Table of Contents

About the Guide

This guide is a cooperative effort of the Community Alliance with Family Farmers (CAFF) and the World Resources Institute (WRI).

CAFF is a nonprofit organization founded in 1978 to work on agricultural issues in communities throughout California. CAFF's mission is to build a movement of rural and urban people to foster family-scale agriculture that cares for the land, sustains local economies, and promotes social justice. CAFF has programs that support farmers with adoption of alternative production techniques, facilitate farmer-to-farmer information sharing, increase direct marketing from farmers to consumers, and encourage grassroots participation in farmland protection efforts and water policy. BIOS, or Biologically Integrated Orchard Systems, is a program that provides information and technical support to almond and walnut farmers in Colusa, Madera, Merced, San Joaquin, Solano, Stanislaus, and Yolo counties who are interested in adopting a biological approach to orchard management.

WRI is an independent center for policy research and technical assistance on global environmental and development issues. WRI's mission is to move human society to live in ways that protect Earth's environment and its capacity to provide for the needs and aspirations of current and future generations. In all of its policy research and work with institutions, WRI tries to build bridges between ideas and action, meshing the insights of scientific research, economic and institutional analyses, and practical experience with the need for open and participatory decision-making.

Learning from the BIOS Approach was produced as part of the Partnerships for Safe and Sustainable Agriculture project, coordinated by WRI working with project partners in eight countries. The project documented nine cases of collaborative alternative agriculture in various parts of the world. The project's final report, *New Partnerships for Sustainable Agriculture*, highlights lessons learned on how to carry out effective research and development for application of integrated pest, crop and soil management.

For further information on BIOS, contact the Community Alliance with Family Farmers, P.O. Box 363, Davis, CA 95617, ph (530) 756-8518, fax (530) 756-7857, email bios@caff.org. To obtain the report *New Partnerships for Sustainable Agriculture*, contact the WRI publications office at (202) 638-6300 or 1-800-822-0504.

Acknowledgements

This publication reflects the expertise and contributions of many individuals. Thanks go first to the farmers participating in BIOS, whose ingenuity and commitment have made the program successful. Thanks also to the original Merced/Stanislaus management team members: Cindy Lashbrook, Glenn Anderson, Lonnie Hendriks, Ray Eck, Sherman Boone, Bill Thompson, and Walt Bentley for their teamwork on this innovative approach.

In 1995, Jeff Dlott worked with CAFF staff and BIOS participants to conduct research and documentation of the BIOS approach for the WRI Partnerships project. The resulting paper, "A Case Study on the Biologically Integrated Orchard System (BIOS) Program" was included in New Partnerships for Sustainable Agriculture. The case study was written by Jeff Dlott with Robert Bugg, Ray Eck, Jill Klein, Liza Lewis, Thomas Nelson, Judith Redmond, and Mike Spezia. The *New Partnerships* report was edited by Lori Ann Thrupp, Senior Associate at WRI, and was published in 1996.

The BIOS case study provided much of the information included in this guide. CAFF staff, particularly Karminder Aulakh, and Lori Ann Thrupp of WRI assisted with editing and reviews. CAFF staff contributing to this publication include Karminder Aulakh, Jill Klein, Liza Lewis, Deanna Simon, and the former BIOS Program Director Mike Spezia. Essential input was also received from BIOS management team members Lonnie Hendriks and Fred Thomas.

Design and production was by Carla Campbell and Clara Okrongly. Funding for the editing, production and distribution of *Learning from the BIOS Approach* (and the case study that preceded it) was provided by the W. K. Kellogg Foundation, the Pew Charitable Trusts, and the Netherlands Ministry of Foreign Affairs.

Why BIOS?

Growing numbers of farmers are searching for effective alternatives to conventional agricultural chemicals. As the environmental and health effects of these chemicals become more widely recognized, and as restrictions tighten on their use, the need for new approaches is increasingly urgent. Along with scientific research on alternative practices, farmers need ways to integrate new findings with their on-farm experiences and circumstances. The Biologically Integrated Orchard Systems (BIOS) program meets these needs by linking scientists, farmers and others in a collaborative effort to develop and implement alternative practices.

Since 1993, BIOS has helped almond and walnut growers scale back their reliance on agricultural chemicals while maintaining or increasing yields and quality. The program promotes adoption of integrated systems, emphasizing a collection of practices that build on naturally occurring biological processes for pest and fertility management.[1] Farmers are introduced to these practices through a unique model of extension and information sharing.

Why has the BIOS approach worked? How can it be improved? As the BIOS program expands and more BIOS-style projects are established in California and other states, the opportunity emerges to share experiences and learn from other programs. While each new project will have its own successes and challenges, sharing lessons from the BIOS experience may benefit those involved in similar projects.

This guide introduces the principles driving the BIOS program, gives an overview of on-the-ground operations, and identifies lessons learned and challenges faced in implementing a BIOS-style program. Those interested in developing such a program should note the fundamental lesson of the BIOS experience: *flexibility* is essential. An effective program will adapt to the
changing needs of participants, modify methods of communication and technical approaches when appropriate, and evolve over time as the needs of participating farmers and institutions change.

The BIOS experience in Northern California should not be seen as a rigid model, since a BIOS-style program will be continuously modified as new needs are identified and approaches refined. However, the principles driving the BIOS program offer guidance for developing similar programs. While the BIOS experience is based on orchard management systems, the general approach may be relevant to production of a variety of crops not only in California, but also in other parts of the United States and abroad. Those using this guide will need to adapt the ideas and principles to local conditions and needs.

