CALIFORNIA, USA: MERCED COUNTY BIOS PROJECT

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California is the top ranked agricultural state in the United States, and many of its farmers rely heavily on pesticides for pest management. (See Box 1). The Merced County Biologically Integrated Orchard Systems (BIOS) Program grew out of local farmers' desire to reduce agrochemical use without sacrificing agricultural productivity, the willingness of several institutions to launch a new project, and support from funders and government agencies.

BACKGROUND AND OVERVIEW

The ideas to develop BIOS emerged in 1992, when staff at the Community Alliance with Family Farmers (CAFF) Foundation and University of California Sustainable Agriculture Research and Education Program (UC SAREP) began discussions on promoting ecological approaches to agriculture. Both groups wanted to initiate a project to influence the research-funding priorities of commodity boards, which in California strongly influence agricultural research conducted by public institutions, as well as agricultural policy. (See Box 2)

CAFF and UC SAREP developed a joint work-plan to:

- select one or two commodities with high pesticide use patterns;
- identify production practices that could reduce or eliminate targeted pesticides;
- create a grassroots outreach program to support farmer experimentation with identified alternative approaches;
- work with grassroots farmer groups to identify important areas of research that could lead to reduced pesticide use; and
- influence the funding decisions of the commodity board.

CAFF Foundation and UC SAREP selected almonds as the initial commodity and Merced County as the initial location. Almonds are the states sixth most valuable crop (1993 estimated farm sales totaled $911 million) and rank second in overall pesticide use. Several almond farmers in the county with well-established alternative production systems had achieved documented success in reducing pesticides, keeping insect damage low, and remaining economically competitive (Hendricks, 1995). In addition, the CAFF Foundation had a grassroots farmer network in Merced County. Indeed, many farmers had personal relationships with the foundation, UC Cooperative Extension-Merced, UC SAREP, and Pest Control Advisers (PCAs). Moreover, the Almond Board of California was likely to support new research projects addressing alternatives to pesticides.

The collaborative activities of CAFF Foundation, UC SAREP, UC Cooperative Extension-Merced County, local farmers, and their PCAs, along with funding from the Pew Charitable Trusts and the Central Valley Agricultural Initiative of the U.S. Environmental Protection Agency, led to the start of a three-year demonstration project called Biologically Integrated Orchard Systems (BIOS) to help Merced County almond farmers and PCAs reduce their reliance on agricultural chemicals by experimenting with various production practices leading to biologically integrated systems. Such systems maintain or enhance naturally occurring biological processes for pest and fertility management.

The BIOS project encouraged diverse agricultural community members to participate in a program that has led to the exchange and synthesis of practical and highly technical contributions. CAFF Foundation recognized that participants undergoing the transition would need a broad range of easily accessible information, skills, and services, so it assembled a consortium of farmers, private agricultural consultants, University of California (UC) personnel, private businesses, and USDA and other governmental agency staff to meet these needs. Also, the pioneering farmers who had already adopted biologically integrated almond systems served as mentors and their farms as models to start the project.

A management team, composed of several consortium members, provides most of the technical assistance. This team has two farmers, two independent pest-control advisers (PCAs), one UC scientist, one UC Farm Adviser, one USDA Natural Resources Conservation Service District Conservationist, and a project coordinator from CAFF Foundation. The team reaches participants through customized farm-management plans, a monitoring program, field days, workshops, problem-solving meetings, seminars, videos, newsletters, reports, and technical papers. The project coordinator facilitates regularly scheduled team meetings to plan and evaluate activities. These meetings and all other activities are designed to foster the mutual sharing of experiences and insights. On-going evaluations and a commitment to flexibility allow the projects to assess and adapt to participants' needs. The BIOS program expanded beyond Merced county in 1994, adding projects in Stanislaus and Yolo/Solano counties, and in 1995-96 expanded into three additional counties.

