Winter 1992

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BGH, Rotational Grazing & Land Grants

Recently I participated in The Joint Economic Committee of Congress' hearing on *Agricultural Industrialization and Family Farms: The Role of Federal Policy*. I was asked to discuss a multidisciplinary project I have been coordinating that compares bovine growth hormone (bGH) and rotational grazing, a pasture management technology. **Suzanne Smalley** of Michigan State University Extension was among those panel members who responded to my presentation. She noted that in Michigan many farmers have asked the university for information about how rotational grazing has been used by other farmers. Unfortunately, although the scientists at MSU have information on bGH, they have very little on rotational grazing, she said.

If Land Grant universities' mission is to serve the citizens of the states, how is it that we have such a dichotomy between information people apparently want from universities and what many scientists are prepared to deliver? This issue may go to the heart of the questions that are important to Land Grant universities. Almost across the board, American universities are suffering severe budget cuts. University scientists feel forced to seek industry grants to continue their research. This is the case with bGH. Biotechnology companies provide research money to help develop this product. Taxpayers' money (faculty salaries, laboratories, research farms) is used for private product development. That means industry grants can set the research agenda. Rotational grazing is a management approach that produces few products that can be sold, and it therefore does not attract large industrial development grants.

I also suspect that most scientists are looked upon more favorably by their peers if they work on bGH rather than on rotational grazing because the growth hormone appears to be more "scientific." All of this suggests that for some Land Grant university scientists, their clients are other scientists rather than the people they are meant to serve. It also raises practical and ethical questions about how research agendas are determined and how the public's money is spent.

Who makes the decisions about where agriculture is headed? How can the public interest be safeguarded? These are very difficult ethical and pragmatic questions, but support of and good will toward public Land Grant universities in the 1990s may well depend upon how well we answer them. Let's use the dairy industry as a case study, and avoid shaping its future by default: "The money was there for research and we developed a product" is not acceptable. An agricultural research agenda attuned to the public's needs is developed through an open process involving the people of the *state. -Bill Liebhardt, director UC Sustainable Agriculture Research & Education Program.*

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National Sustainable Agriculture Program Update

The Operations Committee of the national Sustainable Agriculture Research and Education (SARE, formerly, "LISA") program met in Washington, DC November 19-20, 1992. The two-day meeting included updates on the four regional SARE programs:

- In 1992 the Northeast region took the lead in developing a 124-page handbook, "Managing Cover Crops Profitably"; funded 12 new projects; began a newsletter "Innovations" by communications specialist **Beth Holtzman**; and started a program of minigrants for farmers.
- Major accomplishments of the Southern region include a 26-page booklet of FY 1992 Accomplishments and FY 1993 Goals and Activities; the development of a "State of the South" report; and planning for a regional conference to be held in March 1993.
- The Western region continues to stress systems analysis in its calls for proposals, and developed a paper to stimulate thinking on the topic. Both a research conference and an Extension conference are being planned.
- Activities in the North Central region include the funding of 26 projects under the new producer mini-grant program; a strategic plan; and increased outreach by the new communications specialist, **Lisa Jasa**.
- While most SARE projects are funded by these regional programs, a few projects of national scope are funded nationally. Updates of these projects were also presented at the meeting:
- **John Ikerd** of the University of Missouri is leading a team of sociologists and economists developing a framework for integrating Quality of Life issues into the SARE program.
- **Harry Wells** of the Environmental Protection Agency heads the Agriculture in Concert with the Environment (ACE) program, that has been co-funding research and education on agricultural pollution prevention strategies with SARE.
- **Jayne MacLean** directs the Alternative Farming Systems Information Center at the National Agricultural Library, which publishes free "quick bibliographies" and answers a wide range of questions.
- **Greg Gajewski** of the Economic Research Service is steering a team of economists who are conducting a national study of the economic and

social impacts of sustainable agriculture.

- UC SAREP's **Jill Auburn** chairs the committee developing the Sustainable Agriculture Network (SAN), which is collating information on sustainable agriculture into publications and databases offered on diskette and via the Internet wide-area computer network.

- The Center for Farm Financial Management, **Richard Hawkins**, director, at the University of Minnesota is the home of Planetor, a computer program for farming decision analysis that helps farmers understand the whole-farm implications of their management decisions.

- **Dixon Hubbard** of the Extension Service reported on demonstration projects and workshops funded in all four regions.

Contacts for more information about the SARE program:

Northeast: **Fred Magdoff**, Dept. Plant & Soil Science, University of Vermont, Burlington,VT 05405

North Central: **Steven S. Wailer**, 207 Agriculture Hall, University of Nebraska, Lincoln, NE68583-0704

South: **William H. Brown**, Ag. Experiment Station, Louisiana State University, P.O. Box 25055, Baton Rouge, LA 70894-5055

West: **David Schlegel**, University of California, DANR/OPIA, 300 Lakeside Drive, 6th Floor, Oakland, CA 94612

Free Diskette of Research Project Summaries

*(Editor's note: The following article is by **V Philip Rasmussen,** professor and chair of the Agricultural Systems Technology Department, Utah State University. In formation has been added to assist California readers in ordering disks.)*

We announce the release of the Folio InfoBase of project summaries of the United States Department of Agriculture Sustainable Agriculture Research and Education program (USDA-SARE). The disk includes all projects reported from the four USDA-Cooperative State Research Service regions for the past three years. In addition, it includes reports of the Environmental Protection Agency-USDA "ACE" research and education program (Agriculture in Concert with the Environment). This InfoBase demonstrates how quickly sustainable agriculture information can be retrieved through computer database systems.

InfoBases provide an extremely cost effective and easy way of distributing information. A Folio InfoBase is a unique and unprecedented form of data storage and retrieval unlike most flat-file or relational data base systems. An InfoBase is a stand-alone file of text information (usually compiled from standard word-processed files such as WordPerfect, Wordstar, Word, etc.) wherein each word is pre-indexed. In addition, an InfoBase is compressed so that it occupies much less disk space than the file from which it was derived. InfoBases can easily be distributed as run-time versions, relieving end users of the need to have Folio software to use the InfoBase. Hence, it is ideally suited to applications where users are given a disk and instructions, but do not have access to any particular data base program.

Thus, there are major advantages of an InfoBase over a system such as dBase or Paradox. For example:

- The system does not require any pre-determined structure-any ASCII or word-processed file is usable.
- Original text is compressed and occupies much less space than a word-processed file.
- All original text (though compressed) is readily available as text and can be cut and pasted from within the InfoBase for transfer to new word-processed files.
- InfoBases can be distributed as run-time modules so that users do not need to purchase any special software.
- InfoBases operate efficiently on existing IBM-compatible platforms including XTs so there is no need to purchase new hardware.