What is the BIOS Approach?

BIOS was initiated by the Community Alliance with Family Farmers to support farmers and pest control advisors (PCAs) in Merced County who were interested in adopting a whole systems approach to orchard management. The program was designed to build on the experience of several farmers in the area who had well-established biologically integrated systems with documented success in reducing agricultural chemical use, maintaining low levels of insect damage, and remaining economically competitive.

BIOS was designed to build on the experience of successful farmers.

The BIOS program now has projects in seven counties, with 100 enrolled almond and walnut producers throughout Northern and Central California. Through harvest 1996, project participants have consistently produced an economically viable crop using the biological practices promoted under the BIOS program. During the same period, the use of key agricultural chemicals-particularly organophosphate insecticides-has dropped dramatically among participating growers.

In developing BIOS, CAFF recognized that farmers shifting to biologically integrated systems would need easy access to a broad range of information, skills, and services. CAFF assembled a network of interested farmers, private agricultural consultants, University of California (UC) personnel, private businesses, and USDA and other governmental agency staff to provide technical assistance, financial incentives, and organizational support. The collaboration of these organizations and individuals provides a rich mix of resources for participating farmers and has been critical to the success of the program. It also increases the complexity of program operations and demands effective and ongoing coordination, which CAFF has provided for the BIOS program.

All of the organizations and individuals involved in the BIOS program share similar concerns about the problems associated with dependence on chemical-intensive production methods, and had common interests in implementing effective changes, as outlined in the BIOS mission statement (see The BIOS Mission, below). In addition to collaboration and coordination, the BIOS approach involves the following:

- **Identifying and working with motivated farmers** who are willing to take risks and make significant changes in their management practices. As outlined in the mission and goals, building a community that supports farmers who are making such changes is a long term goal of BIOS.

- **Commitment to link the practical, on-farm knowledge of farmers with scientific information.** This means abandoning the assumption that scientists are delivering knowledge to farmers. Teamwork-where all participants are involved as equals-is critical to the BIOS approach.

- **Program flexibility.** New challenges continuously emerge as such a complex, service-oriented program moves forward. The coordinating team of any BIOS-style effort must be responsive to changing needs.

Teamwork-where all participants are involved as equals-is critical to the BIOS approach.

The BIOS Mission

The mission of Biologically Integrated Orchard Systems (BIOS) is to build a community of farmers, other agricultural professionals and public institutions dedicated to the voluntary adoption of a whole systems approach to farm management that is flexible, maintains long term profitability and less on chemical inputs.

Toward this end, The BIOS program has the following goal:

- To facilitate the exchange of information based on the knowledge and experiences of farmers, pest control advisors and researchers who have pioneered and continue to develop biologically integrated orchard systems;
- To create and coordinate locally based management teams who provide leadership, program guidance and technical assistance;
- To monitor and document the effectiveness of BIOS farm management practices and the program model;
- To foster collaboration and respect among farmers, agricultural service providers and supplies, researchers and public and private institutions; and

- To promote the adoption of the BIOS model within public and private agricultural institutions.

How the BIOS Approach Works

Building on the principles outlined above, the BIOS program evolved into several local and regional demonstration projects with the following key components: a management team, participant recruitment strategy, demonstration site management plans, a monitoring program, on-farm field days and workshops, and individual technical support. The program also distributes publications and monitors program effectiveness through documentation and evaluation. Each of these components are outlined briefly below.

Management Team

The most important step in initiating a project under the BIOS program is bringing together members of the local farm community to serve on a management team, and defining their responsibilities (see BIOS Management Team Responsibilities, below). CAFF assembled management teams of four to ten members rich in farming experience, scientific expertise, and community connections. Suggested management team members for BIOS-style field projects include farmers, PCAs, Farm Advisors, scientists, Natural Resources Conservation Service and Resource Conservation District staff, and program support staff.

BIOS Management Team Responsibilities

Initial Project Design

- Define goals
- Develop general orchard management plan that will later be adapted to each farm
- Develop monitoring protocols

Project Execution

- Recruit participants
- Generate customized orchard management plans
- Generate agendas for farmers/PCA meetings and field days
- Visits to demonstration sites at least once per year
- Participate in presentations at group meetings
- Provide participants with individual technical assistance (via farm visit and phone)
- Help interpret monitoring information
- Contribute to newsletters and other written materials
- Conduct on-going project and documentation and evaluation
- Increase participants' access to financial incentives including government cost-share programs and group discounts on biological farming supplies

Overall Project Management

- Attend group and management team meetings
- Identify resource people and agencies
- Maintain linkages between network members
- Encourage scientific community to conduct research on participants' farms
- Promote project to agricultural community and general public

The majority of BIOS project planning and decision-making takes place in monthly management team meetings. These regular meetings provide a forum to review past, assess current, and plan future project activities. Team members discuss feedback from participants, plan group meetings, field days and other activities, and regularly review team members' responsibilities (such as farm visits, etc.). Meetings are usually designed to take two hours or less to accommodate the busy schedules of team members (see Typical Management Team Agenda, below).

