BIOLOGICALLY INTEGRATED FARMING SYSTEMS (BIFS) PROGRAM

A Progress Report to the California State Legislature on the Implementation of Assembly Bill 3383 (Chapter 1059, Statutes of 1994) and Assembly Bill 1998 (Chapter 434, Statutes of 1998)

University of California
Office of the President
Division of Agriculture and Natural Resources
Statewide Special Programs and Projects
Sustainable Agriculture Research and Education Program

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The BIFS program is an integral part of the University of California Sustainable Agriculture Research and Education Program (SAREP). SAREP provides leadership and support for scientific research and education in agricultural and food systems that are sustainable: economically viable, conserve natural resources and biodiversity, and enhance the quality of life in the state's communities. SAREP serves farmers, farmworkers, ranchers, researchers, educators, regulators, policy makers, industry professionals, consumers, and community organizations across the state. SAREP is a Statewide Special Program within the UC Division of Agriculture and Natural Resources.

Table of Contents

EXECUTIVE SUMMARY

In 1994, Assembly Bill 3383 (Bornstein, Brown, and Snyder) and again in 1998, Assembly Bill 1998 (Thomson) requested that the Regents of the University of California establish (or in 1998 continue) a pilot demonstration program to provide extension services, training, and financial incentives for farmers who voluntarily participate in pilot projects to reduce their use of agricultural chemicals. The resulting program is known as Biologically Integrated Farming Systems (BIFS). In addition to the funding provided by these bills, funding has also been provided by the University of California and the U.S. Environmental Protection Agency.

Agricultural chemical use/risk reduction is a central focus of BIFS projects, which is accomplished through demonstration of an alternative farming system based on biological processes. Fertility, irrigation, cultural practices, marketing, pest and fertility monitoring, wildlife and beneficial insect habitat, watershed and groundwater protection, and economics, where appropriate are integrated into the farming systems.

The BIFS farming systems show great potential to reduce dependence on the most toxic pesticides and the overuse of fertilizers. For example, the Walnut BIFS project has reduced nitrogen fertilizer application rates by an average of 53 lbs./acre, with no apparent effect on yield. This can help protect groundwater from nitrate pollution. The Prune BIFS project has eliminated wintertime sprays of organophosphate insecticides. Eliminating these sprays protects California rivers from toxicity problems. Other BIFS projects have also shown dramatic reductions in targeted pesticides, and increases in farming practices that reduce offsite movement of agricultural chemicals. Included in this report are mid project results as well as evaluations of each project's accomplishments.

Each BIFS project is funded for three years, at approximately $100,000 per year, although some projects are smaller. Projects working with nine different crops have been funded since the inception of BIFS. Projects in winegrapes and cotton ended in 1998. As of December 2000, seven BIFS projects are active: rice in Butte County, walnuts in San Joaquin County, citrus in Fresno County, strawberries on the Central Coast, apples in Contra Costa County, prunes throughout the Central Valley, and dairies, also throughout the Central Valley. The apple and dairy projects will end in 2002 and the others end in 2001. Although all BIFS projects are funded to their end dates, no further state funds have been identified for new projects and only limited US EPA funds may be forthcoming. Additional component research, as requested in AB 1998, has also been funded for four proposals related to specific BIFS projects.

The BIFS projects use an extension approach that involves public-private cooperation; this approach is often called a "farmer-to-farmer" method of information sharing. It brings scientists, farmers and consultants together in a collaborative, "co-learning" environment that enables participants to learn and adapt integrated farming practices to local conditions. It is patterned after the Biologically Integrated Orchard Systems (BIOS) project, initiated by the Community Alliance with Family Farmers (CAFF). BIFS project participants develop reduced pesticide and fertilizer practices that are economically sound. Each BIFS project has enrolled between 8 and 33 farms. Enrolled farms are used for testing new methods, demonstrating proven techniques, and hosting field days. Field days are used by the projects as an outreach tool, because one of the main project goals is to increase the adoption of BIFS practices.

As of 2000, approximately 2.2% of California farmland is farmed by BIFS growers. If the increased adoption of BIFS practices continues, the use and risks of pesticide and fertilizer applications will be reduced. In California, systematic analysis of selected pesticides of environmental concern reveals usage to be fairly constant since 1992, with no large decreases or increases in use. If the majority of farms adopt BIFS practices, there would be a dramatic reduction in pesticide and fertilizer use. As BIFS farming

systems are developed for each crop, increased outreach, over the long term, is necessary to continue to increase the adoption of environmentally friendly agriculture.

This is the third BIFS biennial report to the Legislature; the first report covers activities from January 1995 through December 1996 (available at http://www.sarep.ucdavis.edu/bifs/bifs97/), the second from January 1997 to December 1998 (available at http://www.sarep.ucdavis.edu/bifs/bifs99/). This third report describes the implementation of the BIFS program between January 1999 and December 2000.

PROJECT HIGHLIGHTS

Prune BIFS

During 1999 and 2000, winter applications of diazinon, an organophosphate (OP) insecticide, were eliminated in the demonstration/research sites of the 33 enrolled farms (12 funded by the BIFS program). Diazinon is the main contributor to wintertime toxicity of California river water. The use of irrigation water was also reduced on almost all Prune BIFS farms, due to careful, plant-based monitoring. To promote Prune BIFS practices, such as cover crops and optimized fertilizer applications, over 24 educational meetings were held in 2000 with an audience of over 1,100. The number of enrolled farms has increased 33 percent from 1999, when 22 farms were enrolled.

Walnut BIFS

In 2000, 12 walnut orchards were enrolled in BIOS for walnuts, up from 10 in 1999. The use of pheromone mating disruption technology to control codling moth allowed 83 percent of the enrolled BIOS orchards to eliminate the use of organophosphate insecticides in 2000. In 2000, BIOS growers reduced applications of nitrogen (N) fertilizer by an average of 53 pounds per acre since 1998. Use of cover crops by enrolled growers increased from 60 percent in 1999 to 75 percent in 2000. Cover crops are a cornerstone of an integrated orchard production system. Cover crops can provide beneficial insect habitat, reduce runoff of agricultural chemicals and nutrients, and in some cases provide a biological source of nitrogen for the walnut trees.

Apple BIFS

Nineteen orchards (11 funded by the BIFS program), totaling 656 acres, were enrolled in the apple project in 2000, the first year of this project. The BIFS orchards, by using pheromone mating disruption, were able to reduce the use of organophosphates by 59 percent and carbamates by 92 percent in their first year. The use of all traditional pesticides was reduced in the BIFS orchards by 72 percent. The amount of reduced risk materials (pounds of active ingredient per acre) comprised 93 percent of all pest management materials used. Since the apple BIFS project has provided a cost share for codling moth control materials, the actual grower cost is $296/acre, which is only $10 more than the conventional cost.

Rice BIFS

Nine demonstration farms, on over 1330 acres, were enrolled in Rice BIFS during 2000, up from eight farms in 1999. Collectively, participating growers manage over 14,000 acres of rice. Alternative practices promoted by the project focus on non-chemical weed control strategies and reduced use of chemical fertilizer. On a per acre basis, BIFS project growers use less than half the amount of herbicides on their entire acreage, compared to the county average.

Dairy BIFS

The Dairy BIFS project worked with 11 dairy producers throughout the San Joaquin Valley in 2000, the first full year of this project. Dairy BIFS focuses on developing and demonstrating improved liquid manure management practices. Data collected so far has shown that it is feasible to use manure lagoon water nutrients to fertilize the dairy's forage crop and reduce the amount of synthetic fertilizer. For example, lagoon water nutrients were successfully used to grow silage corn at Dairy 8 in 1999 with yields (29.7 tons/acre) similar to fields where commercial fertilizer supplied needed nutrients (27.6 tons/acre). Controlled use of lagoon water nutrients can help keep those nutrients from contaminating ground water drinking supplies.

Strawberry BIFS

Fourteen farms enrolled 21 acres in the Strawberry BIFS project in 2000, up from seven growers with 10.5 acres in 1999. Strawberry BIFS provides intensive one-on-one scientist-grower interactions. This project focuses on developing alternatives to the soon-to-be-banned fumigant, methyl bromide, as well as aboveground pests like Lygus. The Strawberry BIFS project has completed the first evaluation of commercially available strawberry cultivars for performance under non-fumigated field conditions in California. These trials showed that Aromas, Pacific, and Seascape were the top performers.

Citrus BIFS

The Citrus BIFS project has undergone some changes in 2000. A new principal investigator has joined the project. In 2000, eight farms were enrolled. Citrus BIFS focuses on reducing the use of the herbicide simazine (a known groundwater contaminant), reducing organophosphate insecticide and fertilizer use, and increasing the use of cover crops.

Other BIFS Projects

The Lodi-Woodbridge Winegrape BIFS and the Westside (cotton and row crops) BIFS are not currently funded by UC SAREP. These previously funded projects are described in past biennial reports.

INTRODUCTION

AB 3383 and through extension, AB1998, request that the Regents of the University of California establish a pilot demonstration program to provide extension services, training, and financial incentives for farmers who voluntarily participate in pilot projects to reduce their use of agricultural chemicals. Attachment 1 provides the complete text for AB 3383 as chaptered (Chapter 1059, Statutes of 1994). The goal of AB 3383 is:

"… to expand the use of integrated farming systems that have been proven to decrease the use of farm chemicals," through integration of the following elements (Section 591):

(1) Relying on biological and cultural control to protect crops from pest outbreaks.
(2) Creating on-farm habitats that harbor populations of beneficial insects and mites.
(3) Using cover crops to provide some or all of the nitrogen needed by the crop plants.
(4) Directing overall attention to soil building practices.
(5) Reducing reliance upon chemicals.

The Legislature requested that the University of California establish a program of pilot demonstration projects with the following features (Section 592 (b)):

(1) The program should consist of up to five pilot demonstration projects, each project involving a different commodity or cropping system and each located in a different county.
(2) The program should be designed to extend integrated farming systems through the proven technique of farmer-to-farmer communication, with technical support provided by farm advisors, scientists, and pest control advisers.
(3) The structure of each pilot demonstration project should be patterned, to the degree feasible, after the successful Biologically Integrated Orchard Systems (BIOS) program coordinated by the Community Alliance with Family Farmers in Merced County.
(4) Pilot demonstration projects should be selected through a competitive process that supports the goals specified in Section 591. The proposals for the projects selected should demonstrate the applicant's experience in the farming systems described in subdivision (b) of Section 591, should contain documented financial and technical support, and should provide for a breadth of private sector cost sharing.
(5) Funding for the program should consist of a combination of federal, state and private sector funds…

AB 3383 appropriated $250,000 from the Food Safety Account to the California Department of Pesticide Regulation (DPR) for the BIFS program. The U.S. Environmental Protection Agency (US-EPA) Region IX provided additional funds ($420,000). These funds were sufficient to support the first two pilot projects for three years. In 1997-98, US-EPA ($529,663) and the University of California Division of Agriculture and Natural Resources ($100,000) provided additional funds. Also in 1998, AB 1998 provided another $1,000,000. Finally, further support from US-EPA in 2000 provided an additional $265,000 through their programs, the Pollution Prevention Initiative for States and regional Food Quality Protection Act Funds. The University of California Division of Agriculture and Natural Resources also has provided funds ($5,000 in 1999 and $10,600 in 2000) to support the formation of a BIFS Workgroup. The BIFS Workgroup financially supports annual meetings to exchange information and improve project impacts. The Workgroup also provides training for BIFS project personnel. The Workgroup is open to all BIFS-like projects, even those projects not funded through UC SAREP.