The power of an InfoBase is tapped when the user presses the keyboard space bar to do a global text search. For example, to search for all occurrences of the word "alfalfa" in an InfoBase of research abstracts, simply press the space bar and type "**a**." Immediately, the InfoBase narrows the search and finds all words that begin with "a." Finish typing "**lfalfa**" and the InfoBase might indicate that there are 22 occurrences of "alfalfa" in the InfoBase. If "**alfalfa weevil**" is typed, powerful Boolean logic options collate the information and might reveal that there are 22 occurrences of "alfalfa" and 33 occurrences of "weevil" and 5 occurrences of both "alfalfa" and "weevil" in the same project.

We believe that InfoBase systems represent one of the most important developments in fast information transfer of the past decade. We are not necessarily endorsing the product, nor is the USDA, Environmental Protection Agency, or the Sustainable Agriculture Network. However, we do think it represents a class of hypertext technology that could revolutionize how we search for information to help us in our sustainable agriculture management efforts.

To request a copy of the SAN InfoBase, please send us a blank, formatted, 3.5 or 5.25 inch, high density IBM compatible disk and a self-addressed mailing label. From California, send it to: SAN Infobase, do **Jill Auburn**, Info. Group, SAREP, University of California, Davis, CA 95616. From outside California, send it to: **Phil Rasmussen**, Chair, Agricultural Systems Technology Dept., Utah State University, Logan UT 84321.

The program includes a run-time search capability so you do not need any additional programs to operate it. Just insert it into an IBM compatible high density drive and type SAN.

This project was funded by the national Sustainable Agriculture Network project (see *Sustainable Agriculture News, Vol.4, No.1, Fall 1991).* This project represents academic, agribusiness, and private organizations dedicated to information exchange in sustainable agriculture.

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SAREP Funds New Projects

Thirteen projects focusing on production and social, economic and public policy issues in sustainable food and agricultural systems have been awarded $118,266 in grant money from UC SAREP according to **Bill Liebhardt**, director of the program. Additionally, four graduate students and coordinators of eight sustainable agriculture seminars have been granted a total of $12,000.

Economics and Public Policy

David Campbell, SAREP economic and public policy analyst coordinated the social, economic and public policy grant process. The four projects funded in this area include:

- **Peter Lehman**, Engineering and International Development Technology, Humboldt State University, Arcata, CA: $11,730. The Arcata Farm and Education Project will create a student-operated, community supported two-acre farm in the city of Arcata to be used for sustainable agriculture projects by students, community members and local farmers. The farm will be used as an educational facility to teach university students sustainable small farm management skills, to offer classes to local farmers and community members, and to give local youth groups a place to experiment with sustainable agriculture and husbandry projects. Community members can also participate by buying shares in the farm for which they will receive a weekly supply of fresh produce.

- **Monica Moore**, Pesticide Action Network, San Francisco, CA and **Angus Wright**, Dept. of Environmental Studies, California State University, Sacramento, CA: $13,555. This project will contribute to the development of a pesticide use reduction policy for California by outlining successful policies in European countries, with an analysis of elements that might be appropriate for California. The final product will be an outline of a pesticide use reduction proposal for California, and suggestions for an implementation strategy.
- **Desmond Jolly**, Extension Agricultural Economist, UC Davis and **Stan Dundon**, Dept. of Philosophy, California State University, Sacramento, CA: $8,770. This project will create an Agricultural Professional Ethics program to empower farm advisors, educators, researchers and practicing agriculturalists to explicitly employ ethical considerations in decisions that have ethical implications. With input from an advisory committee of farm advisors, farmers, researchers, packers, retailers and consumers, a curriculum will be developed with

instruction manual, slides and/or videotapes which can be used in a variety of teaching formats.

- **Ann Baier**, Rural Development Center, Salinas, CA: $10,750. This study will evaluate the impact of the Rural Development Center's (RDC) program and goals which provide information and training to low-income, minority and entry-level farming families in the Salinas Valley. By interviewing former RDC students and minority farmers, this study will identify and document key factors and farmer characteristics which contribute to a successful transition to ecological farming operations in this region.

Monitoring and Component Research

Nine projects were funded that focus on monitoring and component research in sustainable production systems, according to Chuck Ingels, SAREP perennial cropping systems analyst. The dollar amounts listed for these projects are for the first year only. The projects include:

- **Steven Koike**, Monterey County farm advisor: $3,850. Several cover crop species will be evaluated for their susceptibility to the lettuce drop pathogen. After specific cover crops have been incorporated in fields, the subsequent lettuce planting will be evaluated for the disease.

- **Donald Dahlsten**, Biological Control, Gill Tract, Albany: $14,487. This project will determine the numbers and species of several beneficial arthropods in cover cropped versus clean cultivated vineyards and in single-wire versus multiple-wire or arbor trellis systems. It will also determine the critical time during which the presence of a cover crop is most beneficial.

- **Bill Williams**, Agronomy and Range Science, UC Davis: $8,700. Dryland legumes will be evaluated for pasture, range, vineyard and farming systems in Northern California. The project will also expand and maintain a native grass nursery and a collection of plants to fill requests.

- **David Pratt**, Solano County farm advisor: $9,870. Ley farming is a cereal grain/pasture rotation system developed in Australia. This project will study the effect of timing and severity of grazing on several key components of a ley farming system.

- **Elizabeth Mitcham**, Pomology, UC Davis: $10,000. Postharvest hot water immersion treatments will be explored for their potential as a non-chemical alternative for control of certain diseases and physiological disorders of apples, pears, kiwifruit, nectarines, pomegranates and persimmons.

- **Eric Natwick**, Imperial County farm advisor: $10,000. The B-strain of the sweetpotato whitefly has become an extremely damaging pest of alfalfa hay production in the last two summers. This project will develop a nonchemical management strategy of shortening cutting cycles to minimize damage from the whitefly while maintaining yield, quality and stand strength.

- **Donald Phillips**, Agronomy and Range Science, UC Davis: $10,000. Flavonoids are natural compounds which have recently been found to promote the growth of beneficial soil bacteria and fungi . This project will determine whether flavonoids are present in soils under mature organic plots and if they accumulate during a transition from conventional to organic management.

- **Lonnie Hendricks**, Merced County farm advisor: $5,000. Building on his previous SAREP-funded research, Hendricks will continue to evaluate the effects of cover cropping on soil fertility and pest management in five innovative almond orchards. The project will also evaluate eight cover crop species in a replicated trial for effects on soil fertility.

- **Richard Smith**, San Benito Countyfarm advisor: $1,554. This project will monitor the release of nitrate from a leguminous cover crop. It will also evaluate the ability of this source to supply adequate nitrogen to bell pepper, a long season, high-nitrogen demanding vegetable crop.

Graduate Student Awards

The four graduate students will each receive $1,000. The students and the titles of their projects are:

- **Jeffery Dlott**, UC Kearney Agricultural Center, Parlier, "Geostatistical and Descriptive Analysis of the Distribution and Abundance of Lepidopteran Pests and the Relationship Between Tree Nutritional Status in Peach Orchards."