How management team meetings are organized and run strongly affects group dynamics. If all members are treated with mutual respect, the overall program will most likely reflect a productive, team approach. Alternatively, if the management team is organized with "leaders and followers," it is likely that project activities will reflect this hierarchical approach. Well-run meetings allow management team members to utilize their respective strengths, be creative as a group, learn from one another, and gain confidence in themselves, each other, and the team as a whole. BIOS works to create a team environment by having the project coordinator assume the role of meeting facilitator rather than group leader. The facilitator helps direct the team to stay focused on the topic at hand, and actively encourages all members to participate.

Typical Management Team Meeting Agenda

BIOS Merced/Stanislaus Management Team Spring Meeting
The Cookstove Restaurant, Winton, April 20,1996

7:00 Welcome, order breakfast
7:15 Review Agenda
7:20 Final plans for today's field day
7:35 Update & discussion of the specialized monitoring program
8:00 Evaluate previous two March field days
8:15 Planning: May grower visit, summer BBQ, other program activities
8:50 Adjourn

Recruitment Strategy

Recruiting participants is an essential component in developing a strong project. It is the farmers' and Pest Control Advisors' (PCAs') willingness to participate that will in large part determine a project's overall success. The coordinating organization should strive to develop an outreach strategy that will attract a group of participants who rely on agriculture for their livelihood, and who will be active in the program (recognizing that levels of participation are difficult to predict). An effort should be made to recruit some farmers who are both highly visible and respected within the local agricultural community and the industry. Before beginning to recruit, the local management team should clearly define what will be expected from participants.

The number of growers to be recruited for the program must also be decided by the management team. The project size will depend on the resources available for coordination and management, and the level of activity for the project (e.g., specialized monitoring, frequent orchard visits, etc.). The BIOS program staff has found that given their resources and activities, 15-20 growers is an optimal project size. A range of production situations are represented with this number of participants (tree varieties, irrigation systems, soil types, etc.) and the project is large enough to influence growers who are not participating directly. Smaller projects may be effective for more intensive programs, but the commitment of participating growers becomes increasingly important as the project size declines.

To participate in a BIOS project, growers must:

- Wish to reduce chemical usage, especially the most toxic class of pesticides;
- Enroll 15-30 acres in the program;
- Be willing to share information and data collected from their orchard, and agree to:

a) monitor insects,
b) keep year-round orchard records,
c) meet with the BIOS management team on-site for problem solving at least once per year,
d) attend field days and group meetings, and
e) complete an annual phone survey about their management practices and a written program evaluation.

Farmers' & PCAs' willingness to participate
in large part determines a program's overall success.

Selection criteria also ensure that participants reflect a range of growing conditions and production practices, including farms with different soil types, irrigation sources and systems. In the initial BIOS projects, preference was given to farmers with high agricultural chemical usage. However, recruiting some farmer participants who have prior experience with at least some elements of the biological system (for example, cover crops) has proven very useful.

BIOS has used a many-pronged approach to recruitment. Growers are identified and initially contacted informally by members of management teams, who know them personally as neighbors, friends or clients. Members of the management teams have also provided lists of prospective participants to project coordinators. Farmers who indicate interest are invited to informational meetings, where the project coordinator describes the project, explains what is required of participants and how to enroll, and answers questions from prospective participants. Recruitment meetings are also advertised through direct mailings, local newspapers, the trade press, and agency newsletters in the project area. It is important to schedule these meetings at a time of the day (and season) which makes it easier for busy farmers to attend.

Growers who wish to enroll submit applications providing information on their current farming practices and describing why they want to participate. Management teams for each project review the applications and select project participants.

"We felt that this project gave us a good opportunity for reducing chemicals and using alternatives to insecticides and fertilizers. We'll be forced to do it anyway, so it will behoove us to learn as much as we can, as early as we can."
Chuck Segers, Hopeton Farms

Project participants are then asked to sign an Agreement of Understanding which states, among other things, that they will share information, will allow data collected from blocks enrolled in the program to be published in newsletters, and will make a good faith effort to attend regularly scheduled meetings and field days. The Agreement also outlines what participants can expect in terms of technical support from the program. Lastly, the Agreement clearly states that the management guidelines regarding pest management and fertilization are suggestions, not official recommendations.

Management Plans

BIOS "demonstration site management plans" outline biologically integrated practices for each target crop. The management teams rely heavily on their farmer members in developing these plans. Farmers, for example, describe and comment on all the important operations to be included from one harvest to the next. The plan only covers those practices that are within the scope of the project goals, and it includes options for

different production practices and farmer preferences. (For example, the different irrigation systems used in almond production-flood, solid set sprinkler, microsprinkler, and drip-influence the choice of cover crop mix.)

The BIOS management team then works with enrolled farmers to customize the demonstration site management plan to fit specific farm conditions and farmer preferences for the biological alternatives to be adopted. The plan is based on farm visits by members of the management team and informal interviews with the participating farmer (see Appendix A for example of questions asked on initial farm visit). Management team members try to be conscious of limitations in their knowledge if difficult management issues arise that are outside their area of expertise. This customized plan offers concrete suggestions for making the transition to biologically integrated systems and identifies problem locations or operations that might need special attention.