BIOS Goals, Approach and Activities

The BIOS program goals have evolved as new projects are added and existing ones change. An expanded set of goals and objectives was drafted in February 1996. (See Box 3)

Farmers and PCAs have taken an active role in the management teams and in the project in general. Among other things, they have demonstrated practices that work in local conditions, and given advice on how to integrate them into an overall operation. The significant involvement of farmers and PCAs in designing and implementing project activities has helped BIOS become known as both an innovative extension program and a biologically integrated systems approach to farm management. (See Box 4)

Project Coordination

The management team and CAFF Foundation staff share principal responsibility for project design and execution. CAFF Foundation assembled a management team rich in farming experience, scientific expertise, and community support, and the project coordinator created a team environment by assuming the role of meeting facilitator rather than a top-down group leader.

To guide implementation, BIOS uses a team-developed "prototypic management plan" that is customized to fit each participant's farm. The plan covers only practices within the scope of project goals, not all aspects of the farm operation. The plan leaves room for different production practices and farmer preferences, such as choices of irrigation systems and cover-crop mixes. The management team developed monitoring protocols and monitoring forms for collecting information on a variety of agro-ecological factors.

To recruit and enroll BIOS farmer participants for the 30 places in the program, the management team developed qualifying criteria and responsibilities and conducted community outreach. Participants themselves had to want to reduce inputs, be willing to enroll 20 to 30 acres of their land in the project, and commit themselves to monitoring insects, keeping records, and sharing collected data and information. The management team and CAFF Foundation then developed an outreach strategy, which included media announcements, personal farm visits, and public meetings, to reach potentially interested people and to attract and recruit an active and dynamic group of participants with experience in a range of growing conditions and practices common in the area. After carrying out these recruitment activities, 26 farmers and 10 PCAs were selected and enrolled in the first year. Enrollees worked with the

management team to customize the prototypic management plan to fit specific farm conditions and farmer preferences. The customized plan included concrete suggestions for switching to biologically integrated systems and included suggestions for cover crops, plants that attract beneficial insects, and other remedies. Several farms faced thorny management issues that required input from management team members who were not part of the site visit team.

This process of developing customized farm management plans helped build the management team's capacity and establish long-term collaborative relationships among the participants and team members. Informal interviews allowed them to exchange knowledge and better understand the almond-production system. In the project's second year, the customized farm plans were fine-tuned using a process similar to the original formula.

CAFF Foundation staff and BIOS management team members helped organize and coordinate discount and rebate programs and donations of cover-crop seed, beneficial insects and mites, insectary shrubs and trees, insect traps, soil and leaf tissue-sample laboratory services, and farm implements. As part of the BIOS financial incentive package, CAFF Foundation staff also helped facilitate the USDA Consolidated Farm Services Agency (CFSA) SP-53 program application process. Technical assistance and practice certification were provided through the USDA Natural Resources Conservation Service (NRCS), which cost-shares up to $20 per acre for perennial and specialty crops, and up to $7 per acre for row crops with farmers who demonstrate a 20-percent reduction in nitrogen fertilizer or pesticide application. Farmers in this program must present usage-records of the materials previously used and document reduced applications in an Integrated Crop Management Plan. Together, the customized farm plan and the prototypic farm-management plan can serve as the Integrated Crop Management plan required by the program.

On-Going BIOS Activities

The BIOS project uses diverse educational materials and formats to disseminate information, provide technical support, and build analytical and problem-solving capacities. To accommodate various learning styles, the educational formats used include hands-on field activities, oral presentations, group discussions, videos, and written materials.

Farmer and PCA meetings are held at key points during the season. Anyone in the agricultural community can attend. Group meetings have a flexible format, responding to farmer needs and weather conditions, and they always include time for discussion to encourage input and feedback from farmers and PCAs. The meeting format (whether field day, workshop, problem-solving meeting, or seminar) varies with the time of year and the topics covered. The coordinating staff at CAFF Foundation arranges certification credit for PCAs and other agricultural consultants who attend BIOS group meetings.

Each participating farmer receives individual technical support from the management team, through a "hot line" during the first year and then through additional farm-site visits. As the project evolved, the management team needed regular contacts with participants to revise and fine-tune customized farm-management plans. One response to these needs is a "buddy system" in which each participant is assigned to a management team member who will answer questions. Management team members also make follow-up site visits when needed.