- **Jeff Mitchell**, Vegetable Crops, UC Davis, "Using Cover Crops to Improve Soil Physical Properties and Stand Establishment in Cyclically Salinized Soils."

- **Eric Tedford**, Nematology, UC Davis, "Development of a Serological Assay for Detection of Spores of the Nematophagous Fungus *Hirsutella rhossiliensis* in Soil."

- **Robert Venette**, Nematology, UC Davis, "Microbial-feeding Nematodes and Plant Growth."

Meetings

The eight sustainable agriculture seminars or field demonstrations and their coordinators were awarded $1,000 each. They include:

- **John Anderson**, director, Yolo County Resource Conservation District, Winters, "Managing Farmland to Restore Wildlife and Biodiversity to the Central Valley."

- **Glenn McGourty**, farm advisor, Ukiah, "Symposium on Farming Winegrapes Sustainably."
- **Kim Rodrigues**, farm advisor, Eureka, "Sustainable Forestry Management Options for Non-Industrial Landowners."
- **Tish Ward**, Southern Sonoma County Resource Conservation District, Petaluma, "Cover Crop Management for Hillside Vineyards in the Coastal and Foothill Regions of California."
- **Otis Wollan**, executive director, Committee for Sustainable Agriculture, Colfax, "Four 1993 One-Day Low and No-Chemical Input Sustainable Agriculture Conferences" (each receives $1,000): Strawberries and Lettuce; Almonds/Walnuts; Tomatoes and Stone Fruit; Rice: Water and Wildlife.

SAREP Publications

UC SAREP has focused much of its staff expertise within the last year on producing concise, usable publications and videos for the California agricultural community. The following items are now for sale or available at no charge.

ANR Publications

UC SAREP has three publications available through the University of California, Division of Agriculture and Natural Resources. To order, contact: UC ANR Publications, 6701 San Pablo Avenue, Oakland, CA 94608-1239. Telephone: (510) 642-2431. The price listed includes shipping and handling. These publications are:

Organic Soil Amendments and Fertilizers

Publication 21505

Organic soil amendments and fertilizers are used to enhance soil quality and promote plant growth. This new publication from UC SAREP serves as both handbook and reference guide. It includes a practical summary of the benefits and value of organic matter, provides some guidelines for evaluating organic materials, and describes many of the organic materials currently available in California. *Organic Soil Amendments and Fertiliz*ers will be of interest to farmers, agricultural advisers, waste management specialists, and home gardeners. Specific materials are listed alphabetically in the index, and a glossary at the end of the publication defines some of the important terms and concepts. 36 pages. Authors: **David Chaney**, **Laurie Drinkwater** and **Stuart Pettygrove**. Price: $5.00

Sustainable Agriculture for California: A Guide to Information

Publication 3349

The need for information, resources, and answers to questions concerning the economic viability of farming and the effect of farm practices on the environment continues to increase. Although a great deal of information exists that can help agriculture improve its sustainability, it is widely dispersed, of uneven quality, limited in supply, or unavailable through conventional sources. *Sustainable Agriculture for California: A Guide to Information* helps remedy this problem by referring readers to libraries, organizations, books, journals, and indexes that contain information on a wide variety of subjects related to sustainable agriculture. Readers can easily locate information on the 60-plus topics covered in the Guide by searching the highly-organized table of contents or index. If you farm and are interested in sustainability, if you advise people who are, if you are a planner looking for resources to guide you, or if you are an agriculture researcher, this publication will be very useful. 198 pages. Authors: **Steve Mitchell** and **David Bainbridge**. Price: $12.00

Proceedings. Sustainable Agriculture in California: A Research Symposium

Publication 3348

More than 150 researchers, agricultural advisers and farmers gathered for this symposium held in Sacramento, March 15-16, 1990. The conference provided a unique opportunity to evaluate the progress in developing the information farmers urgently need to move toward sustainable, resource-enhancing production systems. The proceedings includes papers from featured speakers **Charles Hess**, then the Assistant Secretary of Science and Education at the USDA, and **Garth Youngberg**, executive director of the Institute for Alternative Agriculture. Additionally, there are 19 research papers exploring a range of topics including productions systems comparisons, pest management, and soil and water management. Abstracts from the 40 poster presentations are included and vividly illustrate the wide range of sustainable agriculture research and extension occurring in California. Analysis, comments, and questions of the concluding panel discussion are also provided. The panel included farmers **Bruce Rominger** (Yolo County) and **Brock Taylor** (Contra Costa and Fresno Counties). 226 pages. Editor: **David Chaney**, UC SAREP Price: $15.00

Educational Video

Alive and Well: Sustainable Soil Management, 35 *minutes, 1992.*

This video is a visually attractive technical introduction to sustainable agriculture. Taped on location in Northern California, the program features five different farming operations where sustainable practices have been successfully implemented. The video defines the term sustainable, communicates sound scientific principles, and demonstrates technically accurate procedures by successful growers.

The beautiful photography and concise script and editing have resulted in a piece that is both entertaining and informative. Funded by UC SAREP, the video is an inspiring way to introduce growers to new methods of farming that are more compatible with the environment. This program is highly recommended to both conventional and organic growers, as well as to those in transition. Producers: **Jan McGourty**, **Glenn McGourty**, **Oleg Harencar**. Price: $40 (includes tax and postage) or rent for $5 ($7 out of California) from Visual Media, University of California, Davis, CA 95616-8748, (916) 757-8980. Checks payable to UC Regents. Include name, address, telephone. For information on quantity discounts, contact **Jill Auburn**, UC SAREP, (916) 757-3278.

Free publications

Three publications produced or funded by UC SAREP are available free of charge. They are:

What is Sustainable Agriculture?

Not intended as a definitive statement, this five-page concept paper identifies ideas, practices and policies that makeup the broader definition of sustainable agriculture. Animal and plant production systems and the role of consumers are addressed, and the entire food system is examined within the context of California's economic, social and political environments. To receive a free copy contact UC SAREP, University of California, Davis, CA 95616; (916) 752-7556.

Organic Cost Studies

Free cost-of-production studies for organic almonds and rice are available from UC Cooperative Extension. The 22-page almond study and 20-page rice study include crop overviews, budgets, models and methods of production based on California organic grower practices. Budget tables detail costs per acre, monthly cash costs, annual equipment, investments and business overhead costs, hourly equipment costs, and a ranging analysis. Studies on organic wine grapes and Central Coast organic vegetables are nearing completion. The studies were coordinated by researcher **Laura Tourte**, UC Davis Extension economist **Karen Klonsky**, and researcher **Pete Livingston**. The studies were developed with input from farm advisors and farmers. Contact: Department of Agricultural Economics, University of California, Davis, CA 95616; (916) 752-9376. Also available in selected Cooperative Extension offices.