The full text of AB 1998 (an extension of AB 3383) can be found in Attachment 2.

PROGRAM OVERVIEW

The University of California Sustainable Agriculture Research and Education Program (UC SAREP) was chosen by the UC Division of Agriculture and Natural Resources to implement AB 3383 and AB 1998 in consultation with a program advisory review board.

Program Advisory Review Board

AB 3383 (and by extension AB1998) outlines the appointment and role for a 13-member Program Advisory Review Board (Section 593. (a)). Members of the board were originally appointed in February 1995 by the UC Vice President of Agriculture and Natural Resources (Table 1). During the ensuing years, new members have been appointed to replace some members who left the board.

Table 1. Members of the program advisory review board in 2000.

Name and Affiliation	Category Specified in AB3383, Section 593
Steven Weinbaum, Dept. of Pomology, UC Davis	University of California
Lonnie Hendricks, Farm Advisor, Merced County	University of California
Kathy Taylor, US-EPA Region IX	Relevant Federal Agencies
Tish Espinoza, USDA-Natural Resources Conservation Service	Relevant Federal Agencies
Sherman Boone	Grower
Stephen Griffin, Mission Packing	Grower
Gregory T. Nelson	Grower
John Carlon, Sacramento River Partners	Nonprofit Organization
Currently Vacant- nominations in process	Nonprofit Organization
Judy Stewart-Leslie	Pest Control Advisor
Paul Gosselin	Department of Pesticide Regulation
Casey Walsh Casey	Department of Food and Agriculture
Kevin Olsen, S & J Ranch	DPR Pest Management Advisory Committee

Policies and Procedures

AB 3383 (and by extension AB1998) states that pilot demonstration projects should be selected through a competitive grant process (Section 592. (b) (4)) and lists the duties expected of UC SAREP (Section 594):

> ... an appropriate program whose director, in consultation with the program advisory review board, shall perform the following duties:
>
> (a) Develop policies and procedures to guide the implementation of the pilot demonstration projects. These policies and procedures shall include, but shall not be limited to, a mechanism for monitoring and summarizing pesticide and fertilizer use for each project with an assessment of overall reductions in pesticide and fertilizer use on each project.
> (b) Develop and issue requests for proposals for the pilot demonstration projects.
> (c) Review and select the proposals to be funded.
> (d) Annually review pilot demonstration projects and determine which projects shall be renewed.

UC SAREP developed specific policies and procedures to guide the implementation of the demonstration projects in consultation with the program advisory review board as part of crafting the first Request for Proposals (RFP). These policies and procedures remained in effect as described in the spring 1998 BIFS RFP.

Table 2. Corresponding sections of AB 3383 and the UC SAREP Fall 1998 BIFS Request for Proposals for demonstration projects.

AB 3383 Section Citation	Request for Proposals Section
591. (a) - (c), 592. (a) & 592. (b)	Introduction
592. (b) (4), 594. (a), 596.	Funding
598. (a) & (b)	Use of Funds
592. (b) (3), 592. (b) (4) & 594. (a)	Criteria
594. (a), 592. (b) (3) & 592. (b) (4)	Procedure and Timeline for Application, Evaluation, and Awards
592. (b) (3)	Introduction and additional resources available through UC SAREP

UC SAREP Staff Support for BIFS Project Implementation

UC SAREP staff provides important support work for the BIFS Program using the 10 percent program support funds. These funds principally support one Ph.D. level postgraduate researcher (the BIFS Coordinator) over three years (the life of each project). The BIFS Coordinator provides natural and social science technical support to project management teams in implementation (team facilitation, group meetings, information sharing, etc.), and provides or facilitates monitoring and evaluation work (develop appropriate protocols, analyze data, etc.). The BIFS Coordinator also oversees the reporting process for the projects, is the main interface for the BIFS Program Advisory Review Board and assists with documentation and evaluation of the overall BIFS program.

In addition, the 10 percent program support funds covers expenses to run the BIFS Board meetings, office operating expenses, and transportation expenses related to the BIFS program. Administrative support is provided by the UC SAREP grants manager and accounting officer and additional technical support by the Director and other staff members. The list below summarizes SAREP staff support for the BIFS projects.

Summary of SAREP staff support from January 1999 to December 2000

BIFS Project Support, Oversight, and Reporting

— Developed more explicit reporting requirements in checklist format
— Solicited and summarized all project target pesticides, site codes, and counties for PUR analysis
— Multiple site visits completed to all seven projects
— Critically reviewed and summarized all project original proposals and subsequent reports
— Provided survey data analysis recommendations for projects (social science technical support)
— Provided survey development assistance (strawberries, rice, walnuts)
— Provided recommendations on economic analysis (rice)
— Provided guidance with data management (strawberries, dairies, citrus, walnuts)
— Facilitated budget and contract communications between SAREP and the BIFS projects
— Provided input to projects on meetings, newsletters, and other aspects of outreach
— Summarized project annual reports and wrote Biennial Report to the Legislature
— Prepared funding scenarios for discussion and evaluated BIFS projects for report to the BIFS Board

BIFS Workgroup (UC-funded workgroups facilitate coordination of geographically distant parties)

— Planned and organized the first BIFS Workgroup plenary meeting Feb 17, 2000
— Provided assistance in preparing the newest Workgroup proposal to UC DANR
— Summarized and delivered meeting notes to all Workgroup members
— Represented the BIFS Workgroup at Water Quality Workgroup meetings

BIFS-related presentations

— BIFS overview for UC Davis sustainable agriculture class (January 31, 2000)
— BIFS overview UC Davis Ag Systems and Environment class (November 23, 1999)
— N-budget Workshop at the Nut Grower Trade Show in Turlock (March 15, 2000)
— N-budget Workshop at a BIOS Field Day in Colusa (November 30, 1999)
— BIFS impact on pesticide use at the DPR Pesticide Use Conference in Sacramento (May 8, 2000)
— BIFS, IPM, and cover crops at the CAFF Farm Tour (May 5, 2000)
— Session moderation at Western SARE 2000, Portland OR (May 6-8, 2000)
— BIFS overview in the DANR Building seminar series at UC Davis (December 12, 2000)
— N-budget workshop at a BIOS field day in Woodland (December 13, 2000)

Conferences, Meetings, and Trainings, Planning/Organizing

— Planned BIFS Workgroup Meeting (Feb. 17, 2000)
— Planned BIFS Program Advisory Review Board meetings (October 26, 1999, June 12 and November 29, 2000)
— Planning Access database training for BIFS projects staff and Workgroup (training date Jan 9, 2001)
— Planning for the Ag Partnership Conference to be held March 27-28, 2001

Funding History of Current BIFS Projects

In June 1998 two new proposals were selected for a full three years of funding: Biologically Integrated Farming System for Rice submitted by Randall Mutters, UCCE Butte County Farm Advisor, and Biologically Integrated Production System for Prunes submitted by Gary Obenauf, California Prune Board project manager. Additionally, a first year of funding for the Expansion of the Biologically

Integrated Orchard Systems Model to Northern San Joaquin Valley Walnut Orchards, submitted by Joe Grant, UCCE San Joaquin County farm advisor, was awarded.

With the passage of Assembly Bill 1998 in September 1998, additional funds were made available for the BIFS program. Two additional projects were offered BIFS funding: Citrus Orchard Management - Economic, Environmental, and “Knowledge Access” Considerations submitted by Mark Freeman, UCCE Fresno County farm advisor, and, BASIS (Biological Agriculture Systems in Strawberries): Bio-Intensive Pest Management in the Monterey Bay Region submitted by Sean Swezey of UC Santa Cruz and Carolee Bull of the USDA Agricultural Research Service, Salinas. At the same time, funding was offered for the second and third years of the walnut project in the San Joaquin Valley. In 1999, two additional projects were chosen for funding, Integrated Pome Fruit Production in Contra Costa County (Apple BIFS) submitted by Janet Caprile, farm advisor in Contra Costa County and Integrating Forage Production with Dairy Manure Management in California's Central Valley (Dairy BIFS), submitted by Stu Pettygrove, extension specialist from UC Davis.

Funding is available for all seven current BIFS projects to complete the full three years of each project, however, no new state funding has been identified to extend any current BIFS projects or to fund new BIFS projects. However, U.S. EPA Region IX is expected to continue its current support (approximately $200,000 for 2001) and we are attempting to find matching funds to allow funding for new BIFS projects.

Table 3. Timing and funding of existing BIFS projects, 2000. Funds provided by AB1998 and US-EPA Region 9 Agricultural Initiative, US-EPA Food Quality Protection Act Regional Funds, and US-EPA Pollution Prevention Incentives for States (PPIS) funds.

Principal Investigator	Institution	Title	Year 1 - 98/99	Year 2 – 99/00	Year 3 - 00/01	Total
Mutters, Randall	UC Davis Department of Agronomy and Range Science; UC Cooperative Extension, Butte County	Biologically Integrated Farming System in Rice	$100,000	$86,200	$100,000	$286,200
Obenauf, Gary	California Prune Board	Proposal to Develop and Implement a Biologically Integrated Production System for Prunes	$90,000	$95,000	$90,000	$275,000
Grant, Joseph	UC Cooperative Extension, San Joaquin County	Expansion of the Biologically Integrated Orchard Systems Model to Northern San Joaquin Valley Walnut Orchards	$53,720	$55,867	$50,220	$159,807
Chao, C. Thomas	UC Cooperative Extension Specialist, University of California-Riverside	Citrus Orchard Management BIFS Project	$79,800	$87,435	$81,870	$249,105
Bull, Carolee	Agricultural Research Service, US Department of Agriculture, Salinas, Monterey County	BASIS (Biological Agriculture Systems in Strawberries): A Biointensive Production Methods Innovators Group in the Monterey Bay Region	$100,000	$100,000	$100,000	$300,000
Pettygrove, Stu	UC Davis, Dept. of Land, Air, & Water Resources, Extension Specialist	Integrating Forage Production with Dairy Manure Management in California's Central Valley	$110,0009 (99/00)	$93,012 (00/01)	$97,382 (01/02)	$300,484
Caprile, Janet	UC Cooperative Extension, Contra Costa County	Integrated Pome Fruit Production in Contra Costa County	$52,305 (99/00)	$45,805 (00/01)	$41,890 (01/02)	$140,000
		TOTAL CURRENTLY COMMITTED				**$1,710,596**

BIFS Component Research Activities

As described in section 592E of AB 1998, UC SAREP used 10% of the funds to support component investigations on BIFS farming systems that still need to be developed or refined. Four projects have been funded.

Table 4. Summary of funding for BIFS component research.

Principal Investigator	Principal Investigator's Organization	Project Title	Budget: 98-99	Budget: 99-00	Totals
Harter, Thomas	UCCE – Kearney Ag Center	Impact of Dairy Waste and Crop Nutrient Management of Shallow Groundwater Quality	$14,500	$15,000	$29,500
Ingels, Chuck	UCCE-Sacramento County	Effects of Cover Crops on a Vineyard Ecosystem in the Northern San Joaquin Valley	$6,030	$6,030	$12,060
Mathews, Marsha Campbell	UCCE-Stanislaus County	Use of Dairy Lagoon Water in Production of Forage Crops	$19,760	$10,950	$30,710
Mitchell, Jeff	UC Davis Vegetable Crops Dept.	Conservation Tillage Systems for the San Joaquin Valley's West Side	$12,774	$12,774	$25,548
		TOTALS	$53,064	$44,754	$97,818
		Total Funding	$97,818		
		Funding Source – AB 1998	$89,091		
		Funding Source – SAREP general funds	$8,727		

Thomas Harter's project is linked with the Dairy BIFS Project. This project focuses on understanding the link between dairy waste management and shallow groundwater quality, and on developing dairy waste management methods that will ensure impacts on groundwater quality are minimized.