"I think of BIOS not as having developed the perfect system to offer the grower, but each of us that participates adds a new component, makes a new discovery, finds a new failure."
Jim Haag, Walnut Grower, Esparto

Developing customized farm management plans strengthens the management team by increasing understanding of the production system and on-farm constraints. Informal interviews and farm tours allow for a direct exchange among participants and team members early in the project cycle. The site visits also help to establish long term relationships among participants and team members, and expose management team members to each participant's farm. This allows team members and participants to have concrete discussions about observations or problems in later phases of the project.

Monitoring Information

To inform pest management decisions for each BIOS block and to help build growers' confidence in biological practices, farmers and PCAs participate in a monitoring program for pests and diseases. Farmers, their PCAs, or project field scouts are responsible for making weekly observations of the demonstration sites. Pest management decisions are left in the hands of farmers and/or their PCAs. Through on-farm field days and workshops, participants learn how to identify specific insect pests or damage caused by them, as well as beneficial insects and spiders.

"The key is to be in sync with the insects. You shouldn't spray [Bt] by the calendar or by the weather. You need to spray when the bugs are there."
Fritz Helzer, S & J Ranch

BIOS monitoring has three aims: (1) to increase the farmers' use of field monitoring as part of the decision-making process for pest and disease management; (2) to improve farmer and PCA participants' skills in identifying beneficial insects, pests and plant diseases; and (3) to document the effectiveness of the BIOS management practices. Information collected is disseminated to participants through group meetings, a monthly newsletter for each crop, fact sheets, and year-end reports.

Meeting the data collection needs of the various stakeholders, from small- and large-scale farmers to funders and researchers, is one of the BIOS program's greatest challenges (see Lessons from the BIOS Monitoring Experience in the "Lessons Learned" section). Maintaining focus and effectiveness requires an ongoing commitment to prioritizing, evaluating and refining activities. During the project's early development and at other key times, meetings are held with participants to assess each project and grower community's specific needs. For example, in the walnut BIOS project, most of the farmers did not hire PCAs to do their monitoring.[2] So, in response to participants' request, the project hired a full-time field scout to conduct regular monitoring and train farmers in pest and beneficial insect identification and monitoring techniques. In the almond projects, most farmers hire PCAs to conduct monitoring, so the projects place greater emphasis on more specialized monitoring (e.g., comparison studies). Additional input from participants about the monitoring program is gathered formally through a year-end survey and evaluation process (see Documentation and Evaluation at the end of this section). Refinement of the monitoring program also occurs in management team discussions.

In addition, Monitoring Advisory Teams have been formed to provide guidance and oversight for BIOS pest monitoring efforts. These technical specialists are not necessarily regular management team members, but have been very helpful in reviewing protocols, analyzing year-end results, training the field scout, presenting at field days, and answering technical questions outside the expertise of management team members. The Walnut Monitoring Advisory Team has been very effective in both shaping the program and expanding collaboration. The team consists of a UC researcher, a UC IPM Area Specialist, an independent PCA, a project evaluation specialist, and a UC Farm Advisor from outside the project area. The Almond Monitoring Advisory Team, which is composed mainly of members of the local almond management teams, plays a similar role.

On-Farm Field Days and Workshops

Local on-farm field days and workshops cover a range of topics including pest and disease identification, cover crop management, biological control, fertility and nutrition issues, habitat enhancement, and soil biology. The field days and workshops are held at key points during the season, and are open to all members of the agricultural community. These events are an effective way to provide information to interested farmers who are not currently enrolled in the BIOS program, and often attract large numbers of participants. In addition to farmers and PCAs, field days are often attended by other

agricultural consultants, suppliers, agency and commodity board representatives, members of the media, and students of agriculture. BIOS publications and other program materials are made available to everyone who attends the events.

The field days and workshops always include time for discussion to encourage input and feedback from farmers and PCAs. Often farmers, PCAs, Farm Advisors, scientists, and suppliers present information and/or facilitate part of the discussion. The farmer-to-farmer information exchange is a very important and effective aspect of these events. Farmers explaining and demonstrating their experiences has a particularly strong influence on the practices of fellow farmers.[3]

The management team tries to maintain continuity from one meeting to the next for important management practices. Using cover crops in almonds as an example, a fall meeting includes cover crop seeding and establishment (see Typical Field Day Agenda, below), a spring meeting covers mowing strategies to maximize nitrogen contribution and beneficial insect habitat, and a summer meeting covers pre-harvest orchard floor preparation.

Typical Field Day Agenda

Walnut BIOS Crop Planting Demonstration
Haag Farm, September 5, 1996

8:00	Convene for coffee and juice
8:10	Introduction, agenda review and announcements (project coordinator)
8:25	Overview of Haag Farm (farm owner)
8:35	Choosing the right cover crop for your orchard (PCA) Grower discussion
9:00	Cover crop inoculation demonstration (UC specialist)

Cover Crop Seeding Demonstration

9:15	No-till microsprinkler mix broadcaster and orchard drag (farmer) (Move to young block near parking area)
9:45	Insectary blend with belly grinder and ring roller (PCA)

10:10 Tillage microsprinkler mix with broadcaster and ring roller (farmer)

10:40 Microsprinkler mix with no-till drill (local equipment dealer)

11:10 Tour of insectary shrubs (BIOS field scout, UC specialist)

11:30 Adjourn

Individual Technical Support

Management team members with experience in biological systems are available to answer questions of enrolled participants throughout the year. In addition, during the first year of the program, CAFF staff set up a telephone "hotline" to respond to participants' questions about implementing BIOS management practices. When called, CAFF contacted management team members who were best able to address the issue raised, and management team members responded directly to the participants seeking help.