Sustainable Agriculture

This free quarterly publication from UC SAREP (the one in your hand) is a combination of the former *Sustainable Agriculture News*, the general newsletter, and *Components*, the program's journal of technical notes and reviews. It is a mix of news, announcements, practical information and technical and research summaries. Contact: UC SAREP, University of California, Davis, CA 95616; (916) 752-7556.

A Guide to Agriculture on Internet

An introduction, tutorial and resource guide to finding information on agriculture through the "Internet," a network of inter-connected computer networks. Electronic mail groups (similar to bulletin board conferences, and accessible from many of the for-profit and non-profit systems such as Econet, Handsnet, Compuserve, and MCI-Mail) and databases of research projects and computer programs are all accessible through the 'Net. Not for the computer phobic -the Guide is a step-by-step publication, but requires dealing with the still somewhat arcane language of big computers. 101 pages. Author: **Mark Campidonica**. Price: Free, but donations appreciated.

California Sustainable Agriculture Workgroup Directory

Prepared for the conference "Implementing a Sustainable Agriculture in California," (Davis, CA, July 28-29, 1992), the directory describes the sustainable agricultural activities of 71 university, government and nonprofit organizations within California. Prepared by **Davida Meyer** and **Jill Auburn**, UC SAREP, under a grant from the national Sustainable Agriculture Research and Education program, headed by **Ron Voss** of the UC Small Farm Center. 36 pages. Price: Free, but donations appreciated.

Resources

National Ag Library video/book Lists

Sustainable Agriculture in Print: Current Books, (SRB 92-15), 1992, 29 pages. Selected, reviewed and annotated list of books on sustainable agriculture published within the last three years, compiled by the staff and volunteer **Michael Cassady** at the National Agricultural Library's Alternative Farming Systems Information Center (AFSIC). It is a companion piece to *Tracing the Evolution of Organic/Sustainable Agriculture: A Selected and Annotated Bibliography* compiled by **Jane Potter Gates** on literature from 1580 to 1992. Also available is *Videocassettes in the NAL Collection Pertaining to Alternative Farming Systems,* an annotated list of videocassettes, and the *AFSIC's List of Information Products.* All publications are free from AFSIC, National Agricultural Library, Room 111, 10301 Baltimore Blvd., Beltsville, MD 20705-2351; (301) 504-6559.

Consumer Organic Mail Order

Consumer's Organic Mail-Order Directory, 1992. First annual national directory is an indexed guide of more than 140 farmers and distributors who sell mail-order organically-grown produce and products directly to the public. Available for $9.95 (plus $2.50 shipping and handling) from California Action Network, P.O. Box 464, Davis, CA 95617. Phone orders accepted for Visa and MasterCard at (800) 852-3832 or (916) 756-8518.

Northern U.S. Perspective on Alternative Ag

Which Row to Hoe? A Regional Perspective on Alternative Directions in Commercial Agriculture. 25 pages, 1992. This is an interim report from the Northwest Area Foundation, which has initiated a major research effort to gather and disseminate critical information on the social, economic and environmental implications of conventional and sustainable farming systems for farms, farm families, and rural communities and the potential of sustainable agriculture to stabilize and revitalize rural America. The report is available free from the Communications Dept., Northwest Area Foundation, 332 Minnesota St., Suite E-1201, St. Paul, MN 55101-1373; (612) 225-3863. Other free articles include:

- *Guidelines for Grant Applicants.*
- 0392-4 *Environmentalism and the Challenge of Sustainable Development,* by **Kirk Johnson**,
- March 1992. Argues that sustainability can ease tensions between environmental and economic interests.
- 0491-1 *Bucking the System: Lessons in Agricultural Diversification,* by **William Nothdurft**

and **Mark Popovich**, April 1991. Identifies lessons for agencies seeking to revitalize rural communities.
- 1289-1 *Defining a Sustainable Future: Basic Issues in Sustainable Agriculture by* **William Lockeretz**, Dec. 1989.

Sources of Funding

National Research Initiative

A call for proposals has been issued for National Research Initiative (NRI) competitive grants that will total $92 million in 1993. The grants are administered by the U.S. Department of Agriculture Cooperative State Research Service (CSRS) and are for new or renewed funding of high-priority research in agriculture, forestry and related environmental sciences. Applications are available from the UC Division of Agriculture and Natural Resources Contracts and Grants department (510/987-0050) or from Proposal Services Branch, Awards Management Division, CSRS, USDA, Room 303, Aerospace Center, Washington, DC 20250-2200; (202) 401-5048. At least 30 percent of the funding is available for multidisciplinary teams. The research areas funded, their total allocations and 1993 proposal deadlines follow.

- Natural resources and the environment: $17,039,000. Water quality Feb. 1; plant responses to the environment Jan. 25; improved use of wood and wood fiber Feb. 1;
- Nutrition, food quality and health: $6,153,000. Food safety Mar. 15;
- Animal systems: $23,666,000. Reproductive biology Jan. 19; cellular growth and developmental biology Feb. 22; molecular genetics and gene mapping Jan. 11; disease mechanisms Feb. 22;
- Plant systems: $37,866,000. Photosynthesis and respiration Jan. 11; nitrogen fixation
- and metabolism Mar. 15; growth and development Feb. 16; plant pest interactions: entomology Jan. 19, nematology Jan. 19; alcohol fuels Jan. 25;
- Markets, trade and policy: $3,787,000. Market assessments, competitiveness and technology assessments, rural development Feb. 8;
- Processing for adding value or developing new products: $3,787,000 March 1.

Organic Research Grants

The Organic Farming Research Foundation is offering funds for organic farming methods research, dissemination of research results to organic farmers and growers making the transition to organic production systems, and organic education projects. Projects should involve farmers in design and execution, and take place on working farms whenever possible. Proposals of $3,000-$5,000 are encouraged. Most projects will be less than $10,000. Matching funds from other sources and/or in-kind contributions from cooperators are encouraged. Proposals are considered twice a year. Proposals received by January 31, 1993 will be awarded by April 30, 1993. To receive copies of grant applications and the "OFRF Research and Education Priorities", write Grants Program, Organic Farming Research Foundation, P.O. Box 440, Santa Cruz, CA 95061 or call (408) 426-6606.

Winter, 1992 (v5n2)

Atmospheric emissions from agricultural burning in California: Determination of burn fractions, distribution factors, and crop-specific contributions.

Jenkins, B.M., S.Q. Turn and R.B. Williams

Agric. Ecosystems Environ. 38:313-330. 1992

State legislation enacted in 1983 stipulates that new energy producing facilities that rely on biomass fuels should not result in an increase in the total pollutant emissions for the district in which the facility is constructed. The legislation requires that new facilities reduce or offset pollution levels elsewhere in the region. Since the burning of agricultural wastes in power plants reduces certain types of air pollutants compared to field burning, crop residues could be considered offset fuels. This allowance establishes an economic incentive for using agricultural wastes as fuels.