Chuck Ingel's project has direct application to the previous Lodi-Woodbridge Winegrape BIFS Project. This project focuses on comparing the effects of different cover crops on vine vigor and grape quality.

Marsha Campbell Mathews project is linked to the Dairy BIFS project. This project implemented management practices aimed at improving groundwater quality by 1) minimizing excess dairy manure pond water nitrogen applications to corn forage fields, and 2) eliminating the use of commercial nitrogen fertilizer by substituting similar amounts of pond water nitrogen.

Jeff Mitchell's project is a follow-up to the previous West Side BIFS (cotton and row crops) project. This project compares conservation tillage and conventional tillage practices in crop rotations common to the West Side for productivity, key soil properties, pest and crop management requirements, and production costs.

More details on these and all SAREP funded projects can be found at http://sarepdevel.ucdavis.edu/grants/database .

MEASURING IMPACTS OF BIFS ON CALIFORNIA AGRICULTURE

BIFS project personnel conduct weekly visits to enrolled BIFS farms and annual interviews with each BIFS farmer, documenting the rate and type of chemicals applied and farming practices used. This data is used to track the reduced rates of targeted pesticides and fertilizer, the increased use of reduced risk pesticides, and the increased adoption of various practices that protect air and water quality. The Annual Report Excerpts Section of this document presents this data.

In addition to assisting individual BIFS growers to improve their farming system, the BIFS program is also aimed at increasing adoption of BIFS practices at an industrywide level. Each project has well-defined outreach activities to accomplish increased adoption industrywide; regular newsletters mailed to hundreds, even thousands of farmers (see Attachment 3), World Wide Web sites (see Attachment 4) well-advertised field days, interviews generating articles in the popular press (see Attachment 5), presentations at scientific and industry gatherings, and other measures. These activities increase awareness and understanding of new BIFS practices. However, measuring the impact of these activities on the farming community at large is a complex task.

Through funding available from the US-EPA, UC SAREP has hired a Research Associate/Ecologist to help measure the impact of BIFS on California agriculture. Mail and phone surveys, along with other sociological methods, will be conducted over the next two years, starting in February 2001. The Research Associate/Ecologist will also assist each BIFS project individually to maximize the impact of their outreach activities.

For this report, we have presented two types of baseline data: 1) acreage managed by BIFS farmers and 2) California statewide Pesticide Use Reporting (PUR) data. These data can then be compared to total crop acres throughout the state and pesticide use trends post-project to assess impact at the county and state level. Typically, rates of adoption of new agricultural technologies are measured in years or even decades. We would not expect dramatic statewide changes in pesticide use and adoption of BIFS practices in such a short time (since the beginning of BIFS in 1995). Effects of the BIFS projects will probably be most noticeable at a local county level. The newly hired Research Associate will assist in focusing the analyses on a local level.

The following statewide data on acreage and pesticide use are meant to be baseline data for future comparison purposes. These trends in acreage and pesticide use will also be used to guide and focus BIFS project efforts.

Acreage Under Management by BIFS Farmers

One indicator of the impact of the BIFS program is the number of acres managed by enrolled BIFS farmers (Table 5). Enrolled BIFS farmers demonstrate BIFS practices on their land and lead by example. Typically, enrolled BIFS farmers use BIFS practices on a portion of their acreage, fine-tuning BIFS practices before converting the entire farm. By talking with friends and neighbors, and sharing information, enrolled BIFS farmers are leading the way to economically sound reduced-chemical farming practices. Many other farmers attend field days and receive BIFS newsletters but are not enrolled in the BIFS projects. It is unknown how many acres they have or the adoption rate of BIFS practices on these farms. During 2001-2002, UC SAREP will conduct industrywide surveys in each BIFS crop, to try and measure adoption rates for non-enrolled farmers.

By 2025, we predict that at least 20 percent (and perhaps as much as 60 percent) of California cropland will be under alternative BIFS or organic production systems. For more details please see Attachment 6

(Swezey and Broome, 2000), also available for download at http://danr.ucop.edu/calag/JA00/toc.html .

Table 5. Total cumulative acreage served by the BIFS projects as of the beginning of 2000. (A "*" indicates partial project funding from BIFS or other UC SAREP grants.) Data for California acreage are from the California Agricultural Statistics Service.

BIFS Project	Acres farmed by BIFS Farmers	Total bearing acres in California (1998)	Percent acreage served by BIFS
Almonds*	33,820	460,000	7.4%
Walnuts*	3,430	193,000	1.8%
Winegrapes*	30,000	385,000	7.8%
Cotton	90,000	846,150	10.6%
Prunes*	6,303	83,000	7.6%
Rice	15,000	480,000	3.1%
Citrus	6,360	201,811	3.1%
Strawberries	700	23,000	3.0%
Dairy/Forage (corn)	5,500 (estimate)	Data not available	-- --
Apples*	1,540	37,000	4.2%
Subtotal (excluding dairy/foraging)	187,153	2,708,961	7.1%
All irrigated crops in California	**187,153**	**8,200,000**	**2.2%**

Pesticide Use in California Crops

In California, we have access to the most complete pesticide use information in the world, through the Pesticide Use Reporting (PUR) system (http://www.cdpr.ca.gov/docs/pur/purmain.htm). Farmers in California are required to report all pesticide applications. This data is compiled by the State and is made freely available for analysis.

PUR analysis of the BIFS program will be completed in two stages:
Stage 1. Determine baseline (pre-project) state trends of targeted pesticides over time.
Stage 2. Compare BIFS farm pesticide usage to conventional comparison plots and other appropriate conventional farms in a county or region during the life of the project.

Stage one is almost complete and results are presented in the following figures. For stage two, all seven projects have submitted lists of target pesticides, PUR Identification Numbers for enrolled farmers, and a list of all applicable crop codes. Statisticians will be contracted to analyze this data in 2001. A bid package is being prepared and will be released in February of 2001. US-EPA (Region IX) has provided funding for this analysis.

Stage 1: Baseline Pesticide Use Trends

Pesticide use can be measured in many ways. Typically reported are total pounds of pesticide used for the year on a particular crop (Figure 2). Evaluating the total pounds of certain pesticides used provides a good idea of the magnitude of pesticide use on a certain crop. However, confusion can arise when acreage is rapidly changing for a crop, such as grapes or cotton in Figure 1. For example, when planted acreage increases, it may appear that pesticide use is rising, when on a per acre basis (the rate of use), pesticide use may actually be falling. Also making analysis difficult is the use of large quantities of relatively less toxic chemicals, like sulfur use on grapes. Sulfur is used in large quantities, yet is only slightly toxic, and is allowed for use on organic farms.

These two issues, changes in crop acreage and the use of large amounts of relatively benign chemicals, can complicate analysis. Therefore, we have calculated pesticide use on a "pounds per acre" rate and have only included pesticides of "environmental concern" (Figure 3). "Pounds per acre" is calculated from the PUR database by summing the pounds of active ingredient applied, divided by the base acres planted.

List of Pesticides of Environmental Concern

Our list of pesticides of "environmental concern" includes Proposition 65 chemicals (know to the State of California to cause cancer or are reproductive toxins), known groundwater contaminants (from a list supplied by the Department of Pesticide Regulation), and acetylcholine esterase inhibitors (organophosphates and carbamates, which are the more toxic pesticides being reviewed under the 1996 Food Quality Protection Act of 1996). This list was compiled from the California Department of Pesticide Regulation's Web site http://www.cdpr.ca.gov/docs/pur/pur98rep/98com.htm#trends . Relatively less toxic chemicals used in large quantities, such as sulfur, are not included in this list of pesticides of environmental concern.

Baseline State Level Pesticide Use (in Crops with BIFS Projects)

Figure 3 shows no major increases or decreases in statewide usage of selected pesticides of environmental concern. It does appear, that in walnuts and strawberries, their use is slowly increasing. Also, note that strawberry pesticide use is ten times higher than in other BIFS crops. This is because the pounds per acre rates used of methyl bromide far exceed other chemicals. The BIFS crop with the second highest pesticide use is apples. In general, lower value crops, like rice and corn, have much lower pesticide use rates than higher value crops, like almonds and oranges. Effective BIFS projects are needed if growers of these crops are to reduce their use of these chemicals.

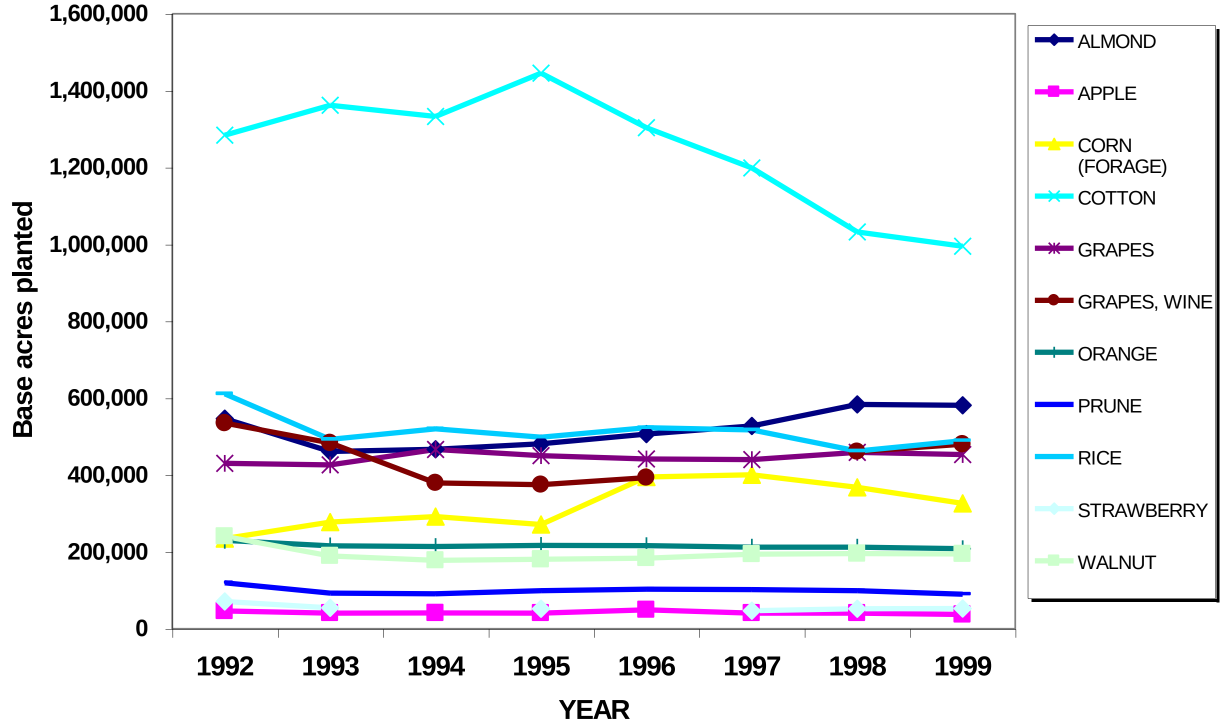


Figure 1. Acres planted in California for various crops. Crops included have had BIFS projects. PUR data supplied by Minghua Zhang and Romeo Favreau, UC Davis.

