date suggest that similar crop yields may be obtained when "best farmer" management practices are used in each of the different systems. Similar yields, however, do not necessarily translate into similar profits. The yields and organic price premiums of tomatoes, and year-to-year variation in production costs for each system were the most important factors determining relative whole-farm profit (Figure 1). During the 1991 growing season, for example, gross returns, per acre operating costs, and net returns above total costs were all highest in the conventional two-year rotation (all crops combined). The 1992 season, by contrast, showed that the organic systems had the highest figures in each of these same categories. Reduced whole-farm profits per acre in the 1993 and 1994 seasons can be attributed to problems with tomato transplants as described earlier.

Results of this study support what other studies have found: The transition period (as evidenced by the performance of the low-input system) carries significant risk. There are no price premiums for "transitional commodities," costs of production may be high, growers are generally on the steep part of the learning curve, and the new production system can be ecologically unstable for a time.

Conclusions

From the standpoint of crop performance and yield, it appears that a rotation of processing tomatoes, safflower, field corn and wheat or winter legume, followed by double-cropped dry beans, is a good crop rotation on which to make systems comparisons. The use of nitrogen-fixing winter cover crops for green manure and as seed crops has merit, but also resulted in crop management challenges that required "best farmer" experience and flexibility to work within the constraints imposed by time and weather. The late winter, early spring management of cover crops, including residue management, seedbed preparation, supplemental manuring and the retention of sufficient soil moisture to germinate tomatoes, corn and safflower has become a central research theme for continuing studies in the large companion plots adjacent to the main experiment. The interdisciplinary group is focusing on several key issues as the project continues its second rotation cycle. These include identifying the best cover crops for each system/season combination and observing phenomena that have an impact on soil fertility and plant nutrition, particularly the season-long monitoring of cover crop nitrogen, crop growth and yield. The long-term implications of weed control, as well as the related demand for creative management and appropriate equipment, are critical.

Conclusions about the preferable crop with which to enter the rotation are still premature. The attractive premiums offered for organically grown tomatoes, and regulations that specify a minimum of three years without pesticides prior to certification, suggest that field corn would be the best starting point of the rotation, but pest control (and especially weed management) implications of this choice must be considered. Choices will also depend on the grower's economic situation and a consideration of the wide range of costs and returns for the five cash crops in the rotation. The challenges of managing winter cover and grain legume cash crops without herbicides (organic), or with short-lived, post-emergence herbicides (low-input), are at least partially offset by the opportunities to plant or replant catch crops, such as spring barley after lupine and pink beans after safflower in this study.

For more information contact the SAFS Project: Department of Agronomy and Range Science, Davis, CA 95616. (916) 752-8940.

The UC SAREP Progress Report 1993-1995 may be ordered from SAREP, University of California, Davis, CA 95616, Tel. (916) 752-7556, and is available through the SAREP homepage on the World Wide Web.

(DEC.537)

Contributed by David Chaney

Organic and conventional management effects on biologically active soil organic matter pools.

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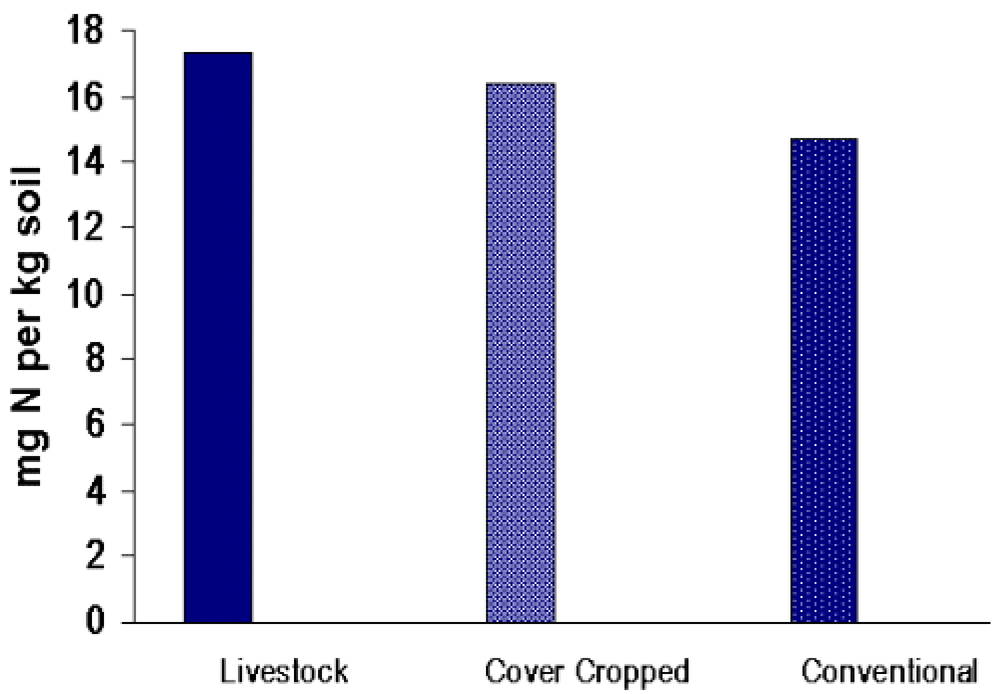