The BIOS Buddy System provides another form of outreach to participants who cannot always make group meetings. The system also helps catch problems before they start and brings continuity to

individual technical support. However, this approach does require considerable management team time.

Regularly scheduled management team meetings provide a forum to discuss past, current, and future project activities. Feedback from project participants, topics and speakers for the next group meeting, and team member responsibilities (farm visits, buddy system), number among the topics addressed.

The project includes a monitoring program; in-season weekly field monitoring in each BIOS block, periodic specialized field monitoring, and an outreach strategy to disseminate findings. Participants receive a monitoring plan and forms to be completed weekly based on protocols developed by the management team. The monitoring plans outline how to spot specific insect pests or damage, as well as common beneficial insects and spiders. Pest management decisions are left in the hands of the farmers or their PCAs.

The implementation of the monitoring program has grown and evolved. At the end of the first season, participants told CAFF that the monitoring program was less useful than the other project elements, so CAFF hired a Monitoring Coordinator and assistant to oversee and improve the collection and dissemination of monitoring information.

CAFF Foundation offers participants and other community members various publications, including *BIOS Update* (a newsletter featuring summaries of presentations and discussions from group meetings, news on miscellaneous topics in biologically integrated systems, and announcements of upcoming BIOS events), information on farm practices, a "BIOS reader" that includes technical articles on biologically integrated systems, and *BIOS for Almonds: A Practical Guide to Biologically Integrated Orchard Systems Management* - a production manual based on the experiences of BIOS farmers, the Merced and Stanislaus almond-management teams, and scientific research.

DOCUMENTATION AND EVALUATION

The progress, strengths, and weaknesses of the BIOS program are documented and evaluated, along with the changing needs of participants. BIOS uses a range of informal and formal evaluation techniques and collects data on acreage enrolled, crop yield, pest damage, the adoption of selected management practices, the use of targeted agricultural chemicals, and attendance at group meetings. During initial farm visits, application forms and interviews were used to collect baseline data on these variables. After the 1993o94 season, the CAFF Foundation mailed out a survey to assess outcomes; 18 of the 26 farmers returned completed surveys (a 69-percent response rate).

Survey results showed that BIOS growers farmed 11.5 percent of total almond acreage (67,028) in Merced County in 1994 and incorporated BIOS practices on about 879 acres, or 11 percent of this land. Thus, each farmer enrolled an average of 32 acres in the project.

According to first-year results, the project increased farmers' use of management practices to enhance naturally occurring biological processes for pest and soil management. Cover-crop use increased from 12 percent to 92 percent of the farmers involved. The cover-crop practice consisted of seeding a mixture of legume and grass species to fix atmospheric nitrogen, provide habitat for beneficial arthropods, and improve soil quality. Releases of beneficial arthropods to help manage insect and mite pests increased from 60 percent to 80 percent. The utilization of *Bacillus thuringiensis*, a selective insecticide that does not kill beneficial arthropods and can be used instead of broad-spectrum insecticides, increased from 41 percent to 65 percent. (See Figure 1)

BIOS promoted the planting of perennial insectary plants to provide year-round habitat for beneficial arthropods-a new practice for participating farmers. Forty-seven percent of the survey respondents planted perennial insectary plants. The number of farmers applying compost or manure did not change during the 1993o94 season. (See Figure 1)

BIOS farmers markedly decreased use of targeted agricultural chemicals in the 1993o94 season. Employment of broad-spectrum organophosphate insecticides fell from 35 to 0 percent, use of the herbicide Simizine by 24 to 6 percent, and mean applications of synthetic nitrogen fertilizer by 46.6 percent (from 200 to 107 lbs/acre). (See Figure 2)

For the 1993-94 season, crop yield and the percentage of insect damage (worm-reject level) were similar for BIOS blocks and comparison blocks from the ten farms that reported harvest results. Mean yields for the 10 BIOS and comparison blocks were 1,935 and 1,871 pounds per acre, respectively. (See Figure 3) Mean worm-reject levels were similar (BIOS blocks 0.6 percent and comparison blocks 0.7 percent). (See Figure 4) These results suggest that BIOS management techniques do not lead to yield reductions or to increases in pest damage in the first year. These data are consistent with harvest data reported by Hendricks (1995) in his long-term study of almond production in Merced County.