As the BIOS program evolved, CAFF realized that the hotline system was not fully meeting participants' needs. They recognized that management teams needed more regular contact with participants to revise and fine-tune customized demonstration site management plans. BIOS initiated a "buddy" system, through which each participant is assigned a member of the management team who serves as a primary contact. Team members call assigned participants from time to time to check in with them about upcoming management practices. Team members also make "trouble-shooting" site visits as needed.

Although it is more time consuming than the hotline approach, the buddy system has added continuity to the program's individual technical support. It is also a way to reach participants who cannot always make group meetings, and it helps the team address concerns before they become problems.

Other BIOS Incentives

As part of the BIOS incentives package, CAFF staff encourage growers to apply to USDA cost-share programs such as the former Agricultural Conservation Program (ACP) and current Environmental Quality Incentives Program (EQIP).[4] The former ACP program provided up to $20 per acre for perennial and specialty crops as a cost-share for farmers who demonstrated a 20% reduction in nitrogen fertilizer and/or pesticide application. The BIOS customized demonstration site management plans helped growers to meet the documentation requirements for the program, reducing the amount of paperwork farmers had to complete to qualify for cost-share funds.

The new EQIP program requires that farmers develop a long-term resource management plan for the entire farm in order to receive substantial cost-share payments for specific practices such as planting a cover crop or perennial insectary shrubs. EQIP is coordinated by the Natural Resources Conservation Service (NRCS) of the USDA. The involvement of NRCS staff on local BIOS management teams has made both of these USDA cost-share programs more accessible and more appealing to enrolled growers.

CAFF staff and BIOS management team members also helped organize and coordinate discount and rebate programs from suppliers of inputs for alternative practices. Companies have also periodically donated cover crop seed, beneficial insects and mites, monitoring equipment, and other inputs for BIOS demonstration sites. Although these incentives can be helpful, it is worth noting that third-year Merced-Stanislaus almond BIOS growers indicated that other components of the BIOS program-such as field days, workshops and interaction with the management team- were more important to them than the financial incentives.

Publications

To provide support to enrolled farmers and PCAs and others interested in biological farm management practices, the Community Alliance with Family Farmers produces and distributes several publications.[5]

- *The BIOS Update* is a quarterly newsletter that includes summaries and announcements of program activities from all five BIOS projects. The mailing list for the Update is intentionally expansive, including both enrolled and non-enrolled nut growers throughout the state, hullers, processors, commodity board members, suppliers, UC personnel, and representatives of many state, local and federal agencies.

- *BIOS Field Notes* is a seasonal newsletter summarizing the weekly monitoring results and current field conditions in BIOS orchards. Two versions of the Field Notes (one for each crop) are published frequently throughout the growing season and sent to enrolled farmers and PCAs. The mailing list for this publication is intentionally selective, in order to protect the privacy of enrolled growers, and because its contents pertain more specifically to farmers.

- *BIOS for Almonds: A Practical Guide to Biologically Integrated Orchard Systems Management* was produced by CAFF and the Almond Board of California. Based on the experiences of BIOS farmers, the almond management teams and scientific research, this manual provides an overview of the BIOS almond production system.

- Fact Sheets were developed by the management team and CAFF staff covering various topics, such as *Chipping and Shredding in Almond and Walnut Orchards* (accompanied by a local resource list for Yolo and Solano Counties), *Compost*

Use in Walnut Orchards, *Establishing a Cover Crop*, and *Navel Orange Worms* for almonds and walnuts.

- The management team and CAFF staff also developed a *BIOS Reader* for both almonds and walnuts that includes a number of technical articles on various components of biologically integrated systems. The *BIOS Reader* is distributed upon request of program participants.

- CAFF staff prepare two year-end reports for each crop, one analyzing results of the annual grower survey, and the other summarizing monitoring results. These reports are sent to all enrolled growers and project collaborators, and made available to others upon request.

- *The Foghorn* is the newsletter of CAFFÕs Lighthouse Farm Network. Through a statewide network of monthly meetings and field days, this program provides technical information and support to those interested in biologically based farming systems.

Documentation and Evaluation

Documentation and evaluation activities allow a project to gather the necessary information to document progress, build on strengths, identify and improve weaknesses, and adapt to the changing needs of participants. The BIOS program has collected data on acreage enrolled, crop yield satisfaction, pest damage, adoption of selected management practices, use of targeted agricultural chemicals, and evaluation of technical support activities.

This data has been collected formally through the administration of an annual year-end survey interview with enrolled growers, and a written program evaluation. The survey and evaluation results are summarized into reports which are distributed to enrolled growers, project collaborators and others upon request. The results of these evaluations show overall positive impacts in reducing the use of targeted agricultural chemicals, while maintaining or increasing yields and economic returns (see Figure 1 & Figure 2).

BIOS also uses a range of informal and formal evaluation techniques to allow for on-going feedback to improve weak elements and respond to participants. BIOS participants are encouraged to communicate their criticisms and suggestions to management team members and CAFF staff. At each management team meeting, members discuss their perspectives on the effectiveness of program activities (field days, workshops, etc.) and on comments they have received from participants since the last team meeting. Small group focus sessions have also been used to assess and develop changes for specific components of the BIOS projects. These evaluation systems have been effective in identifying areas that need improvement.