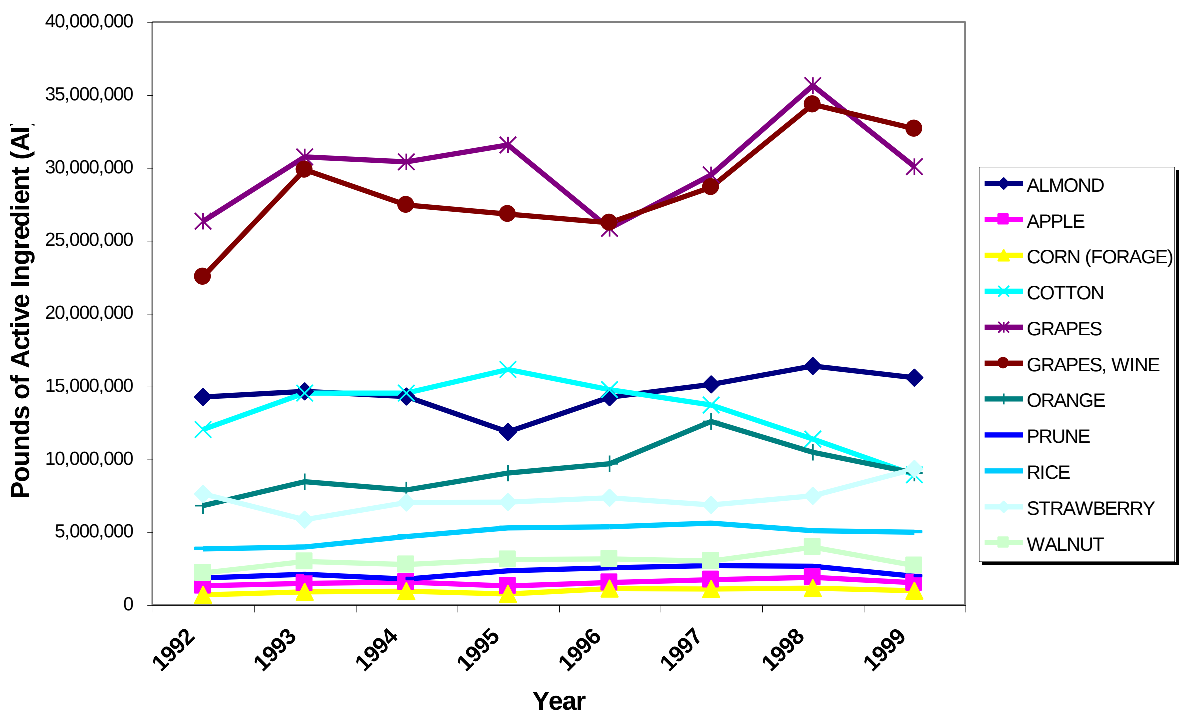


Figure 2. Pounds active ingredient of pesticides applied per year to various crops. Crops included have had BIFS projects. Data supplied by Minghua Zhang and Romeo Favreau, UC Davis.

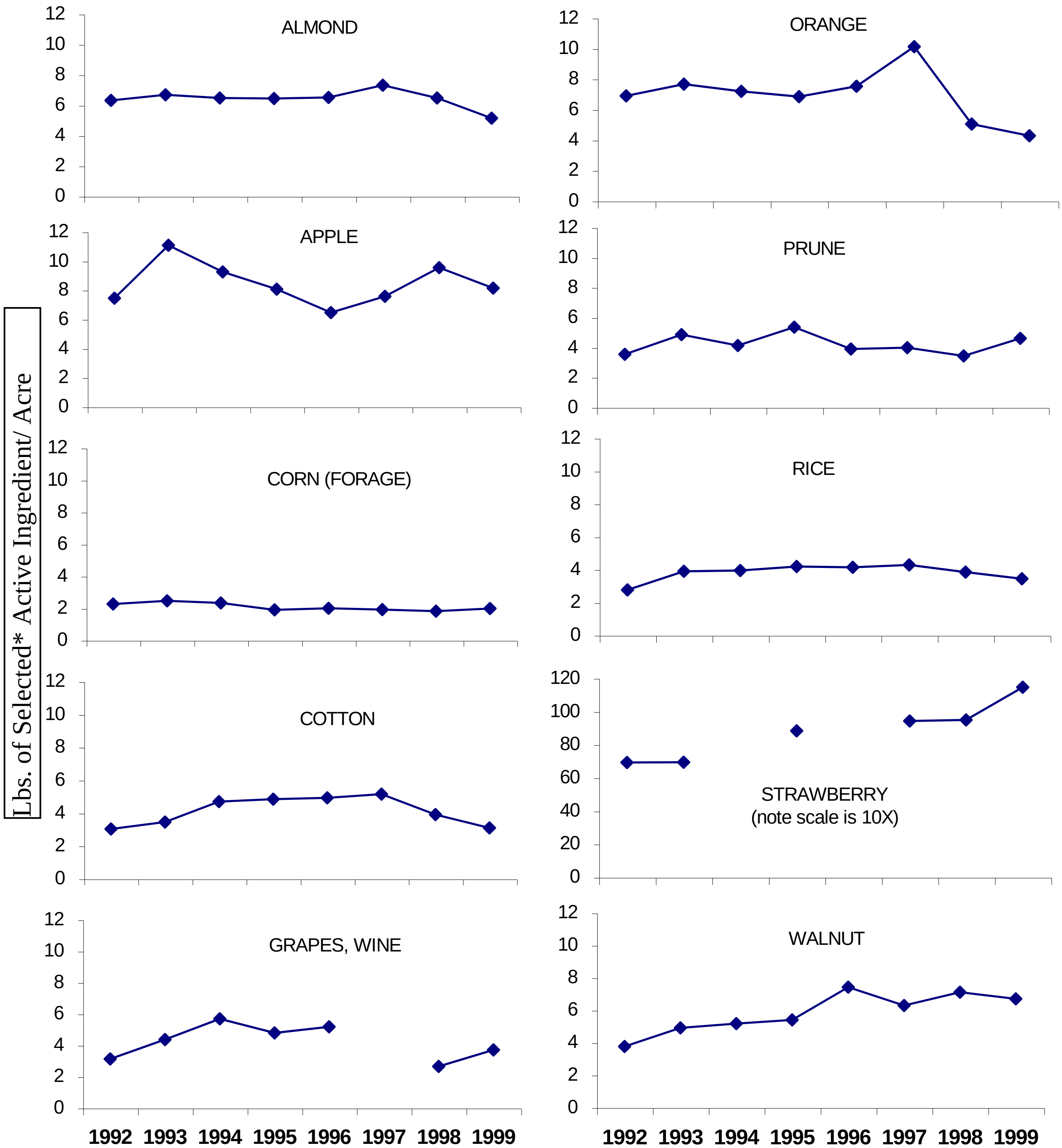
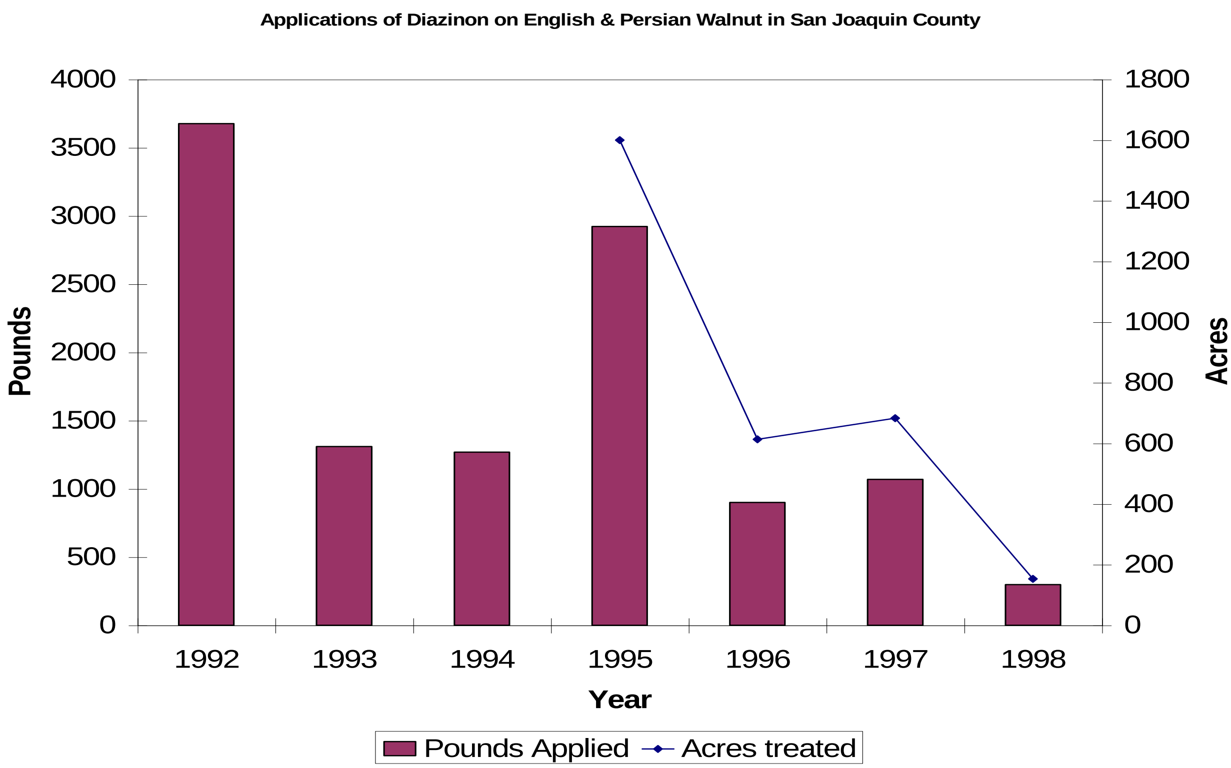


Figure 3. Use rate of selected pesticides of environmental concern. Shown is the average use rate in the State of California, for crops that have had BIFS projects. *Selected pesticides include the Proposition 65 list, organophosphates, and known groundwater contaminants. Missing data indicate errors with the Pesticide Use Reporting (PUR) database. PUR data supplied by Minghua Zhang and Romeo Favreau, UC Davis.

Baseline County Level Pesticide Use

For each BIFS project, a list has been made of the pesticides targeted for risk reduction, the counties in which the project operates, and the crop codes used in the State PUR database. With this information, graphs of pesticide use over time can be made for each project's crop, county, and pesticide of interest. An example of these graphs is shown in Figure 4. The raw data used for this graph is taken from http://www.cdpr.ca.gov/docs/pur/purmain.htm (version March 28, 2000) and http://www.ipm.ucdavis.edu/PUSE/prepared.html (version January 19, 2000).
Approximately 600 graphs will be generated during this process. This is the number of county/pesticide combinations for all seven projects. Each project will receive its own set of graphs to be used in targeting project efforts. In Stage 2 PUR analysis, baseline data like that presented in Figure 4 will be compared to BIFS farms' pesticide use.

Figure 4. An example of county-based baseline trend of pesticide use, in this case diazinon, on walnuts in San Joaquin County. This type of graph is used by projects to target project efforts. In Stage 2 PUR analysis, part of this data will be used as a baseline, to which BIFS farm pesticide use will be compared.