Farmer satisfaction with harvest results during the first year of BIOS was high. Eighty-eight percent of survey respondents were satisfied (n=15), compared to 12 percent who were not (n=2). Farmer satisfaction with harvest results in comparison blocks was similar. After one year with the Merced BIOS project, 47 percent (n=7) of respondents planned to increase their acreage under BIOS management. Ten of the 26 farmers placed all their almond acreage under BIOS management at the beginning of the project.

BIOS participants are encouraged to convey their criticisms and suggestions to management team members and CAFF Foundation staff by talking to team members or using the suggestion box at events. At each management team meeting, and in group focus sessions, members discuss how well program activities are going and which areas need improvement. Such discussions have led to appropriate modifications. The 1994 BIOS Grower Evaluation was mailed out with the 1994 BIOS Grower Survey. (See Table 1)

BIOS EXPANSION

The BIOS program expanded in 1994 and again in 1995-96. The 1994 expansion included the addition of an almond project in Stanislaus County and a walnut project in Yolo/Solano counties. The 1995-96 expansion involves three new almond projects in Madera, San Joaquin, and Colusa counties. The 1994 expansion projects were modeled directly after the original Merced County BIOS project. The three most recent almond-expansion projects are in the very early stages of development.

The Stanislaus almond project has enjoyed much of the same success as the original Merced project in terms of participant enthusiasm, high attendance at meetings, and positive feedback. CAFF Foundation attributes this success to several factors: the commodity is the same and cropping conditions are similar; there is overlap in the management team membership; the same person coordinates the Merced project, and program resources and activities are shared.

The Yolo/Solano walnut project has been less successful. Differences in the biology and ecology of walnut production systems may be one explanation. In particular, a later harvest and denser tree canopy make cover crops more difficult to plant and maintain than in almond orchards. A key walnut pest - the codling moth - is also harder to manage without insecticides than are most almond pests. In addition, the UC Farm Adviser responsible for walnuts in Yolo/Solano counties decided not to support the program, leaving a vacuum in terms of UC Cooperative Extension technical assistance and local credibility.

In response to these challenges, CAFF Foundation, the management team, and participating farmers have suggested several options. These include downsizing the project and perhaps using a different model from the one used in the almond projects; strengthening CAFF leadership by hiring more staff and dedicating more time to program coordination; clarifying the roles of management team members; and evaluating and developing a plan to recruit farm advisers, strategic walnut farmers, and other walnut-industry supporters of a BIOS approach.

CONCLUSION

The Merced almond BIOS project has made great strides toward increasing the use of biologically intensive management practices, reducing or eliminating the use of targeted agricultural chemicals, improving information exchange, and being responsive to participants. These accomplishments are due largely to the extraordinary collaboration among private business, a non-profit organization, and local, state, and federal agencies. In a 1995 workshop on "Charting the Future of Merced County BIOS" for representatives from all the participating groups, one key theme that emerged was the essential role of coordination among partners and the outstanding job that CAFF Foundation has done in performing this function. Workshop participants also cited these strong points of collaborating within BIOS:

- the project's ability to meet diverse needs and goals of individuals and agencies;
- excellent cooperation among scientists, extension agents, and farmers, where all are treated with respect;
- a forum for experimenting with new ideas and equipment;
- the ability to demonstrate success in farmers' fields; and
- a small-group atmosphere with an individual orientation.