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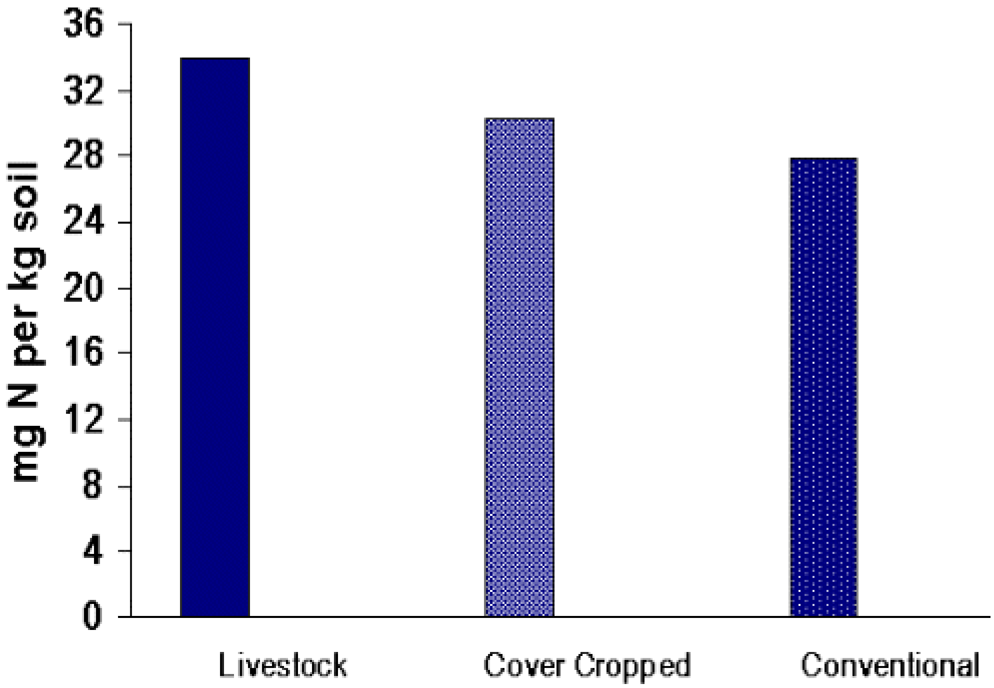

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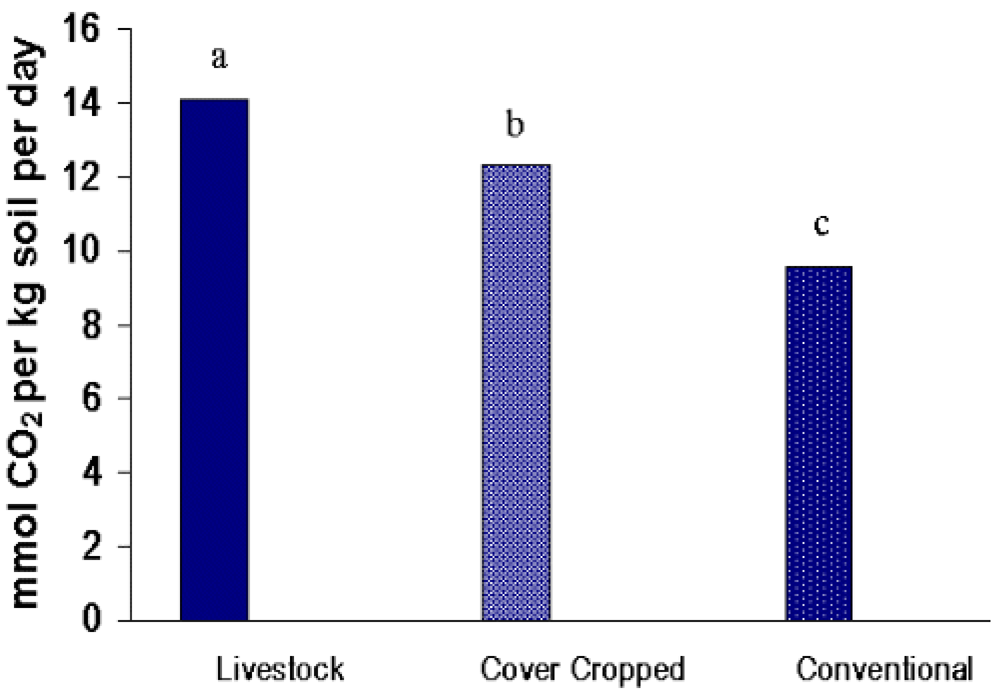

Figure 1. Average soil nitrogen supply and respiration rates in three different farming systems in 1990: I. Available inorganic nitrogen. II. Mineralized nitrogen. III. Whole-soil respiration rates. Different letters indicate treatments were significantly different based on Fisher's protected LSD ($P<0.05$). Mean separation based on pooled ANOVA is not indicated in I and II because soil nitrogen supply (available and mineralized nitrogen) parameters had significant date x treatment interactions; however, the appropriately calculated LSDs would distinguish between the animal-based and conventional treatment.