Stage 2: BIFS Farms versus County Average Pesticide Use

On the county or regional level BIFS projects have started to have an effect. A recent report by the California Institute of Rural Studies found that, "…uniformly, BIOS Orchards report a significantly lower proportion of fields treated with registered pesticides as compared with a matched group of Cohort [conventional] Orchard fields. The share of all BIOS Orchard fields treated with any registered material has significantly declined throughout the period in which the BIOS programs have been implemented. In the case of almonds, this share is now less than one-half; in walnuts about one-fourth" (Villerejo and Moore, 1998). This report is available for order at http://www.cirsinc.org/pub/pubcat.htm.

Epstein, et al. (2000) published a study showing dramatic reductions in dormant season organophosphate use by almond and stone fruit growers on a county-by-county basis, from 1992 to 1998. This is the type of analysis we will pursue in evaluating BIFS projects. A comparison will be made between pre- and post-project analysis of pesticide use in counties with BIFS projects and counties without BIFS projects. We expect to see greater reductions in targeted pesticide use in counties with BIFS projects.

Simazine use on vineyards in San Joaquin County, on BIFS and non-BIFS acreage, is another example of a Stage 2 PUR analysis (Figure 5.) Simazine is a known groundwater contaminant in many parts of the Central Valley. The Lodi-Woodbridge Winegrape Commission's (LWWC)Winegrape BIFS project targeted this herbicide for use/risk reduction. Since the beginning of the project in 1996, BIFS farmers have used less simazine on their vineyards than the county average (Figure 5). In the coming years, if the LWWC's continuing outreach program is succcessful, we would expect to see further reduction in both BIFS farms and the county at large.

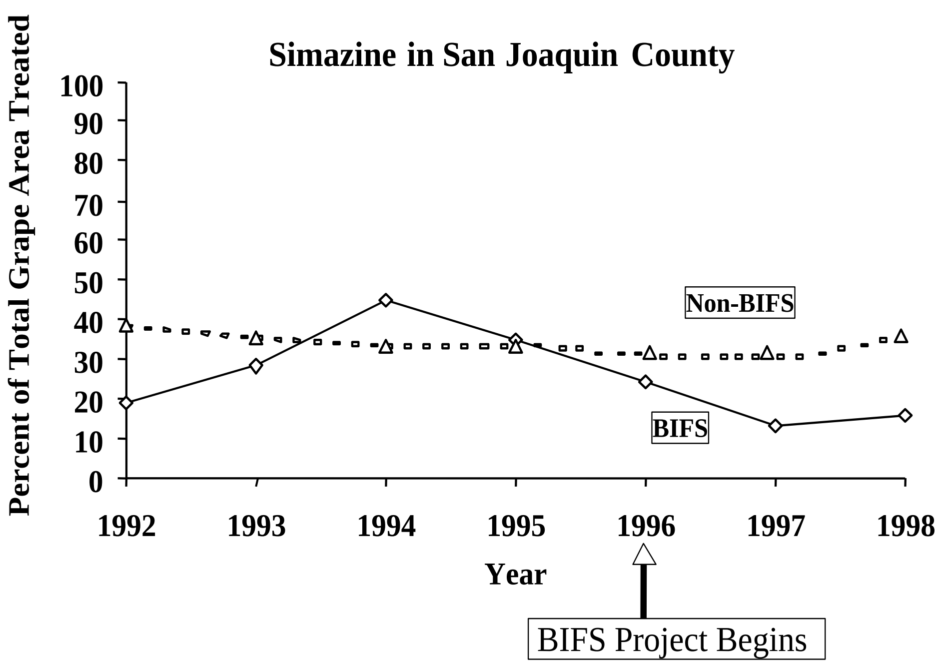


Figure 5. Simazine use in winegrapes in San Joaquin County for BIFS and non-BIFS vineyards. Note: all data is from the State PUR except BIFS data from 1996-1998, which is from in-person interviews (figure adapted from Broome, et al. 2000).

Plans for Continued PUR Analysis

Further PUR analysis is necessary for the BIFS projects. With funds provided by US-EPA Region IX, a statistician will be contracted to perform Stage 1 PUR analysis for all seven currently funded BIFS projects. This will be completed before June 2001. Stage 2 PUR analysis will also be performed by contract with a statistician in the second half of 2001 and in 2002.

ANNUAL REPORTING AND REVIEW OF FUNDED PROJECTS

AB 3383, and by extension AB1998, require that the program director, in consultation with the Program Advisory Review Board, "annually review pilot demonstration projects and determine which projects shall be renewed." (Section 594. (d)). Each project submits six-month and annual reports to UC SAREP. The board and staff review the annual project reports before each meeting, principal investigators give a half-hour presentation during the meeting, which is followed by questions and discussion. The board votes on which projects should receive continued funding and provides a recommendation to the Director of SAREP. The current projects have all been reviewed, found to be making good progress, and their funding renewed. Citrus BIFS, after its first year, was determined to not be advancing sufficiently and was given six months to improve its performance. Ultimately, a new principal investigator took over the project. The board's meeting dates and projects reviewed are listed in Table 6. Comments and decisions of the BIFS Program Advisory Review Board and SAREP staff are officially communicated back to the projects through an award letter and through the BIFS Coordinator.

Table 6. Meetings of the BIFS Program Advisory Review Board

Date of meeting	**Projects Reviewed**
October 26, 1999	Prunes, Walnuts, Rice, Strawberries, Citrus
June 12, 2000	Dairy, Citrus
November 29, 2000	Prunes, Walnuts, Apples, Rice, Strawberries

Criteria for Evaluation

To qualify for continued funding, a project must demonstrate and document continued and expanding grower participation, progress in agricultural chemical use reduction, and adoption of BIFS practices. To these ends, BIFS projects are evaluated by the board and SAREP staff in three basic areas: 1) an organized program of monitoring key biological, agricultural chemical, and economic variables, 2) on-farm demonstrations of an innovative biologically-based farming system, and 3) a collaborative outreach and extension model. These three areas build on one another. All projects collect data (1), both for BIFS farm management and project evaluation. However, some projects have not yet developed a well-defined, biologically integrated, production system (2) and therefore promoting the project with extensive outreach and extension (3) would be premature. During evaluation, it is necessary to consider the stage of development of each project.

Project Evaluation

Each BIFS project is located in a different geographic area and working with a different cropping system. It is expected that each project will develop at a different rate. In general, perennial tree crops (such as prunes, walnuts, and apples) have developed a BIFS production system more quickly than the other BIFS projects working with annual crops (rice, strawberries, and dairies (corn and alfalfa)). In Table 7, the most developed projects are listed first, while less developed projects are listed last. The citrus project received a "beginning" rating in all categories because the project has recently been reorganized, changing the principal investigator. We will be watching for improvement in the Citrus project in the next year.

The prune, walnut, and apple projects have made the most progress in terms of pesticide use reduction, data collection, the development of an integrated production system, and in outreach. (The apple project received a beginning rating in outreach because it has just ended its first year, while prunes and walnuts are ending their second year.) Prunes, walnuts, and apples are the most advanced projects, mainly because extensive background work has already been done in these, or similar crops. Almond BIOS, started in 1993, shares many pests with prunes, and apples and walnuts share the same main pest, codling moth. The pheromone mating disruption technology used in apples and walnuts to control codling moth has recently been refined and become more widely available for use. This has allowed the dramatic reduction in the use of broad-spectrum insecticides for control of codling moth.

Table 7. Evaluation of BIFS Projects. The BIFS Board has unanimously approved continued funding for all BIFS projects. Some BIFS projects have been rated as "beginning" in certain areas because of the particular development stage of each individual project. Most projects show promise of becoming successful in all areas.

	Project Development Stage			
BIFS Project	**Data Collection and Monitoring**	**On-Farm Demonstration of the "System"**	**Outreach and Extension**	
			Statewide Outreach	**Participatory Extension Model**
Prunes	Advanced	Advanced	Advanced	Intermediate
Walnuts	Advanced	Advanced	Advanced	Advanced
Apples	Advanced	Advanced	Beginning	Beginning
Rice	Advanced	Beginning	Advanced	Intermediate
Dairies	Advanced	Beginning	Intermediate	Intermediate
Strawberries	Advanced	Beginning	Beginning	Intermediate
Citrus	Beginning	Beginning	Beginning	Beginning

The Rice BIFS project is focused on herbicide and fertilizer use reduction, however, a completely integrated system of production methods has not yet been developed. Many different techniques are being tested in BIFS Rice fields. It is not yet clear which methods will be the most effective or economic. A similar situation occurs in the Strawberry BIFS project. Many new techniques to grow strawberries without methyl bromide are being tested in BIFS strawberry fields. A completely integrated and effective BIFS system for growing strawberries has not yet been developed.

The Dairy BIFS project is developing completely new methods for measuring lagoon water application to forage fields. The Dairy BIFS project has an active group of enrolled dairies and all are highly interested in using dairy waste as fertilizer and protecting groundwater. Once the Dairy BIFS group has fine-tuned the lagoon water application measurement system, the project will begin more aggressive outreach to other dairies. The dairy BIFS project is building a statewide mailing list of dairies that have requested information on Dairy BIFS.

The Citrus BIFS project has gone through many changes recently. A new principal investigator has taken over the project as of August 2000, and a new project manager will soon be hired. The citrus industry is facing many challenges: new restrictions on simazine use, possible restrictions on organophosphate insecticide use, and a falling market for citrus. Despite a slow start, the Citrus BIFS project is well-positioned to demonstrate biologically integrated methods of citrus production that are environmentally friendly and economically viable.

The BIFS Program Advisory Review Board has found that, in general, these BIFS projects need to focus more on outreach and increased adoption of the environmentally friendly, economically sound BIFS practices. The BIFS projects generally excel at developing and refining the alternative farming practices, but more needs to be done to increase statewide impact (Table 7). BIFS projects with the best collaborative extension programs are locally based to maximize effectiveness, but unfortunately this leaves non-BIFS counties without access to the new techniques developed by the BIFS projects. Coordinated statewide outreach efforts could be more effectively used by the most successful projects (prunes, walnuts, apples, and rice), but are beyond the current budgets of these BIFS projects. The BIFS Board has requested SAREP staff to continue to pursue additional funding opportunities for BIFS, so as to support additional commodities in different regions in development and demonstration of alternative farming systems and to increase statewide adoption of the current BIFS environmentally sound and economically viable practices.

MODIFIED EXERPTS FROM:

Prune BIFS Annual Progress Report - November 17, 2000

Principal Investigator: Gary L. Obenauf
Consultant to the California Prune Board
144 W. Peace River Drive
Fresno, CA 93711-6953
Phone: (559) 447-2127
FAX: (559) 436-0692
E-mail: gobenauf@agrc.cnchost.com

Introduction

The California Prune Board (CPB) is a State Marketing Order that represents the 1,400 growers and 21 packers of California prunes. California produces about 200,000 dried tons annually on 81,000 bearing acres. California prune production represents 99 percent of the U.S. total and about 70 percent of the world total. The annual crop value is approximately $200 million.

Although prune growers in the state must contend with a variety of insect, disease, nematode, and weed pests, the number of severe problems are relatively few when compared to other stone and pome fruits such as peaches and pears. In many cases prunes can be grown with a minimum of synthetic fertilizers and pesticides. The California Prune Board has long been committed to reducing high-risk inputs and the adverse environmental effects connected with their use. Because of this support a significant knowledge base has been developed which allows growers to move toward a reduced-risk pest management system.