Recognition of BIOS and its impacts have moved beyond the initial partners. In fall 1994, California Governor Pete Wilson signed into law Assembly Bill 3383 (AB 3383) which established an agricultural chemicals reduction pilot program. Key concepts for AB 3383 come directly from the BIOS program. For example, the bill aims to:

- establish pilot-demonstration projects to provide extension services, training, and financial incentives for participating farmers to reduce their use of chemicals for agricultural production;
- extend integrated farming systems through the proven technique of farmer-to-farmer communication, with technical support provided by farm advisers, scientists, and pest control advisers; and
- pattern the structure of each pilot-demonstration project, to the degree feasible after the successful Biologically Integrated Orchard Systems (BIOS) program coordinated by the Community Alliance with Family Farmers in Merced County.

AB 3383 has become known as the Biologically Integrated Farming Systems (BIFS) bill. In 1995, following a competitive grants process, two groups were awarded approximately $100,000/year grants to implement BIFS projects. (Each group is eligible for renewed funding for up to three years.) Funding for the BIFS program comes from the California EPA Department of Pesticide Regulation (DPR) and US EPA Region IX. BIOS has also been formally recognized by Cal EPA DPR, which gave it an IPM Innovators award in 1994 for leadership "...in adopting techniques that increase the benefits and reduce the risk of pest control."

Having expanded the BIOS program and begun implementing the new BIFS program, the CAFF Foundation and the BIOS consortia members defined project steps that are transferable across cropping

systems and local farming culture. These include:

- initiate a program based on existing biologically integrated systems and the people who have contributed to developing these systems;
- combine scientific and practical knowledge;
- emphasize farm-level decision-makers (farmers and PCAs) through program activities conducted on the farms;
- include these farm-level decision-makers in the overall program decision-making framework (whether the management team or its equivalent); and
- provide organizational support to link public and private groups to provide technical assistance, and financial incentives.

In summary, the existence of local biologically integrated systems was fundamental to creating the Merced BIOS project. Farmers with several years of demonstrated success in terms of similar yields, pest-damage levels, and profits were the working models for BIOS. The farmers who developed these systems did so in the context of information exchange. The synthesis of information generated by both scientific research and actual farming experience continue to be a cornerstone in the foundation of BIOS and in BIFS as well. Scientific research helped identify, describe, and evaluate the performance of key farming system components. Farmers' experiential knowledge allowed participants to integrate scientific information into their local production systems. The exchange and interaction between the groups has also been critical.

As the BIOS program expands and more BIOS-style projects get started in California and other states, the opportunity emerges to share experiences and learn from other programs. Each new project will have its own successes and challenges. Sharing how we understand our own successes and meet our challenges will greatly benefit everyone involved in similar projects.

BOX 1: OVERALL AGRICULTURAL PRODUCTION AND PESTICIDE USE IN CALIFORNIA

- California has 3 percent of all U.S. farmland (30 million acres) but produces 55 percent of U.S. fruits, nuts, and vegetables.
- California accounts for about 22 percent of U.S. agricultural pesticide use.
- California is the top-ranked agricultural state with $19.9 billion in cash farm receipts and over $70 billion in related economic activities (Texas is second with $12.8 billion and Iowa third with $10 billion in cash farm receipts).
- California has 8 of the top 10 agricultural counties in the United States.

Source: California Department of Food and Agriculture, California Agriculture 1993 Statistics; California Department of Pesticide Regulation, *Pesticide Use Annual Report 1993*.

BOX 2: CALIFORNIA COMMODITY BOARDS

- California growers have created 27 Commodity Boards through state legislation.
- Commodity Boards collect fees assessed on a unit-of-production basis.
- Commodity Boards usually allocate their funds to research and marketing.
- Most research supported by Commodity Boards is conducted by University of California or California State University researchers.

Source: CAFF Foundation.

BOX 3: BIOS GOALS AND OBJECTIVES

Overall Program Goals

- Demonstrate that biologically integrated systems reduce reliance on agrichemicals and are profitable.
- Increase the adoption of a biologically integrated systems approach by farmers.
- Build farmers' confidence through technical support and information sharing.
- Document the changes and effectiveness of BIOS production practices.
- Cultivate and maintain private and public agricultural industry participation and support.
- Develop and enable long-term community leadership and coordination for BIOS.