In 1984, the California Air Resources Board, which has primary responsibility for regulating atmospheric emissions, developed a procedure to determine the magnitude of the offset credits, that is, the incremental emissions permitted in a given period of time because facilities use offset fuels. The offset credit for a particular pollutant (in kg per day) takes into account: 1) the quantity of biomass used by the facility, 2) the mass of pollutant emitted per mass of biomass burned, and 3) the fraction of the total crop residue that is burned in the field during a specified period (winter, spring, summer, fall).

The purpose of this study was to determine with greater accuracy the third factor listed, i.e., the proportion of the crop residue burned in a given season of the year. This information would be used to refine the procedure for calculating allowable atmospheric emissions from power-generating facilities using fuel that would otherwise be burned in the field.

Methods

The authors attempted to use two sources for their study: 1) a compilation of agricultural burn reports, and 2) direct survey (interviews) of growers. Because the burn reports were shown to be highly inaccurate, only the interview method was used. Interviews were conducted with 609 growers in Fresno, Kern, Merced, and Stanislaus Counties. Sixteen crops were represented, including 6 field crops and 10 orchard and vine crops. In addition to the survey results, existing information on emission factors and crop residue yields statewide were used.

Results

The proportion of crop residue burned in the San Joaquin Valley was high for almonds, apricots, cherries, walnuts, and rice (table 1).

Table 1. Burn fractions (proportion of crop residue that is burned) for sixteen crops surveyed in the **San Joaquin Valley**.

Crop	**Burn Fraction (%)**
Almonds	84
Apricots	60
Cherries	56
Walnuts	95
Rice	99

The total emissions from agricultural burning were highest for almonds, walnuts, rice, and wheat. Statewide, orchard and vine crops account for 27 percent of the agricultural biomass that is burned; for the San Joaquin Valley alone, this figure increases to 75 percent of the total biomass burned. The difference between the statewide percentage and that for the San Joaquin Valley alone is due primarily to rice straw burning in the Sacramento Valley. Statewide, rice and almonds together make up 82 percent of the agricultural biomass that is burned (table 2).

Emissions of particulate matter into the atmosphere from agricultural burning are over 3.5 million tons annually in California. This figure, however, represents less than 1 percent of the total particulate matter emissions from various sources. The contribution of agricultural burning to emissions of carbon monoxide, hydrocarbons, oxides of nitrogen, and sulfur is also quite low, both statewide and in the San Joaquin Valley.

While the authors found some inconsistencies in the quarterly distribution of emissions, the very high value obtained by the survey for the fall season was consistent with rice straw burning in the Sacramento Valley. On an annual basis, power plants would have full emission offsets available. On a quarterly basis, however, they are likely to lose offsets in the spring and summer when power plant emissions exceed field burning emissions. To protect ambient air quality, therefore, the facilities will be required to: 1) install additional pollution control equipment, 2) reduce non-agricultural source emissions to obtain sufficient offset credits, or 3) defer the burning of some fuel sources to different seasons than would have been the case if field burned.

For more information write to: B. Jenkins, Agricultural Engineering Department, University of California, Davis, CA 95616.

(DEC.344)
Contributed by Chuck Ingels

Table 2. Crop residue burned in California for four of the sixteen crops surveyed.						
Crop	**Winter**	**Spring**	**Summer**	**Fall**	**Total**	**% of Total (all crops)**
Almonds	242,407	5,155	0	28,020	275,582	18
Walnuts	46,564	57,406	0	5,451	109,420	7
Rice	267,004	0	0	727,318	994,321	64
Wheat	0	0	86,144	2,674	88,817	6

Agroecological foundations of alternative agriculture in California

Altieri, Miguel A.

Agric. Ecosystems Environ. 39:23-53. 1992

(Abstract reprinted with permission)

"Most agricultural regions of California enjoy long growing seasons, fertile soils and irrigation, all conditions that favor a highly diversified cropping. In addition, the wide variety of vegetables, field and tree crops determine a high diversity and flexibility of agricultural enterprises. Despite these factors, Californian agroecosystems are dominated by monocultural cropping systems. Although productive, these systems lack the ecological features to ensure efficient nutrient cycling, water and soil conservation, and biotic regulation. Productivity is subsidized with chemical inputs such as pesticides and fertilizers, some of which cause undesirable environmental and public health hazards. Large-scale monocultures are also highly susceptible to wind erosion and are dependent on ground water for irrigation, leading in some areas to a considerable 'overdraft'. In other regions, poor field drainage and rising water tables are leading to unacceptable soil salinity levels. In summary, California agriculture is very productive, but the environmental cost of such productivity is threatening the sustainability of agriculture.

"The search for self-sustaining, low-input, diversified and energy-efficient agricultural systems is now a major concern of researchers, farmers, policy makers and the public in California. The long tradition in biological pest control in California, as well as the experience of a number of organic farmers who developed low-input systems through 'trial and error', provide the building blocks for the search for a more sustainable agriculture.

"A key in sustainable agriculture is to restore the agricultural landscape. Diversity can be enhanced in time through crop rotations and sequences, and in space in the form of cover crops, intercropping, agroforestry crop/livestock mixtures, etc. Vegetation diversification not only results in pest regulation through restoration of natural control, but also produces optimal nutrient recycling, energy conservation and less dependence on cultural inputs. In California, although this new approach to agriculture is actively researched, realistically it will work only if it is economically sensible and can be carried out within the constraints of a fairly normal agricultural system. Therefore, adoptions of recommended diversification designs will proceed as these reduce costs and increase the efficiency and viability of farms."

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(DEC.343a)
Contributed by David Chaney

Winter, 1992 (v5n2)

Environmental and economic impacts of reducing U.S. agricultural pesticide use.

Pimentel, D., D. Andow, R. Dyson-Hudson, D. Gallahan, S. Jacobson, M. Irish, S. Kroop, A. Moss, I. Schreiner, M. Shepard, T. Thompson and B. Vinzant

In Pimentel, D., (ed.) *Handbook of Pest Management in Agriculture,* Vol.1. CRC Press, Boca Raton, FL. pp.679-718. 1991

Can pesticide use be reduced without substantial increases in food costs? This is the question David Pimentel addresses in new research published in the 1991 edition of the *Handbook of Pest Management in Agriculture.* A condensed version of the same article appears in the June 1991 edition of BioScience (pp.402-409).

Pimentel concludes that a 50 percent reduction in pesticide use can be achieved with a total price increase in purchased food of only 0.6 percent. The reduction in pesticide use would involve "substituting currently available biological, cultural, and environmental pest-control technologies for some current pesticide control practices." Because this conclusion undercuts the argument that pesticides are necessary to keep consumer food costs low, it is being cited frequently by advocates of sustainable agriculture.