A Biologically Integrated Production System for Prunes is part of the Integrated Prune Farming Practices (IPFP) Program. IPFP serves as an umbrella project for several projects relating to reduced-risk of pesticides in prune production including the BIFS Project. Project objectives are: 1) Develop and implement replacement pest management systems impacted by Food Quality Protection Act (FQPA 1996). 2) Reduce surface water contamination by diazinon and other organophosphates. 3) Reduce groundwater contamination by herbicides. 4) Evaluate ground covers and cover crops for their ability to increase biological control of pest organisms and reduce groundwater contamination by toxic pesticides. 5) Optimize nitrogen and other nutrient programs. 6) Optimize water use. 7) Reduce human exposure to pesticides. 8) Reduce risks to urban environments. 9) Delay resistance to currently used materials.

During 1999 and 2000, dormant applications of diazinon (an organophosphate insecticide) were eliminated in all demonstration/research sites. Asana was applied in the conventional blocks and if a dormant treatment was needed in the reduced risk block, oil was applied. In-season pesticide applications were based on pest monitoring protocols. The trend of diazinon use from 1990-1999 shows a reduction of approximately half the amount used in 1992 or 45,000 pounds.

Plant nutrient applications (fertilizations) were based on plant and water analysis, and in most cases, less than what the grower would have used. Some locations had enough nitrates in the well water to significantly reduce the amount and cost of nitrogen applied to the prune trees. Irrigation water was significantly reduced in most of the IPFP sites and has in fact been the surprise of the IPFP Program relative to potential benefit and response from growers. Over 24 educational meetings were held in 2000 with an audience of more than 1,100.

A great deal has been accomplished by the prune industry after the first two years toward pesticide risk/ reduction in California Prunes. The reduction in use of diazinon by half by the prune industry over the last several years has been in part by the IPFP Program. We are aware that fully reaching the stated objectives will take multiple years. The prune industry is committed to accomplishing the objectives.

Demonstration and implementation of this project will demonstrate the feasibility of growing stone fruits while greatly reducing the reliance on toxic pesticides. This could be especially important in almonds, cling peaches and fresh stone fruits where similar pest complexes occur. Grape growers near prune orchards would also benefit because prunes act as a reservoir for grape leafhopper parasites.

Pesticide Usage Survey and Pesticide Use Reporting

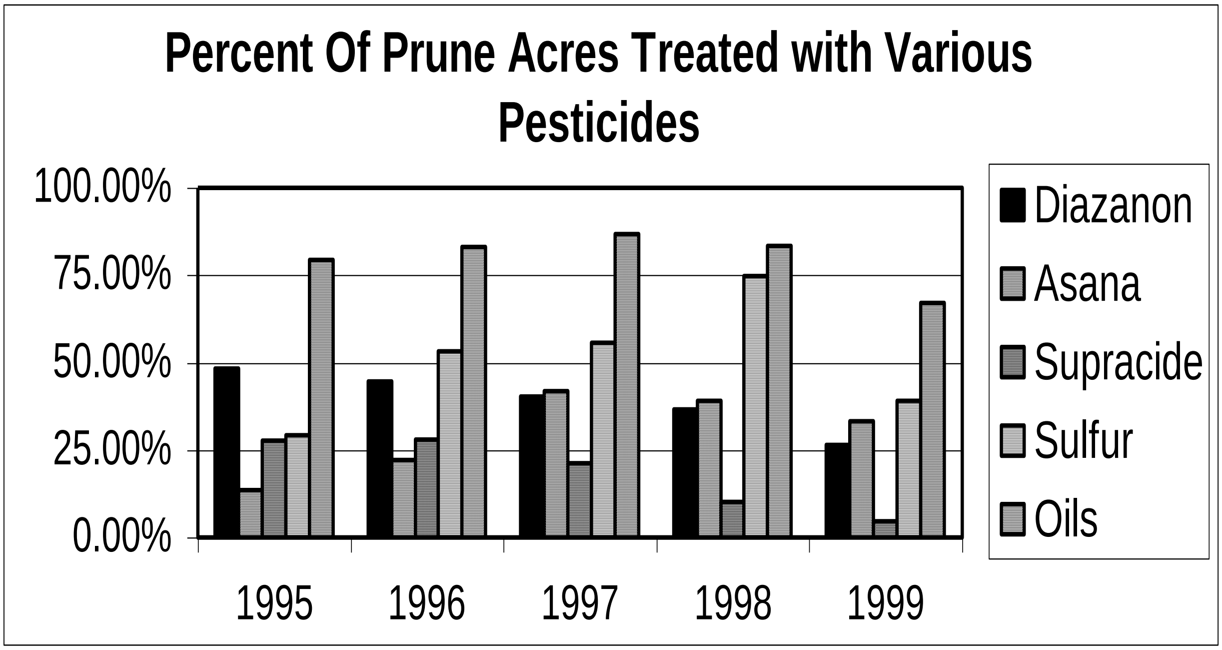
Ten Butte County growers farming 3,500 acres of prunes were interviewed to see what changes have taken place in their pesticide usage over the past five years. All 10 growers have used an annual dormant insecticide and oil treatment to control peach twig borer, San Jose Scale, European Red Mite, Mealy Plum Aphid and Leaf Curl Plum Aphid. Many have experimented with not using a dormant insecticide spray program but most continue to use either an organophosphate or pyrethroid spray during the dormant season on much of their acreage because of the likelihood of aphid problems when a dormant spray is not used. Many growers interviewed explained that their spray programs consist of every other row spraying with reduced rates of materials. Table 14 shows the dormant spray programs used on ten of the enrolled prune BIFS farms. This indicates that there is a fairly clear trend of less reliance on organophosphates and a shift to more pyrethroid dormant season sprays during the five years covered by the enrolled grower interviews. During the past four years about 30 percent of the acreage involved in this survey received no dormant spray.

In order to see if the results of this grower survey were a good representation of the pesticide usage trends on all prunes in California, Pesticide Use Reports were evaluated over the same years that the survey covered. The results of evaluating the Pesticide Use Reports coincide with the results of the grower survey. Graph 18 clearly shows a trend of fewer acres being treated with diazinon and Supracide, and more acres being treated with Asana. Graph 19 illustrates the total pounds of pesticides (active ingredients) applied to California prune orchards. This graph was included to show that oils and sulfur make up the majority of the pounds of pesticides used as reported by the California Department of Pesticide Regulation.

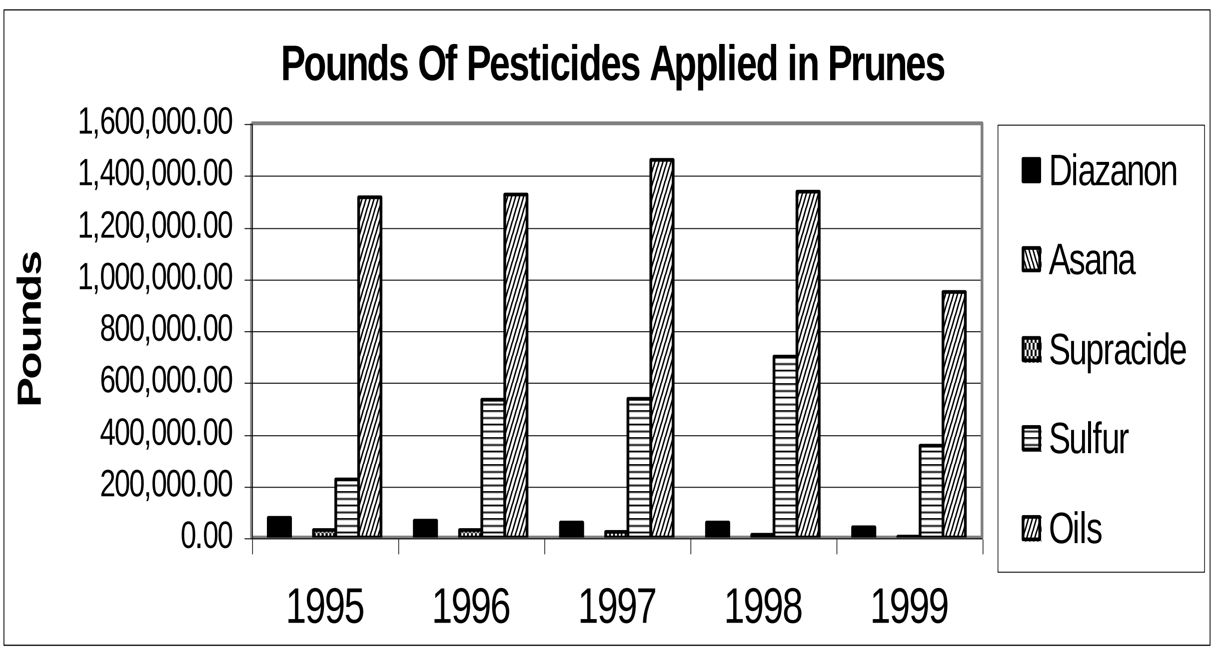
Table 14: Dormant spray program for 10 Prune BIFS growers (data from year-end surveys of project growers).

	Acres Sprayed out of 10 Orchards				% of Acres with	% of Acres with	% of Acres with	
	Total	Diazanon	Supracide/oil	Asana	Diazanon Applied	Supricide/oil Applied	Asana Applied	% Untreated
1995	2620	1075	850	695	41.03%	32.44%	26.53%	0.00%
1996	2620	75	220	1495	2.86%	8.40%	57.06%	31.68%
1997	3195	275	1370	420	8.61%	42.88%	13.15%	35.37%
1998	3195	0	20	1695	0.00%	0.63%	53.05%	46.32%
1999	3500	527	20	1770	15.06%	0.57%	50.57%	33.80%

Graph 18: Percent of total prune acres in California treated with various pesticides (data from the state PUR database).

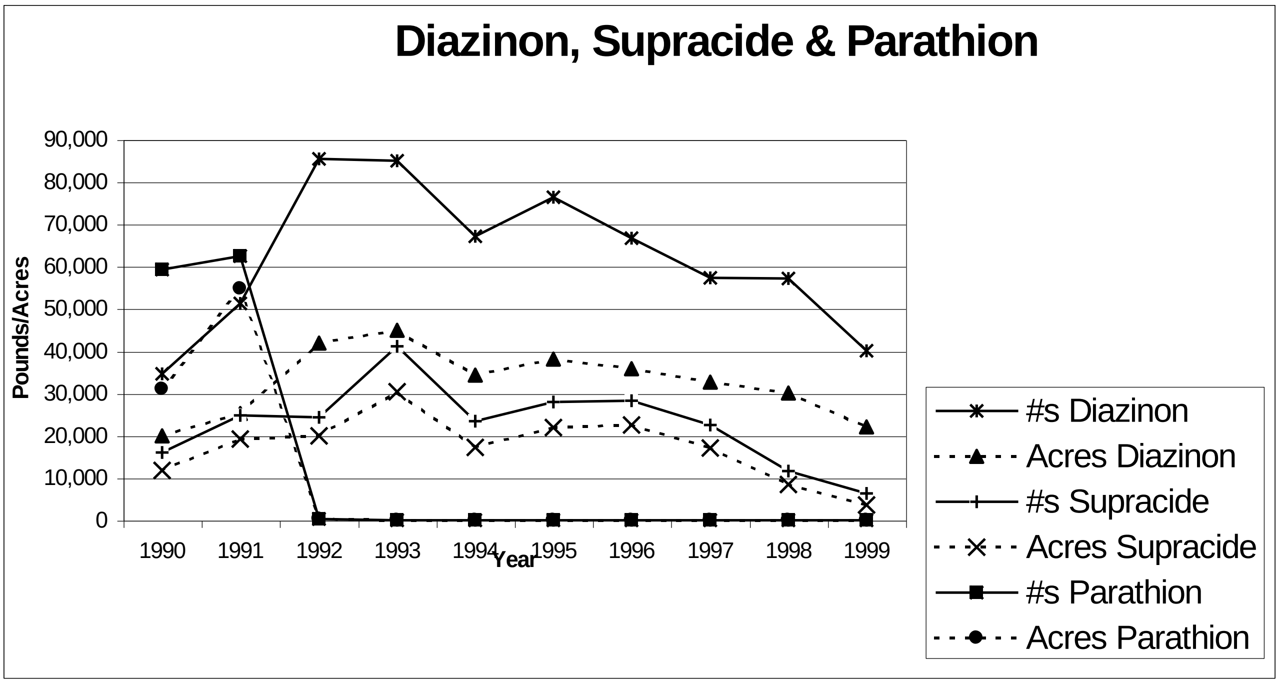


Graph 19: total pounds of various pesticides applied to California prune orchards (data from the state PUR database).