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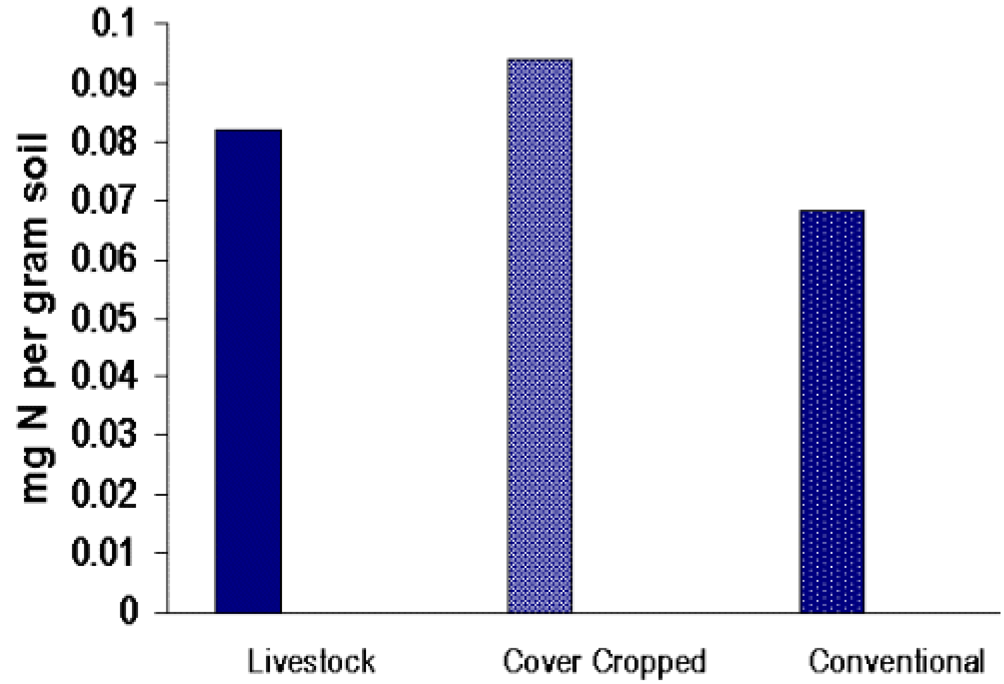

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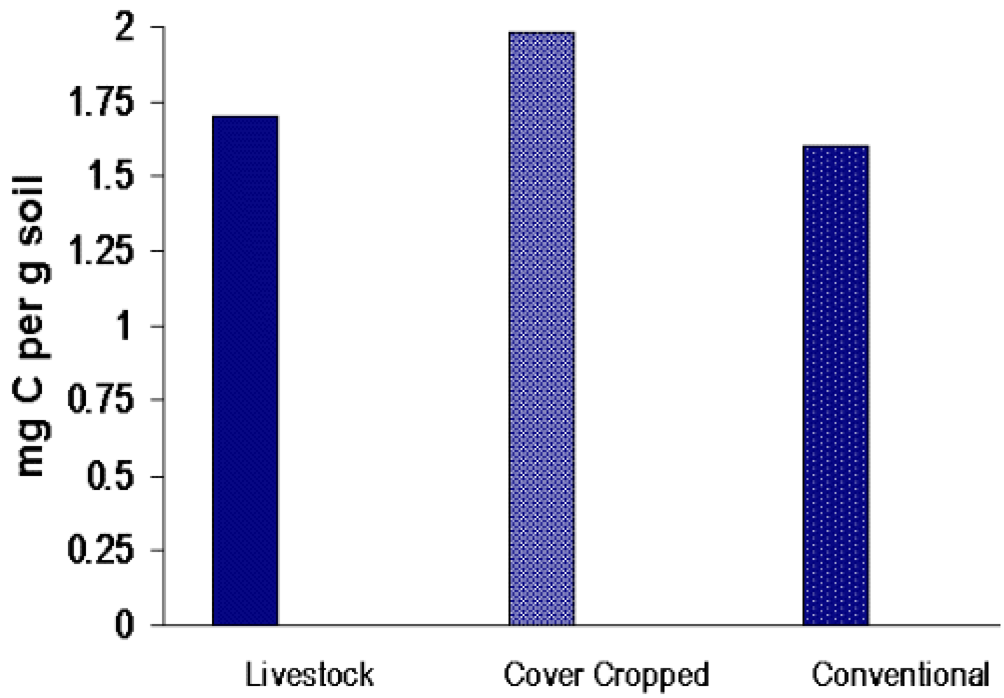

Figure 2. Average soil light fraction (LF) measurements in three different farming systems in 1990: I. Carbon. II. Nitrogen. Different letters indicate significantly different seasonal averages based on Fisher's protected LSD (P<0.05).

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