Methodology

Pimentel begins by noting that farmers spend approximately $4.1 billion on pesticides annually. They justify this high cost by a direct dollar return of from $3 to $5 for every $1 spent on pesticides. This cost ratio does not include the indirect costs of pesticide use on human and environmental health, nor does it take into account evolved pesticide resistance or the creation of secondary pest problems. Because calculating the costs of these indirect costs is extremely complex, it is difficult to calculate the net benefit to farmers or to society of pesticide use. (For one such methodology, see the review of *Paying the Farm Bill* in *Components, 2(3), Summer 1991, pp. 1-3.)*

Pimentel's objective is to document whether a 5O percent reduction in pesticide use can be achieved without yield decreases due to increased crop losses to pests. He admits that obtaining accurate crop loss data is difficult. Experimental field tests often exaggerate crop loss because assessments of insect, weed, and disease losses are carried out separately and then combined. (Using this approach one study found a total crop loss on untreated apples of more than 140 percent!) In other cases, data simply do not exist and must be extrapolated from closely related crops. With these limitations in mind, Pimentel characterizes his effort as a "first approximation" and calls for better data collection in the future.

To arrive at his conclusion, Pimentel looks at 40 major crops, concentrating on two crops for each type of chemical: corn and cotton for insecticide use, apples and potatoes for fungicides, and corn and soybeans for herbicides. For each crop he considers the alternative pest control strategies already available for the crop, their cost comparison with pesticide use, and any impact they have on crop yields. He then calculates the total percentage decrease in pesticide use possible and the effect of this decrease on the cost of production.

Improved monitoring and application equipment alone account for much of the total reduction Pimentel believes is possible. For example, he notes that fungicide use on apples could be reduced 10 percent by monitoring and better forecasting of disease based on weather data, and another 10 percent by employing a recent design in spray nozzle and application equipment.

By totaling the combined reductions made possible by substituting non-chemical alternatives on 40 major crops, Pimentel argues that a 50 percent reduction in agricultural pesticide use can be obtained in the near future. The total cost of implementing the alternatives is estimated to be approximately $1 billion. This would increase total pest control costs by approximately 25 percent, while increasing total food production costs at the farm by 0.6 percent.

Reviewer's Comments

The data limitations facing Pimentel (or any other researcher in this field) make it difficult to grant conclusions much validity. The 0.6 percent figure Pimentel reports suggests a degree of precision that Pimentel himself is quick to dismiss in the article. Advocates of sustainable agriculture should be careful to treat Pimentel's work not as a definitive but a suggestive statement.

On the other hand, Pimentel's conclusion is consistent with previous studies indicating that pesticide bans or reductions would increase annual food costs to consumers by less than 10 percent. Many consumers would be willing to pay these additional costs, especially if they were understood as simultaneously decreasing the social, environmental, health, and political costs associated with pesticide use.

Two deeper issues are not addressed in Pimentel's research. One is the fact that food prices are largely determined by processors, wholesalers and retailers, <u>after</u> food leaves the farm gate. Pimentel's work erroneously implies a direct link between on farm production costs and the price the consumer pays for food.

The second issue is that pesticide reduction strategies inevitably impact much more than the practices of farmers or the price of food. Pesticide use is linked to a broad range of social, economic, and political issues, among them: government policies to promote cheap food and export earnings; the growth of large agribusiness entities through which farmers could (from the same company) purchase various farm inputs and supplies, obtain advice and recommendations, and in some cases, market their product; the sources farmers trust for information; and, farmers' predisposition to avoid risk. These broader issues must be examined to fully understand the root causes of pesticide use and abuse.

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(DCC.003)
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Habitat manipulation to enhance the effectiveness of aphidophagous hover flies (Diptera: Syrphidae).

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Article written for Sustainable Agriculture Technical Reviews.

Introduction

According to Vockeroth and Thompson (1987), the Syrphidae (Diptera) comprise three subfamilies, 180 genera, and about 6,000 described species. Adults of many syrphid species resemble stinging bees and wasps. Larvae of some species are aphidophagous; these are in the subfamily Syrphinae. Common nonaphidophagous syrphids on Californian farmlands include *Eristalis* spp., the larvae of which live in liquified manure or in sewage ponds; *Eumerus* spp., the larvae of which feed on bulbs of plants; and *Syritta pipiens,* the larvae of which live in manure or compost. The uninitiated observer may mistake these for aphid predators.

Adult aphidophagous Syrphidae are frequent flower visitors, and the morphology of the mouthparts suggests that certain species are predominantly nectarivorous, where as others are pollinivorous (Gilbert, 1981). Adults require honeydew or nectar and pollen to ensure reproduction, whereas larvae usually require aphids to complete development (Schneider, 1969). This seems to indicate that complementary foods are required for completion of the life cycle. However, there are exceptions to the rules: lacking aphids, larvae of several species can subsist on plant materials such as pollen *(*e.g., *Melanostoma* and *Allograpta obliqua*-Schneider, 1969; *Toxomerus* [*Mesograpta* sp.]-Cole and Schlinger, 1969).

Adult syrphids can be sampled by a variety of methods, including visually scanning crops while walking, aerial netting, suction traps, Malaise traps, and water traps. For assessing eggs, larvae, and pupae of aphidophagous Syrphidae, whole-plant removal from the field and examination in the laboratory proved superior to quick inspection of plots (while walking) and to detailed visual inspection of plants in the field (Lapchin et al., 1987). Keys to Syrphidae are found in Cole and Schlinger (1969) (adults), and Heiss (1938) (1arvae and puparia).

Aphidophagous Species

World-wide, there is a fairly large number of species of aphidophagous syrphids. For example, at least 49 species of Syrphidae attack green peach aphid, *Myzus persicae* (Sulzer) (Van Emden et al., 1969). Some of the aphidophagous syrphids most common in California were described by Smith and Hagen (1956) as follows:

1. The large hover fly, *Scaeva pyrastri* (L.) may consume over 500 aphids during its larval stages. Adults are 1.27 cm in length. Abdomen is dark, with six white, curved stripes. Larvae are light green with a white dorsal longitudinal stripe.
2. The western hover fly, *Syrphus opinator* Osten Sacken: adult is slightly smaller than S. pyrastri, has a yellow face, is slightly smaller, and has two black spots and two bands extending across the abdomen. The larvae are spiny and yellow or brown.
3. *Metasyrphus meadii* (Jones) is similar to S. *opinator* but has black markings on the face, and the thorax is shiny.
4. The bird hover fly, *Eupeodes volucris* Osten Sacken: the female looks similar to the large hover fly, but is only 0.85 cm long; males have a narrow cylinder at the tip of the abdomen.
5. The chevroned hover fly, *Allograpta obliqua* (Say) is about 0.85 cm or less in length, and slenderer than E. *volucris.* This species has transverse yellow bands on the abdomen, and two oblique yellow marks near the tip. The larvae are smooth and green, with a broad white median strip. The breathing tubes are prominent.
6. *Sphaerophoria cylindrica* (Say) is about the same size as A. *obliqua*, but has a narrow cylindrical abdomen. Larvae are greenish yellow and more or less transparent.