Program Objectives

- Create and coordinate locally based teams to provide program leadership and guidance.
- Facilitate the exchange of information based on the knowledge and experience of farmers who have pioneered and developed biologically integrated systems.
- Improve participants' skills to identify beneficial insects, spiders, and mites, pest insects and mites, plant diseases, and cover-crop species.
- Increase the use of field monitoring in decision-making related to pest and other management operations.
- Keep program flexible and responsive to participants' needs and to local agricultural conditions.
- Encourage the scientific community to conduct research on biologically integrated systems.
- Conduct outreach activities to the broader agricultural community.

BOX 4: SUMMARY OF BIOS EXTENSION APPROACH

General Features

- Assembles consortia of farmers, agricultural consultants, UC scientists, UC Farm Advisers, private businesses, and governmental agencies to provide participants with technical assistance, financial incentives, and organizational support.
- Composes management team from consortium members to provide most technical assistance.
- Emphasizes learning environment where farmers, scientists, and agricultural consultants share experiences and insights.
- Uses diverse educational formats including hands-on activities, oral presentations, group discussions, videos, and written materials to accommodate different learning styles.
- Provides customized support to adapt production system to individual farms.
- Conducts ongoing evaluations and is flexible in adapting to participants' needs.
- Targets whole production systems.
- Entrusts program coordination to non-profit organization (CAFF Foundation).
- Encourages scientific community to conduct on-farm research and economic studies.

Technical Assistance

- Customized management plan developed first year and fine-tuned in later years.
- Coordinated program of pest monitoring for each BIOS block.
- Specialized monitoring program to assess orchard ecology.
- Newsletter summarizing results of monitoring and current field conditions.
- Before/after and side-by-side comparison of BIOS and conventional blocks.
- Regularly scheduled field days, workshops, problem-solving meetings, and seminars.
- "Buddy system" that provides individual technical assistance throughout season.
- Collection of written materials that provide technical details and scientific background.
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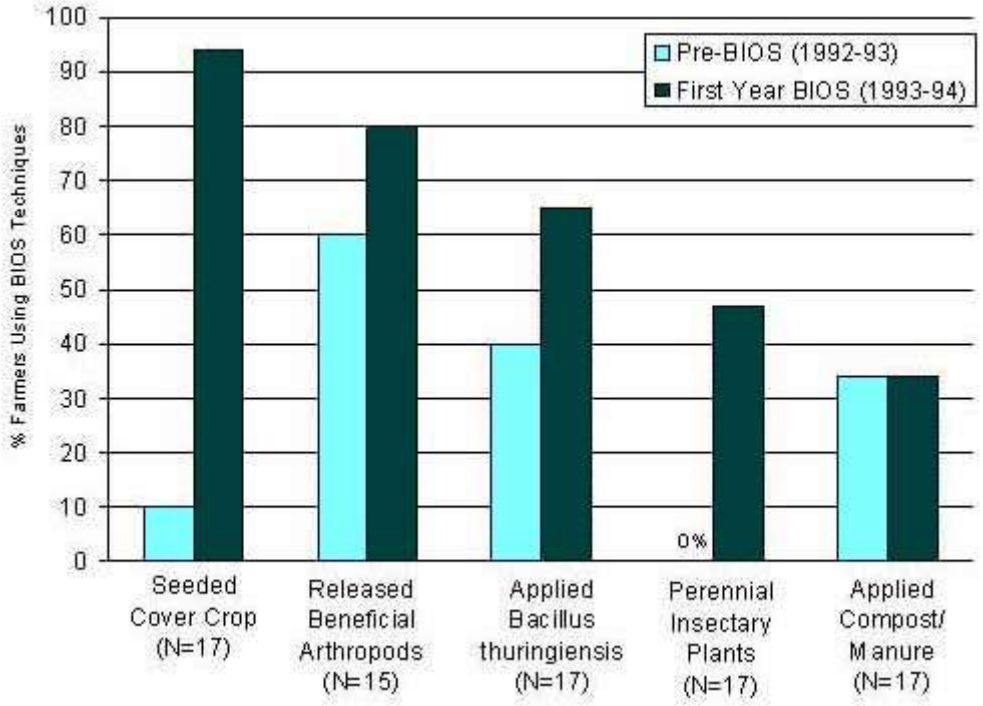
Incentives

- Assistance in applying for cost-share of up to $20 per acre through USDA Consolidated Farm Service SP-53 program.
- Discounts on products and services through various corporate sponsors.
- Certification credit for agricultural consultants who attend BIOS field days and workshops.