Lessons Learned & Ongoing Challenges

Why has the BIOS approach been effective? What challenges remain?
Evaluating the BIOS experience may speed the implementation and effectiveness of similar programs for other crops and in other regions. The principles and approaches will need to be adjusted for local conditions, but learning from the BIOS approach may help those building new programs recreate the successes and avoid the mistakes made by CAFF and its partners. Some key lessons and challenges emerging from the BIOS experience are outlined below.

Lessons

1-Build on farmer experience
The existence of several local farmers who had successfully implemented biologically integrated systems was fundamental to creating BIOS. Farms with several years of demonstrated success in terms of yields, pest damage levels, and profits became the working models for BIOS. The farmers who developed these systems did so by exchanging information and advice with other farmers, PCAs, UC Cooperative Extension Farm Advisors, scientists, non-profit organizations and private businesses. These existing personal relationships among a range of community members led to the formation of BIOS management teams and the larger network of partner organizations.

2-Integrate scientific and practical knowledge
The synthesis of scientific research results and on-farm experience continues to be a cornerstone of the BIOS approach. Scientific research helps to identify, describe, and evaluate the performance of key farming system components such as pest biology and management, soil fertility management, etc. Farmers' hands-on knowledge allows them to integrate scientific information into their on-farm decision making. As mentioned above, this means abandoning the assumption that scientist-farmer information sharing is a one-way street.

BIOS abandons the assumption that scientist-farmer information sharing is a one-way street.

3-Encourage teamwork
A commitment to teamwork is critical to the BIOS approach. Whether a member of the management team, participating farmer, PCA, or supporting staff, everyone involved in the program participates as an equal. Program meetings and events are structured so all are treated with mutual respect, based on a team approach. For example, a speaker at a field day might include a grower, a private consultant, and a university researcher. This type of teamwork can be challenging for some participants. Scientific researchers, for

example, may be accustomed to lecturing and giving "expert" advice, rather than listening to and working collaboratively with farmers. Yet by being responsive to the farmers' practical needs and suggestions, the researcher may identify opportunities to conduct on-farm research with potential for widespread adoption within the farming community.

4-Effective coordination enhances participation
BIOS has shown that effective coordination is central to creating and maintaining a collaborative approach. BIOS-style projects will thrive by finding or creating an organization with the necessary technical skills and local credibility to organize management teams and consortia. A number of groups in the farm community may have the ability to provide administrative, coordinating and outreach functions. Possible collaborators include farmers' associations, non-profit organizations, cooperative extension offices, commodity boards, grower cooperatives, private businesses, universities and colleges,
Resource Conservation Districts, and the USDA Natural Resources Conservation Service.

Historically, these institutions have seldom worked closely together, and in fact, have faced tensions stemming from their different approaches (e.g., scientific vs. hands-on problem solving, participatory vs. traditional extension). The BIOS experience has shown that these tensions and differences can sometimes be overcome through a commitment to collaboration. The collaborating institutions can learn from each other and come to appreciate their complementary capacities. The coordinating organization assumes responsibility for ensuring that the teamwork described above takes place, and that all participants have an equal "stake" in making the project work.

5-Maintain program flexibility
While the mission and goals of the BIOS program have not changed since its inception, specific program elements have been modified to better meet participants' needs. BIOS teams have modified methods of communication and technical support, changed technical recommendations based on farmer feedback, and altered institutional arrangements as new needs, constraints and opportunities emerge. The program has evolved over time based on lessons learned in implementation, and in response to the changing needs of participating farmers in the five project areas.

Examples of program flexibility include the type of technical support provided (shifting from "hotline" to "buddy system"), and modifying topics chosen for field days and workshops in response to farmer requests. This responsiveness requires a combination of characteristics, such as providing participants an opportunity to voice their needs and concerns easily and often, and establishing ways for collaborating groups to evaluate and respond to suggestions (see Lessons from the BIOS Monitoring Experience, below).

Lessons from the BIOS Monitoring Experience

Coordinating monitoring efforts in the five projects has presented some of the biggest technical and operational challenges for the BIOS program. BIOS management team members, the Monitoring Advisory Teams and CAFF staff have compiled the following list of successful and unsuccessful of the program.

Successful Components

(1) Tools for Promoting On-Farm Monitoring

- Hands-on monitoring demonstrations at field days (e.g., use of hand lenses, microscopes, sweep nets, etc.)
- Panel discussions of researchers, extension agents, PCAs, and farmers on topics where management approaches vary (e.g., cover crop seeding, winter sanitation, beneficial insect releases)
- Postcards with timely updates on topics related to monitoring, such as *Bt* applications or cover crop mowing strategies
- Setting a model of thorough field monitoring forms and guidelines
- Hiring a field scout to conduct weekly monitoring and provide on-site training farmers

(2) Data Collection, Management & Dissemination

- Cooperating with UC farm advisors, UC researchers and district conservationists to collect standardized data
- Hiring field scouts to conduct weekly monitoring
- Working with advisory teams made up of technical specialists to analyze data and refine monitoring protocols
- *Monthly Field Notes* with timely reports from participating PCAs and specialized monitoring updates
- Publishing individual orchard data from participating growers so that comparisons and trends can be observed
- Providing on-farm sites for research related to BIOS practices

Unsuccessful Components

- Expecting farmers and PCAs to send in monitoring forms on a regular basis
- Relying on farmers and PCAs for weekly data collection
- Distributing monitoring supplies in counties without field scouts
- Trying to transfer a successful monitoring model from one region to a different crop in another region
- Finding suitable comparison blocks (on-farm trials) in all counties with BIOS projects

6-Gain institutional and policy support
The wide range of organizations collaborating in BIOS program implementation provides institutional support, which has been critical to program success. Key supporters include the University of California, Agricultural Commissioners, Commodity Boards, USDA, the Environmental Protection Agency, and the California Department of Pesticide Regulation. Key personnel at these institutions are interested in seeing the program succeed and have become important advocates at the local, state and national levels.