Syrphid Behavior

Aphid colonies are ephemeral resources: they can appear quickly and just as suddenly disappear due to predation, parasitism, fungal epizootics, declining host-plant quality, changes in weather, or dispersal. Therefore, it may be important to predators to locate aphid infestations quickly. Because of their strong flight and ability to hover and inspect foliage for aphids, syrphids may be especially adept at this. Based on mean number of aphids on plants with predators divided by mean number of aphids on all collard plants, syrphids sometimes appeared better at locating aggregations of aphids on collards than were Coccinellidae (Coleoptera) or Chrysopidae (Neuroptera) (Horn, 1981).

Aphidophagous syrphids are high-performance insects and, although strong fliers, fare relatively poorly when weather is cold, wet, or windy (Lewis, 1965a). In the Sacramento Valley, *Eupeodes* spp., *Scaeva pyrastri*, and *Syrphus* spp. are often abundant from late spring through early summer, but seem to disappear with the advent of hot weather. By contrast, the smaller species *Toxomerus* spp. and *Paragus tibialis* (Fallen) are most common during the summer (Bugg and Wilson, 1989). In coastal areas, the larger species often remain abundant during the summer (Bugg, personal observation).

Adult females of several syrphid species determine whether to oviposit based on the size of aphid colonies. Several syrphid species discriminate against older, larger colonies in favor of smaller "promising" colonies (Kan, 1988a, b, c). However, syrphid species vary as to the size of aphid colonies or aggregations "preferred." Chandler (1968a) showed that for *Platycheius* spp. and *Syrphus ribesii* (L.), different aphid densities elicited peak numbers of syrphid eggs per plant. Chandler (1968b) reported that *Platycheirus manicatas* (Meigen) oviposited selectively on uninfested plants adjoining those that are heavily infested. This response was seen to cabbage aphid *(Brevicoryne brassicae* L.) on brussels sprouts, and to bean aphid *(Aphis fabae* Scopoli) on faba bean. Syrphids that oviposit on plants that have been poorly colonized by aphids may be especially good at keeping aphids at low densities.

Managing Vegetation to Enhance Biological Control by Syrphidae

Wind inhibits activity by adult syrphids. Hedgerows, windbreaks, or shelterbelts can protect croplands in windy areas, and they provide some protection to windward as well as to leeward. Shelter can reduce soil erosion, and improve photosynthetic and water-use efficiency by crop plants, and can lead to locally elevated temperatures in the sheltered areas (Van Eimern, 1964). These practical considerations raise the possibility of using wind shelter to enhance biological control by aphidophagous syrphids.

Using segregating traps and painted pan traps containing water and detergent, Lewis (1965a) showed that syrphids occurred in areas sheltered by artificial windbreaks (0.915 m in height, made with horizontal slats, 45 percent open area), and that of all 13 insect taxa assessed (diurnal and nocturnal), syrphids showed by far the greatest tendency to concentrate in the sheltered area. Aphids also settle selectively near shelter (Lewis, 1965b), so the net effect of windbreaks on aphid control is in question.

Because hedgerows and windbreaks often contain flowering plants used by syrphids, effects of shelter and of flowers may be confounded. Bowden and Dean (1977) used suction traps to assess the distribution of adult syrphids on both sides and at two distances from a high (7 m) hedgerow. Prevailing wind did not seem to influence the distribution: syrphids were consistently more abundant on the western side, which was more diverse floristically.

Pollard (1971) believed that shelter influenced syrphid oviposition, but that flowers did not. In Pollard's experiment, potted brussels sprouts plants were placed in various habitats, then retrieved and inspected for syrphid eggs. Adult syrphids were more abundant in areas with flowers, but oviposition was depressed in unsheltered areas, regardless of whether flowers occurred nearby. However, Pollard's was not a true factorial experiment, and the two factors of interest were neither manipulated nor controlled. The experiment also lacked systematic interspersion of treatments and rigorous statistical analysis.

Nectar and Pollen Sources

Floral resources are clearly valuable to adult syrphids. Nectar serves principally as an "energy food" to sustain the strong flight; pollen sustains ovariole development (Schneider, 1969). Table 1 lists some of the nectar sources used by aphidophagous syrphids, including a variety of trees, shrubs, and forbs. The table refers to research conducted in both North America and Europe. As indicated in table 1, flowers of some cover crops, such as buckwheat *(Fagopyrum esculentum,* Polygonaceae) and tansy phacelia *(Phacelia tanacetifolia,* Hydrophyllaceae) are especially attractive to adult syrphids (see Ozols, 1964). Sweet alyssum *(Lobularia maritima,* Brassicaceae) flowers are also heavily visited (Bugg, personal observation), and this species is commonly included in proprietary "insectary cover crop" seed mixes (e.g., Germain's Incorporated, Harmony Farm Supply, Lohse Mill Inc., Pacific Coast Seed, Peaceful Valley Farm Supply) (Bugg and Waddington, in press). Knuth (1908) compiled detailed records of flower visitation by insects, including syrphids.

Effects of flowers on oviposition have proven difficult to demonstrate, perhaps because of the difficulties of spatial scale encountered with the highly vagile adult syrphids. Distribution of syrphid flies and their oviposition on brussels sprouts was related to flowers, in an unreplicated study involving a hedgerow (Van Emden, 1965). As mentioned earlier, Pollard (1971) contended that shelter provided by hedges was important, but that flowers were not. For example, potted plants were located amid standing gram, which was counted as "shelter." But grain fields, depending on phenological stage, can also be sources of alternate prey or pollen. Chandler (1968b) found that *Senecio jacobaea* (Asteraceae), in buckets, did not influence oviposition by syrphids. These flowers were presumably cut, which can reduce the flow of nectar. This was not considered, although Chandler did suggest that syrphids continued to visit the flowers.

By contrast, Sengonca and Frings (1988) showed apparent enhancement of biocontrol in a two-year, replicated study, involving tansy phacelia. This annual forb is native to California and was introduced as a bee plant to Europe during the early 1900's. Tansy phacelia was grown in interior strips, and in "islands," in conjunction with 200-m2 plots of sugarbeet. Control plots featured monocultures of sugarbeet. Densities of bean aphid *(Aphis fabae)* and eggs and larvae of aphidophagous hover flies (Diptera: Syrphidae) were highest in control plots. In plots with phacelia, sugarbeet yields were significantly higher, and adult syrphids (which feed on floral nectar and pollen of phacelia, and were presumably attracted thereby) were significantly more abundant. Syrphids were credited with reducing the aphids in plots with phacelia. Aphidophagous syrphids observed included *Episyrphus balteatus*, and *Metasyrphus corollae Sphaerophoria scripta*, *Scaeva selenitica*, and *Melanostoma scalare*. As reported by Blake (1990), Steven Wratten at the University of Southampton, England is also using tansy phacelia to enhance activity of syrphids, especially *Episyrphus balteatus* and *Metasyrphus corollae.* Hoverflies with the distinctive star-shaped phacelia pollen in their guts were collected as far as 200 m from strips of flowering phacelia.