Program Support

- CAFF Foundation coordinates project activities.
- CAFF Foundation seeks funding and administers grants.

FIGURE 1: USE OF SELECTED FARMING PRACTICES BY MERCED COUNTY ALMOND GROWERS



Source: BIOS applications, initial farm visits, and 1994 BIOS Grower Survey, CAFF Foundation

FIGURE 2: (A) USE OF TARGETED PESTICIDES AND (B) MEAN ANNUAL APPLICATION OF SYNTHETIC NITROGEN BY MERCED COUNTY ALMOND GROWERS

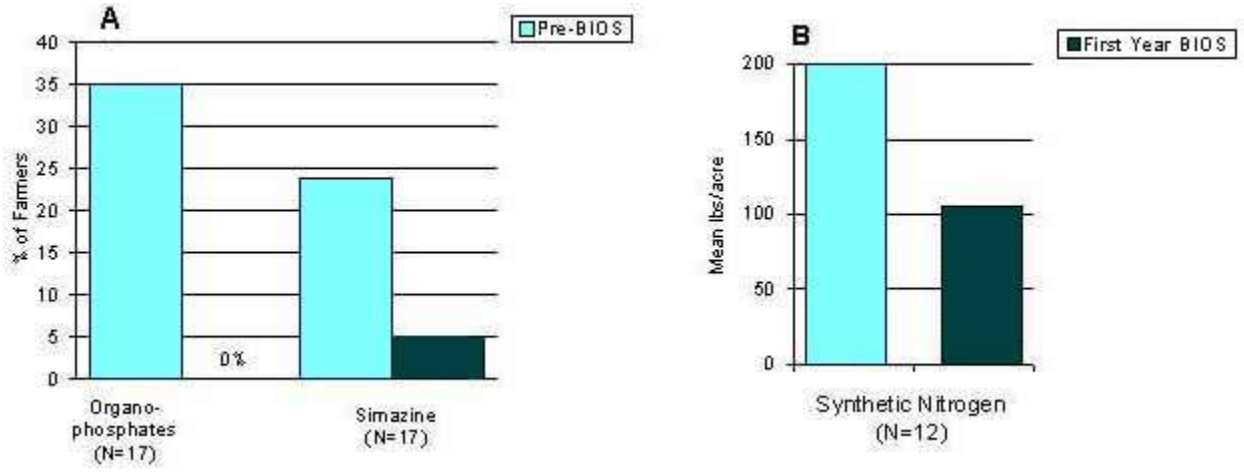
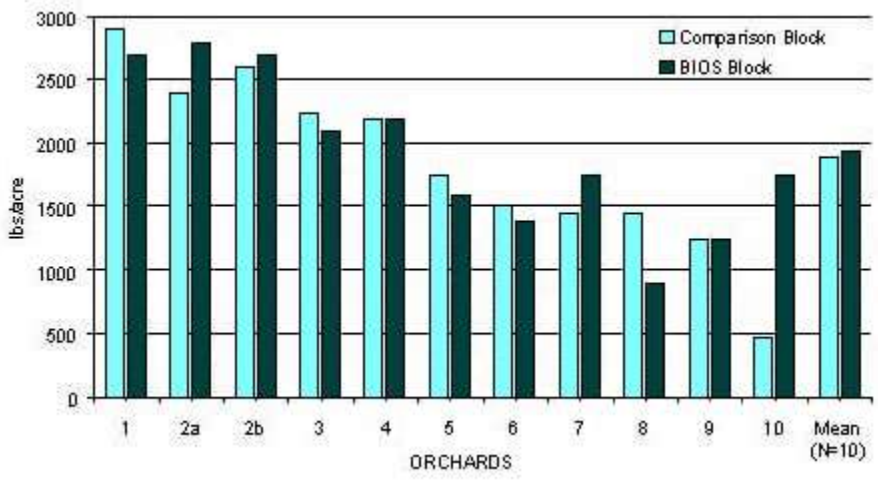
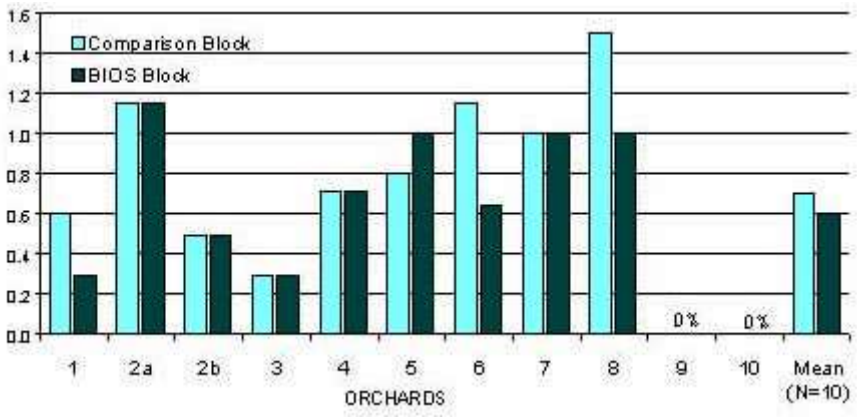