In the policy arena, the BIOS program received recognition among policy makers in the California legislature as a model for a "Biologically Integrated Farming Systems" (BIFS) program, established in 1995. The BIFS program, administered by the UC Sustainable Agriculture Research and Education Program (UC SAREP), provides funding through competitive grants to groups implementing innovative, biological farming projects. In 1997, two BIFS projects were up and running in California, one in wine grapes and the other in vegetable crops. They are pursuing collaborative approaches similar to those used in the BIOS program. Educating policy makers about on-the-ground program impacts can lead to new support for and/or broader impact of the successful approach.

Challenges

1-Program complexity
As BIOS projects spread to Yolo and Solano counties in walnuts and to Colusa, Madera, San Joaquin and Stanislaus counties in almonds, the BIOS program had to adapt to unique local needs, influences and resources.

CAFF and their collaborators initially used the original Merced County BIOS program as a "cookie-cutter" model for new programs. Project coordinators found that this over-simplified the BIOS approach and resulted in inappropriate project elements. To address this problem in the new projects, emphasis was placed on recruitment of local leaders for management teams who could more successfully shape the goals and strategies in each project area. Since there are many active collaborators in each area and the projects are complex, fairly management-intensive coordination is required. The BIOS program has found that the most effective structure is to have a full-time coordinator and a management team of at least four local members for each project.

"A project coordinator must remain very flexible in working with the local management team. This team will be made up of talented, busy people who may understand the local situation better than the coordinator."
Fred Thomas, CERUS Consulting

2-Personal dynamics
Most management teams in a BIOS-style project are composed of creative, dynamic and extremely busy members. Different people have distinct communication styles. It takes a skilled facilitator to keep meetings productive and reasonable in length, and to find the most effective means of communicating with team members outside of meetings. It also takes skill to manage conflicts that are bound to occur when you convene a group of people with different professional backgrounds. Establishing and maintaining a team often depends on finding or cultivating a project coordinator that members can trust to represent the interests of the whole team.

3-Sustainability
CAFF has provided the catalytic force and played the coordinating role thus far in implementing BIOS projects in California. The BIOS approach, however, is based on the assumption that the long-term responsibility of providing BIOS-type technical support and resources for farmers and PCAs lies with existing local organizations, agencies and institutions. In other words, CAFF's central coordinating role in each BIOS project is meant to be short-term. A strategic goal of the program is therefore to convince local groups and institutions to provide resources to support promotion of biologically integrated farming practices beyond the initial three-year project.

The first such example of this transition from CAFF coordination to local institutions is the original Merced BIOS project. After many exploratory meetings with enrolled growers, management team members, and the East Merced Resource Conservation District (EMRCD) Board, the EMRCD hired a half-time coordinator to continue BIOS activities in the area, with training from the previous CAFF coordinator. The impact of this recent transition on project activities in Merced is not yet entirely clear. Other scenarios are being explored in the various project areas. The project management teams, farmers, pest control advisors, local cooperators and coordination staff for all BIOS-type projects should begin working toward identifying and/or developing a sustainable support system for ongoing BIOS-type activities well before the sunset date for the project.

Conclusion

The BIOS program continues to be effective as it applies its unique and innovative approach to working with growers. Accomplishments of the program include increasing the adoption of biologically intensive management practices, reducing or eliminating the use of targeted agricultural chemicals, improving the exchange of information, and being responsive to participants. The BIOS experience has also inspired and influenced similar programs, such as the statewide Biologically Integrated Farming Systems program administered by the University of California.

The fundamental principles and lessons behind the BIOS approach can help guide the development of new BIOS-style projects in various cropping systems in California and other states. The specific procedures used in BIOS, however, may need to be adjusted and adapted to local conditions. In sum, this program is an excellent approach for development and extension of biological farming practices, and serves as a flexible model for others seeking similar goals.

APPENDIX A
Initial Visit Questionnaire

Name: _____

Acreage in BIOS: _____ **Harvest completion date:** _____

IRRIGATION

Where is your water from (irrigation district, groundwater)?
Type of irrigation
Post-harvest irrigation date
Irrigation cut-off date
Are you willing to irrigate up a cover crop?

COVER CROPS

Are you interested in planting a cover crop?
What benefits do you want from cc's (N, beneficials, OM, erosion control, weed suppression, dust control, microbial activity, water infiltration)?
Do you seed all BIOS acreage or some?
Do you plant just in middles or tree rows also?
Do you have a preference for low growing or taller growing cover crops?
Will a partially mown understory look okay to you?
Do you have equipment available for planting cover crops (drill, belly grinder, spring tooth harrow, ring roller)?
Width of middles/Width of mower
Are you willing to make more than one pass if necessary?
Type of mower (berm, rotary, flail, etc.)
Do you use any specialized equipment (weed eater)?
Are you willing to mow in winter/spring?
What is your soil condition after harvest (trashy, soft, hard/compacted)?