Diazinon and Supracide peaked in use in the prune industry shortly after parathion was removed from use. Graph 20 shows the peak in Diazinon use in 1992 at 85,388 pounds and down to 40,116 pounds in 1999. Many things including the efforts of the IPFP Program have influenced this downward trend in use of Diazinon.

Graph 20: Pounds applied and acreage treated with Diazinon, Supracide & Parathion 1990-1999 (data from the state PUR database).



Yield and Quality Evaluation from P-1 Grade Sheets:
Growers/cooperators were asked to provide P-1 grade sheets and weight receipts from the conventional and reduced risk blocks of the comparison sites. The growers/cooperators of the Demonstration orchards were also asked to provide the same documents. Grade sheet information for the 2000 crop year was not received in time to be used in this report. The 1999 grade sheet data indicated no significant difference in yield; dry away, % ABC screen fruit, or % ABC screen offgrade fruit, between the Conventional and Reduced Risk sites. However the reduced risk blocks did have significantly larger fruit (count per pound) than did the conventional blocks (Table 13). Based on the data obtained from the 1999 P-1 grade sheets, no adverse affects were seen in the reduced risk program as compared to the conventional program.

Table 13: 1999 Prune P-1 Grade Sheet Analysis

1999 P-1 Grade Sheet Analysis					
	Yield (lbs/acre)	**Average Count per Pound**	**Dry Away**	**% ABC screen**	**% ABC Offgrade screen**
Reduced Risk	4705 A	52.5 B	2.79 A	91.4 A	2.21 A
Conventional	4387 A	54.75 A	2.77 A	90.1 A	1.13 A

New Directions in the IPFP Program:

- Defoliation of the orchard early in the fall will be tested as a control of Prune Aphids.
- Oil applications made in the fall will be tested for aphid control.
- Reduced rates of Diazinon and Asana in a dormant application will be tested for control of aphids.
- Trapping for aphids in the fall will be evaluated as a tool to predict the need for aphid control.
- Pest Control Advisors (PCAs) will continue to be involved in the project by using the monitoring techniques in some demonstration plots.
- Some of the monitoring techniques will be modified so that they can be conducted faster and made more “PCA friendly.”
- Early forecasting of potassium deficiency will be implemented.
- Efforts will be made to improve quality of IPFP Newsletter, number of meetings and measuring impacts of IPFP Program on prune growers and industry.

MODIFIED EXERPTS FROM:

Walnut BIFS Annual Progress Report - November 17, 2000

Principal Investigator: Joseph A. Grant
Farm Advisor
UC Cooperative Extension
420 S. Wilson Way
Stockton, CA 95205
Telephone: (209) 468-9490
Fax: (209) 462-5181
E-mail: jagrant@ucdavis.edu

Introduction

California produces 99 percent of the walnuts grown in the United States and 38 percent of the world's production. Over 40 percent of the California crop is currently exported. The Sacramento and San Joaquin valleys are the largest production areas. Pest and disease pressures vary from region to region due to soil, climate, presence of natural enemies, chemical resistance, pesticide application, availability of effective pest control measures and the knowledge to use them.

Over 15 walnut varieties are grown commercially; numerous other varieties are planted on a smaller scale. Varieties and rootstocks vary in susceptibility to diseases, nematodes, and insect pests. Codling moth is the key insect pest and requires one to three treatments annually on certain varieties. Feeding by codling moth larvae cause direct damage to developing nuts. Damage by codling moth also predisposes nuts to navel orangeworm and mold infestation. Chemical treatments for codling moth are generally disruptive to the biological control of aphids and mites. Additional treatments are often needed for these pests where broad-spectrum insecticides are applied. Organophosphate insecticides account for approximately 65 percent of insecticide use in walnuts, and much of this usage is for codling moth suppression.

Like codling moth, navel orangeworm and walnut husk fly attack nuts directly. Although cultural methods are available for suppressing navel orangeworm, broad-spectrum insecticides are frequently used, causing secondary pest outbreaks. Broad-spectrum insecticides are also applied for walnut husk fly, but they are not as disruptive because they are applied later in the season. Secondary or indirect pests of walnuts including scale insects, mites and aphids do not require regular treatment except in chemically disrupted orchards.

Walnut blight is the major disease affecting walnuts. The severity of blight depends primarily on over-wintering population of the walnut blight pathogen in dormant walnut buds and the presence of free moisture. This disease is most severe in years and regions with high spring rainfall.

At 50 percent recovery efficiency thought achievable in well managed orchards, application of around 100 pounds of nitrogen per acre is considered sufficient to meet the needs of growth and production. Most walnut orchards are fertilized at rates that exceed this guideline. Tools for assessing nitrogen fertilizer needs such as nitrogen budgeting and leaf tissue analysis, though widely promoted and fairly well understood by growers and fertilizer sales personnel, are rarely used. Reducing supplemental nitrogen applications to levels more consistent with actual demand would save growers money and reduce the potential for leaching and groundwater degradation.

Impending impacts of the 1996 Food Quality Protection Act, concerns over surface and groundwater contamination, and escalating costs and uncertainties of chemical control have heightened the urgency of efforts to find effective and cost-efficient ways of producing walnuts with minimal use of pesticides, herbicides, and mineral fertilizers.

BIOS for Walnuts in the San Joaquin Valley

Through its innovative Biologically Integrated Orchard Systems (BIOS) project in Yolo and Solano Counties, Community Alliance with Family Farmers (CAFF) demonstrated that it is possible to reduce pesticide and fertilizer usage and still produce walnuts of high quality with low damage levels. The BIOS approach combines holistic and biologically intensive farming practices with a hands-on, farmer-to-farmer educational model. It brings together growers, pest management professionals, researchers and extension personnel, government agencies and other agricultural community groups in an environment of collaborative problem-solving aimed at finding and implementing ecologically and economically sustainable farming methods. This project proposed to adapt and extend the BIOS model to fit the biological, economic, and infrastructure conditions of the walnut farming industry in the northern San Joaquin Valley.

In our first year we successfully deployed an infrastructure of project personnel and relationships capable of accomplishing project objectives. Ten growers established BIOS demonstration blocks in 1999. Two additional growers enrolled in 2000. An implementation team was organized in 1999, and has continued to provide technical guidance to project growers and pest control advisors this season. An intensive monitoring program guides orchard management decisions and provides information for assessing the effectiveness of BIOS practices.

Using a combination of innovative practices, project growers successfully controlled codling moth and other key pests in BIOS blocks while reducing pesticide use.

Use of pheromone mating disruption in BIOS demonstration blocks increased dramatically in 2000. We are gaining valuable information on effective deployment of this technology in walnuts.

We have developed effective and productive collaborative relationships with other research and implementation projects aimed at refining tools useful for farming walnuts in a biologically integrated context. These relationships benefit project growers directly and contribute to the overall effort to develop reduced risk methods for growing walnuts.

Three successful field workshops and a series of informal grower “breakfast” meetings highlighting alternative farming practices were held this season.

Changes in assignment of project personnel aimed at expanded outreach efforts are planned for 2001.

Use of BIOS Practices

Table 6. Use of alternative practices by project growers in BIOS blocks

Practice	**Grower**											
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
Cover crops												
Replace fertilizer N	X			X	X				X	X		
Beneficial insect habitat	X			X	X				X	X		
Water infiltration/soil tilth	X	X	X	X	X		X		X	X		
Codling moth												
Pheromone mating disruption	X	X	X	X	X	X	X	X	X		X	X
T. platneri releases												
M. ridibundus releases	X	X				X			X	X	X	
Non-disruptive insecticides	X							X		X		
Orchard vegetation management												
Narrow herbicide strips	X	X										
Emphasize post-emergence materials	X	X	X	X	X	X	X	X	X	X		
Mites												
Reduce disruptive CM sprays	X	X	X	X	X	X	X	X	X	X	X	X
Release predators							X					
“Soft” miticides							X					
Sampling-based treatments	X	X	X	X	X	X	X	X	X	X		
Fertility												
Compost or manure	X						X					
Leaf analysis	X	X	X	X	X	X	X	X	X	X	X	X
N budgeting	X	X		X	X				X			
Habitat enhancement												
Owl/bat nesting boxes	X	X			X	X			X	X		
Insectary plantings	X								X	X	X	

Yields and Quality

Information on farming practices and yields was obtained from year-end questionnaires completed for BIOS and conventional blocks by all growers. Nut quality was evaluated using harvest samples collected when trees were shaken for commercial harvest (Table 10). Sixty randomly selected nuts collected from each of ten trees in each block were inspected for quality defects and pest damage. Yield and quality data were also obtained after harvest from growers’ grade results for loads delivered to commercial handlers from BIOS and conventional blocks.

Yields were generally comparable in BIOS and conventionally managed comparison blocks. Kernel mold is a prevalent and increasing problem for the walnut industry, and the harvest crack-out and grading results from most of our orchards reflect this. BIOS and conventional blocks did not differ consistently in kernel mold, and we do not think management differences between BIOS and conventional blocks contributed to the observed differences.

Table 10. 2000 Harvest crack-out. Average nut quality and damage in BIOS and conventional blocks from 600 nuts per orchard. (For ease of presentation, this table is modified from the original.)

% of kernels								
	Sound	**CM**	**NOW**	**Mold**	**Shrivel**	**Oilless**	**Dark**	**Blight**
BIOS	76.2	1.5	0.8	4.1	4.8	4.1	8.4	1.1
Conventional	77.5	1.1	0.7	3.9	3.8	3.8	8.1	1.0

Pesticide Use

Growers' pesticide use records for BIOS and conventional blocks show that our successes in managing key walnut pests in BIOS blocks were achieved while using few conventional pesticides (Table 23).

Table 23. Percentage of enrolled walnut orchards applying pesticides for codling moth control. (For ease of presentation, this table is modified from the original.)