Alternate Prey

Only survey studies have been conducted on the possible role of alternate prey in enhancing biocontrol by syrphids. Bugg and Ditcher (1989) evaluated several warm-season cover crops as sources of alternate prey for aphidophaga: American jointvetch *(Aeschynomene americana),* cowpea *(Vigna unguiculata* ssp. *unguiculata), sesbania (Sesbania exaltata*), and hairy indigo *(Indigofera hirsuta)* all supported cowpea aphid *(Aphis craccivora* Koch), whereas a sorghum X sudangrass hybrid *(Sorghum bicolor)* hosted corn leaf aphid *(Rhopalosiphum maidis* [Fitch]) and greenbug *(Schizaphis graminum* [Rondani]). Aphidophaga observed included syrphid flies (e.g., *Allograpta obliqua* [Say], *Ocyptamus fuscipennis* [Say], *Ocyptamus costatus* [Say], *Pseudodoros clavatas* [Fabricius], *Sphaerophoria* spp., *Toxomerus boscii* Macquart, and *Toxomerus marginatus* [Say]). Sesbania appeared to be the best source of cowpea aphid, and reservoir for pooled aphidophaga, including coccinellid beetles and syrphid flies. Densities of aphidophagous Syrphidae were significantly different among cover crops on three of the eleven dates assessed, September 10, 14, and 29; sesbania featured the highest densities on all three.

Bugg et al. (1990) assessed aphidophagous Syrphidae in various cool-season cover crops in southern Georgia. *They observed Allograpta obliqua* (Say), *Syrphus* sp., *Eupeodes (Metasyrphus)* sp., *and Toxomerus marginata* Say). Whole-plot inspection for pooled aphidophagous syrphids indicated significant differences among cover crops on 5 of the 19 sampling dates: 1) Crimson clover and 'Cahaba White' vetch on February 22; 2) Crimson clover and lentil on March 13; 3) Arrowleaf and crimson clovers on March 30; 4) Arrowleaf clover, hairy vetch, 'Cahaba White' vetch, and narrow-leafed lupin, on April 19. Thus, significant differences for adult aphidophagous Syrphidae were only seen on a relatively few occasions. Adult syrphids seldom fly and may seek concealed locations when the weather is windy, cold, or rainy, and therefore may not have been observable on all sampling dates.

Bugg and Ellis (1990) evaluated five prospective cover crops in Falmouth, Massachusetts. Four distinguishable taxa of aphidophagous hover flies were observed. A total of 725 syrphid adults were observed, with the breakdown as follows (numbers of specimens observed in parentheses): *Allograpta obliqua* (3), *Sphaerophoria* spp. (55), *Syrphus* spp. (9), *Toxomerus* spp. (658). Thus, *Toxomerus* spp. represented over 90 percent of the observations. Buckwheat (a nectar source) showed the highest densities on 3 dates; hairy vetch, *Vicia villosa* (infested with pea aphid), did so on 2 dates (1 tie).

Conclusion

Local oviposition by syrphids may be more strongly influenced by shelter than by flowers, though there are some conflicting data. It is difficult to demonstrate effects of flowers, probably because adult syrphids are highly mobile, and benefits acquired by pollen feeding (e.g., ovariole development) do not occur immediately. Moreover, nectar is an energy food and enables dispersal. Therefore, landscape-scale experiments may be needed. I found no studies on effects of alternate prey on syrphid efficiency in agroecosystems.

Given the importance of syrphids in field, orchard, and vegetable crops, further experiments on enhancement should be under-taken.

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Table 1. Flowering plants and associated aphidophagous hover flies (Diptera: Syrphidae).

Nectar Source	**Syrphidae Attracted**	**Reference**
Buckwheat (*Fagopyrum esculentum*)	*Allograpta obliqua, Ocyptamus costatus, O. fuscipennis, Pseudodoros clavatus, Toxomerus boscii, T. marginatus*	Bugg and Ditcher, 1989
Buckwheat and canola (*Brassica napus*)	*A. obliqua, Spaerophoria* spp., *Syrphus* spp., and *Toxomerus* spp.	Bugg and Ellis, 1990

California lilacs (*Ceanothus* spp.)	*A. obliqua*, *Spaerophoria* spp., *Scaeva pyrastri*, *Eupeodes volucris*, *Metasyrphus* spp., *Melanostoma* spp., *Toxomerus* spp.	Bugg, (personal observation)
Common knotweed (*polygonum aviculare*)	*Allograpta* spp., *Sphaerophoria* spp., *Paragus tibialis* [Fallen]	Bugg et al., 1987
Corn spurry (*Spergula arvensis*)	*A. obliqua*, *Eupeodes volucris*, *Melanostoma* sp., *Scaeva pyrastri*, *Sphaerophoria* spp., *Syrphus meadii*, *Toxomerus* spp.	Bugg, (personal observation) L. Linn, (personal communication)
Coyote brush (*Baccharis pilularis*)	*Allograpta obliqua*, *Sphaerophoria* spp., *Scaeva pyrastri*, *Eupeodes volucris*, *Metasyrphus* spp., *Melanostoma* sp., *Toxomerus* spp.	Bugg, (personal observation)
Holly-leaved cherry (*Prunus ilicifolia*)	*Allograpta obliqua*, *Sphaerophoria* spp., *Scaeva pyrastri*, *Eupeodes volucris*, *Metasyrphus* spp., *Melanostoma* sp., *Toxomerus* spp.	Bugg, (personal observation)
Soapbark tree (*Quillaja saponaria*)	*Scaeva pyrastri*, *Eupeodes volucris*, *Metasyrphus* spp., *Melanostoma*	Bugg, 1987
Tansy phacelia (*Phacelia tanacetifolia*) and White mustard (*Sinapis alba*)	*Episyrphus balteatus*, *Melanostoma mellinum*, *Metasyrphus corollae*, *Sphaerophoria mentastri* group, *Sphaerophoria scripta*, *Syrphus ribesii*	Klinger, 1987
Toothpick ammi (*Ammi visnaga*)	*Allograpta obliqua*, *Sphaerophoria* spp., *Paragus tibialis*. When the plant was induced by summer planting to flower out of season (during the spring), it attracted *Scaeva pyrastri*, *Eupeodes volucris Metasyrphus*, *Melanostoma*.	Bugg and Wilson, 1989
Wild buckwheats (Eriogonum spp.)	*Allograpta obliqua*, *Sphaerophoria* spp., *Scaeva pyrastri*, *Eupeodes volucris*, *Metasyrphus* spp., *Melanostoma* sp., *Paragus tibialis*, *Toxomerus* spp.	Bugg, (personal observation) Bugg and Heidler, 1979 Swisher, 1979