BACKGROUND

Have you sampled soil or leaf tissue in the past?
Reject levels
Yields
Are you happy with these levels?
Any major pest or disease problems?
Are you interested in releasing beneficial insects or trying pheromone confusion?
Are you interested in enhancing habitat with perennial insectary shrubs? Owl boxes?
Are you interested in chipping prunings?

AGREEMENT OF UNDERSTANDING

Are you comfortable with sharing information?
Will you allow data to be published in Field Notes?
Are you able to participate in quarterly workshops or field days and twice yearly management team visits?
What is generally the best day and time for you to attend meetings?
Are you interested in applying to the EQIP cost-share program?

OTHER

Do you know any other walnut growers who might be interested in this program?

Figure 1 - Chemical Insect Control
Season-long:Pre-BIOS versus BIOS 1996

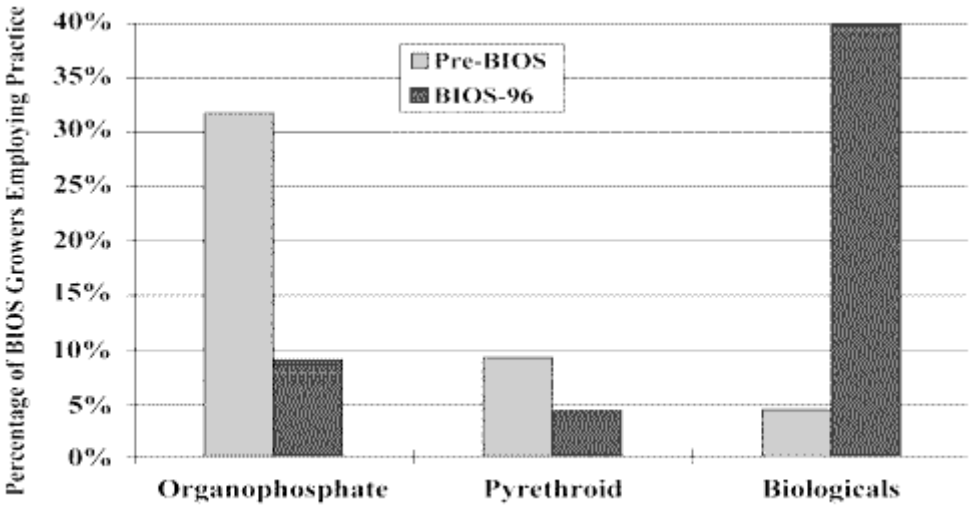
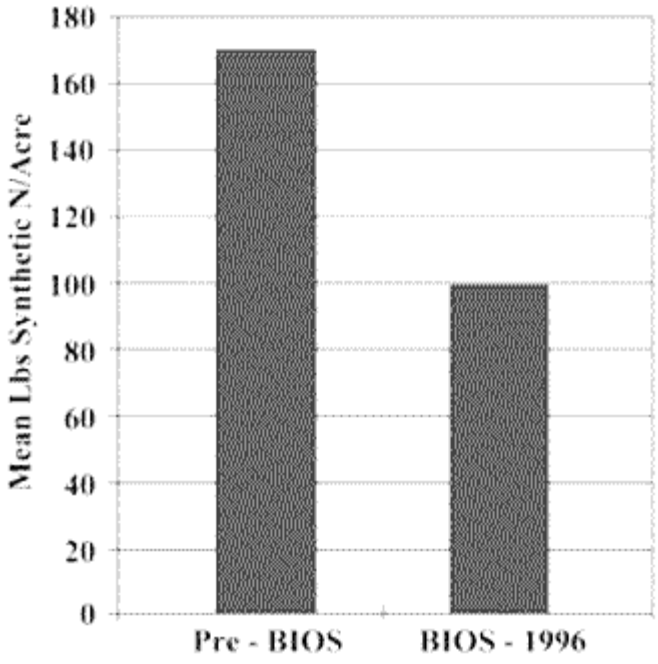


Figure 2 - Synthetic Nitrogen Use
Pre-BIOS and BIOS 1996



Notes

1) For a detailed description of these practices for almonds, see 1995 publication *BIOS for Almonds: Practical Guide to Integrated Orchard Systems Management* produced by the Community Alliance with Family Farmers and the Almond Board of California. For an outline of these practices for walnuts, see the 1996 document *Management Options for Biologicall Integrated Walnut Orchards* and associated Fact Sheets developed by the Yolo-Solano Walnut BIOS management team and CAFF staff. Both documents are available from the CAFF office.

2) Since the orchards in this area are smaller scale, growers often do not invest in consulting services. There is also a shortage in the area of independent PCAs; most PCAs are affiliated with chemical companies, and have little experience with the biological approaches promoted under the BIOS program.

3) CAFF's Lighthouse Farm Network is based primarily on this farmer-to-farmer approach. Through a statewide network of monthly meetings and field days, this program provides technical information and support to those interested in biologically-based farming practices. For more information on the Lighthouse Farm Network, contact CAFF.

4) Provisions of the 1996 Farm Bill replaced the ACP program with EQIP.

5) Many of these publications are available for general distribution. Contact CAFF for more information (530) 756-8518.