FIGURE 3: 1994 YIELD DATA FOR 10 MERCED COUNTY ALMOND ORCHARDS WITH BIOS AND COMPARISON* BLOCKS



* "Comparison block" was defined as "A block which is comparable to the BIOS block in soil type, irrigation, and location" but not under BIOS management
Source: 1994 BIOS Grower Survey, CAFF Foundation.

FIGURE 4: 1994 PERCENT WORM DAMAGE FOR 10 MERCED COUNTY ALMOND ORCHARDS WITH BIOS AND COMPARISON* BLOCKS



* "Comparison block" was defined as "A block which is comparable to the BIOS block in soil type, irrigation, and location" but not under BIOS management
Source: 1994 BIOS Grower Survey, CAFF Foundation.

TABLE 1: 1994 BIOS GROWER EVALUATION (69% OF RESPONDENTS; N=18)

Q1. How useful was the farm management plan developed with the management team?		
Not Useful (1-4)	6%	(1)
Somewhat Useful (5-7)	29%	(5)
Very Useful (8-10)	65%	(11)
Q2. How useful were the meetings/field days?		
Not Useful (1-4)	0%	(0)
Somewhat Useful (5-7)	39%	(7)
Very Useful (8-10)	61%	(11)
Q3. How useful was the *BIOS Update*?		
Not Useful (1-4)	19%	(3)
Somewhat Useful (5-7)	38%	(6)
Very Useful (8-10)	44%	(7)
Q4.How useful were the Weekly Monitoring Reports?		
Not Useful (1-4)	35%	(6)
Somewhat Useful (5-7)	29%	(5)
Very Useful (8-10)	35%	(6)
Q5. How useful was BIOS monitoring program?		
Not Useful (1-4)	31%	(5)
Somewhat Useful (5-7)	19%	(3)
Very Useful (8-10)	50%	(8)
Q6. How helpful was the Bios management team in offering advice?		
Not Useful (1-4)	19%	(3)
Somewhat Useful (5-7)	6%	(1)
Very Useful (8-10)	75%	(12)
Q7.How helpful was the CAFF Foundation staff?		
Not Useful (1-4)	7%	(1)
Somewhat Useful (5-7)	27%	(4)
Very Useful (8-10)	67%	(10)
Q8.How helpful did you find the money from SP-53 in making changes on your farm?		
Not Useful (1-4)	42%	(5)
Somewhat Useful (5-7)	33%	(4)
Very Useful (8-10)	25%	(3)