Orchard Type	N (# of orchards)	Mating Disruption	Organophosphate	Pyrethroid
BIOS	12	92%	17%	8%
Conventional	8	0%	88%	13%

Barriers to Adoption of Mating Disruption in Walnuts

The biggest current obstacle to promotion and broader use of the alternative codling moth strategies we are using is the experimental nature of the pheromone mating disruption products. The pheromone emulsion is not registered for use in California. Gowan Corporation acquired the product last winter and has accelerated its field development program. We are committed to continued testing if the product remains available and has potential for eventual registration. Isomate C+, though very effective at all project sites, has not been widely tested in walnuts, and the manufacturer has not aggressively pursued development opportunities in walnuts. Our project represents the largest scale testing to date in walnuts. We remain in close contact with representatives of Pacific Biocontrol and have encouraged them to expand their research and development efforts in walnuts and their collaboration with our project. As discussed earlier in this report, the California Walnut Marketing Board and Walnut Pest Management Alliance have expanded their research efforts aimed at evaluating mating disruption strategies in walnuts this season. We see the demonstration work we are doing as complementary to these efforts which, taken together, should help accelerate the development of this critical technology in walnuts.

Nitrogen Fertilizer Management

Leaf samples for nutritional analysis were collected in late July (Table 26). Results of these analyses were provided to growers and their PCAs, and case-by-case consultations were provided on individual results. In 1999, tree nutritional status was generally good in all blocks. In cases where leaf nitrogen levels were greater than that considered sufficient for walnuts, we have worked with growers to use a nitrogen budgeting approach and modify nitrogen fertilizer applications accordingly. Most growers reduced nitrogen fertilizer applications in both BIOS and conventional blocks in 2000, by an average reduction of 53 pounds per acre N between 1998 and 2000. In general, blocks that previously had July leaf sample nitrogen levels considered excessive (greater than 3 percent) dropped to levels considered adequate for walnuts (2.6 percent) in response to these reductions.

Table 26. Nitrogen fertilizer use and leaf nitrogen concentration for BIOS and conventional blocks

			Pounds N applied Per acre			Leaf % N		
Grower	**Block**	**Variety**	**98**	**99**	**00**	**98**	**99**	**00**
A	**BIOS**	Vina	110	80	50 (est[1])	ND[2]	3.3	2.6
	Conv.		110	95	50 (est[1])		2.8	2.4
B	**BIOS**	Chandler	225	240	195	3.4	3.0	3.1
	Conv.		225	240	195		3.7	2.7
C	**BIOS**	Vina	160	160	130	ND	2.5	2.9
	Conv.		160	160	130		2.7	2.8
D	**BIOS**	Serr	180	160	40	ND	3.0	2.6
	Conv.		180	160	40		2.8	2.7
E	**BIOS**	Hartley	80	87	75	NA[3]	2.6	2.3
	Conv.		106	106	75	NA	2.7	2.4
F	**BIOS**	Vina	42	0	67	3.3	2.9	2.8
G	**BIOS**	Vina	300	300	200	ND	3.1	3.1
	Conv.		300	300	200	ND	3.0	2.7
H	**BIOS**	Vina	75	75	75	ND	2.7	2.7
I	**BIOS**	Serr & Vina	80	55	20 (est[4]) 100 (est[5])	ND	3.0	2.6
J	**BIOS**	Hartley	0	0	0	2.7	3.0	2.4
K	**BIOS**	Serr	NA	NA	0	NA	3.4	2.6
	Conv.				0			2.6
L	**BIOS**	Hartley	NA	NA	100	NA	NA	2.6
	Conv.		NA	NA	100	NA	NA	2.5

1 Estimated N from chicken manure
2 Not done; single tabular entries indicate BIOS and conventional blocks sampled together
3 Not available at time of report
4 Estimated N from legume cover crop
5 Estimated N from compost

BIOS for Walnuts Outreach and Extension
Our primary emphasis during the 1999 season was on building project expertise and implementing the BIOS farming practices in project orchards. We continued to work diligently to foster a spirit of well-informed and proactive collaboration among project growers, PCAs, and implementation team members in 2000.

Three field workshops were conducted in 2000. Flyers publicizing these events were sent to around 2,600 individuals on combined CAFF and UC Cooperative Extension mailing lists targeting Central San Joaquin Valley walnut growers. Though they have attracted a few out-of town participants, most attendees at our workshops have been from our local area. We are pleased at the large turnouts and interest these events have generated; especially given the relative skepticism toward alternative approaches that prevails among local growers and allied industry professionals.

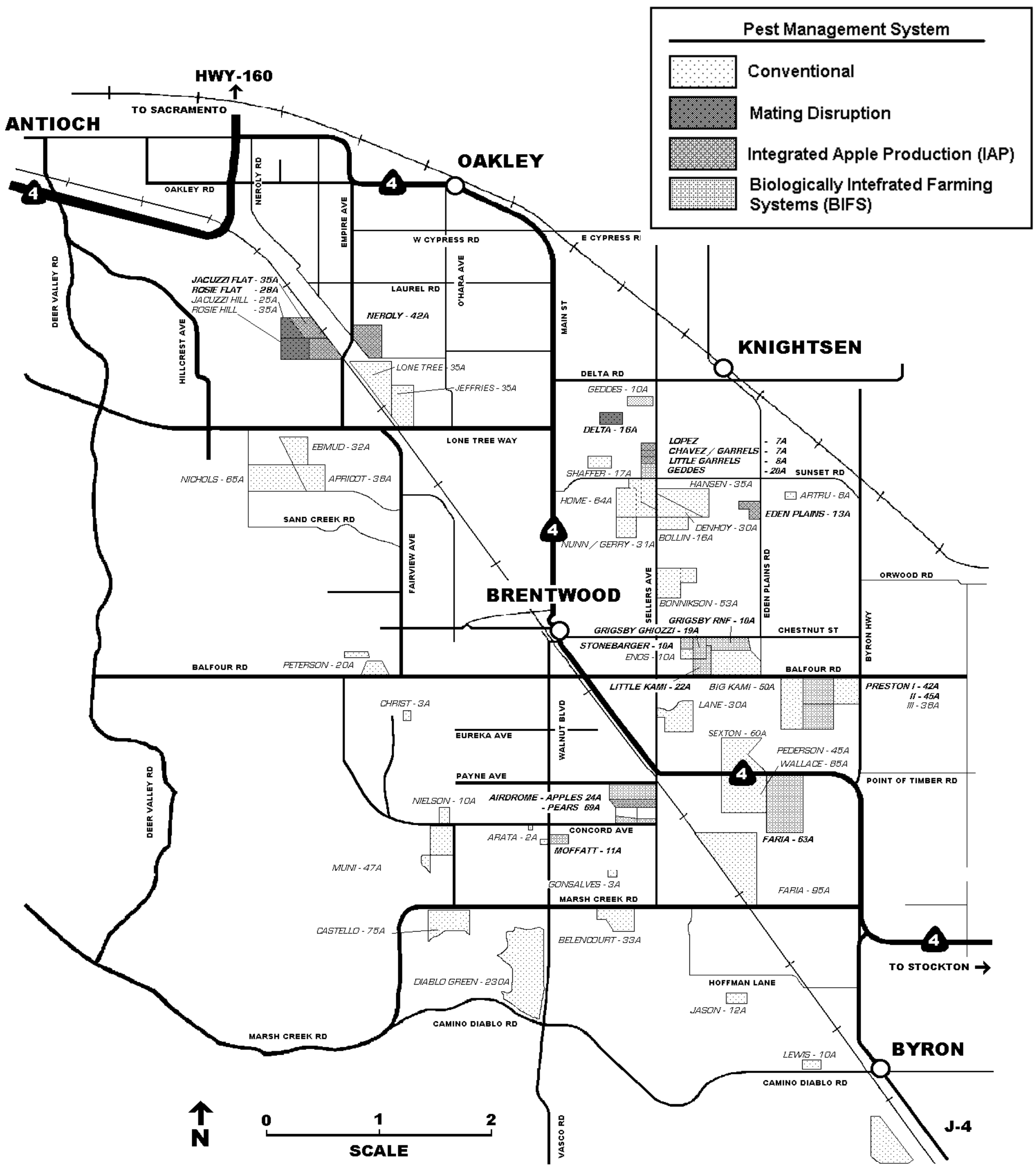
In response to an outreach team recommendation, we began holding periodic informal grower "breakfast" meetings this season. Project growers had expressed an interest in seeing other growers' BIOS blocks and having opportunities to interact. Beginning in February, we held four such meetings this season, approximately on a monthly basis. Attendance has varied from four to seven growers and PCAs, and meetings have lasted from one to two hours depending on content and time constraints.

Plans for 2001
We are planning project structural changes to make our collaboration with CAFF more effective. In 2001, we plan to redirect a portion of the project field scout's time to outreach and use part-time field help to get some of the monitoring done. CAFF began organizing a walnut BIOS project in Stanislaus County this past season, and we envision a number of excellent opportunities with that project as it gains momentum. Our 2001 budget proposal submitted earlier this year August 29 provided details and justification for a budget augmentation supporting this initiative.

MODIFIED EXERPTS FROM:

Apple BIFS Annual Progress Report - November 17, 2000

Principal Investigator: Janet Caprile
Farm Advisor
75 Santa Barbara Rd., 2nd floor
Pleasant Hill, CA 94523
Phone and FAX (925) 646-6708
jlcaprile@ucdavis.edu



Introduction

Agriculture-urban interface problems have led to an interest in adopting a reduced risk pest management program in Contra Costa County orchards. The use of pheromone mating disruption (MD) and other pheromone based “reduced risk” (RR) practices would allow apple growers to significantly reduce the use of controversial materials. However, the cost and risk of these practices have been prohibitive. The BIFS program (and the similar IAP program) was developed to offset these factors by providing a cost share for the pheromone products and monitoring assistance to help reduce the risk of failure.

Eleven orchards (311 acres) enrolled in the BIFS program this season joining the eight orchards (164 acres) continuing with their second year of the IAP program funded by the California Department of Pesticide Regulation. The two programs were run cooperatively sharing a Management Team, Project Coordinator, Field Scout and certain growers who enrolled acreage in both programs. Three conventional orchards (105 acres) and three orchards in the third year of mating disruption (72 acres) were used as comparisons to evaluate program performance. A total of 656 acres were monitored by the BIFS and IAP programs this season. A flexible set of Reduced Risk Guidelines was developed to assist participating growers with their IPM decisions during the course of the season.

Codling moth (CM) was the primary pest and CM damage in the BIFS orchards averaged 7.3 percent and ranged from 0 to 54 percent. The highest damage occurred in a block transitioning to organic production and was due to the lack of suitable organic supplemental controls and underestimation of MD product longevity. Without the organic block, CM damage in the BIFS orchards averaged 2.6 percent and ranged from 0 to 6.3 percent. The IAP orchards averaged 3.2 percent and ranged from 0-8 percent. The damage was higher than acceptable in eight of the 19 program orchards and, with the exception of the organic block, resulted primarily from unexpected, offsite migration into those orchards. There was minimal damage from other insect or mite pests, however, several orchards had disease problems. This was related to the lack of an effective predictive model and efforts to reduce inputs and the number of sprays.

Leaf tissue analysis showed that nine orchards had adequate nitrogen and two orchards were slightly high. These two orchards and two other pear blocks were the only orchards receiving N fertilizer this season. Three orchards were slightly deficient in zinc although most orchards received supplemental zinc foliar sprays in the spring. All orchards received 3-5 foliar calcium sprays and successfully prevented fruit quality problems. Only three of the 11 BIFS orchards applied any herbicides this season.

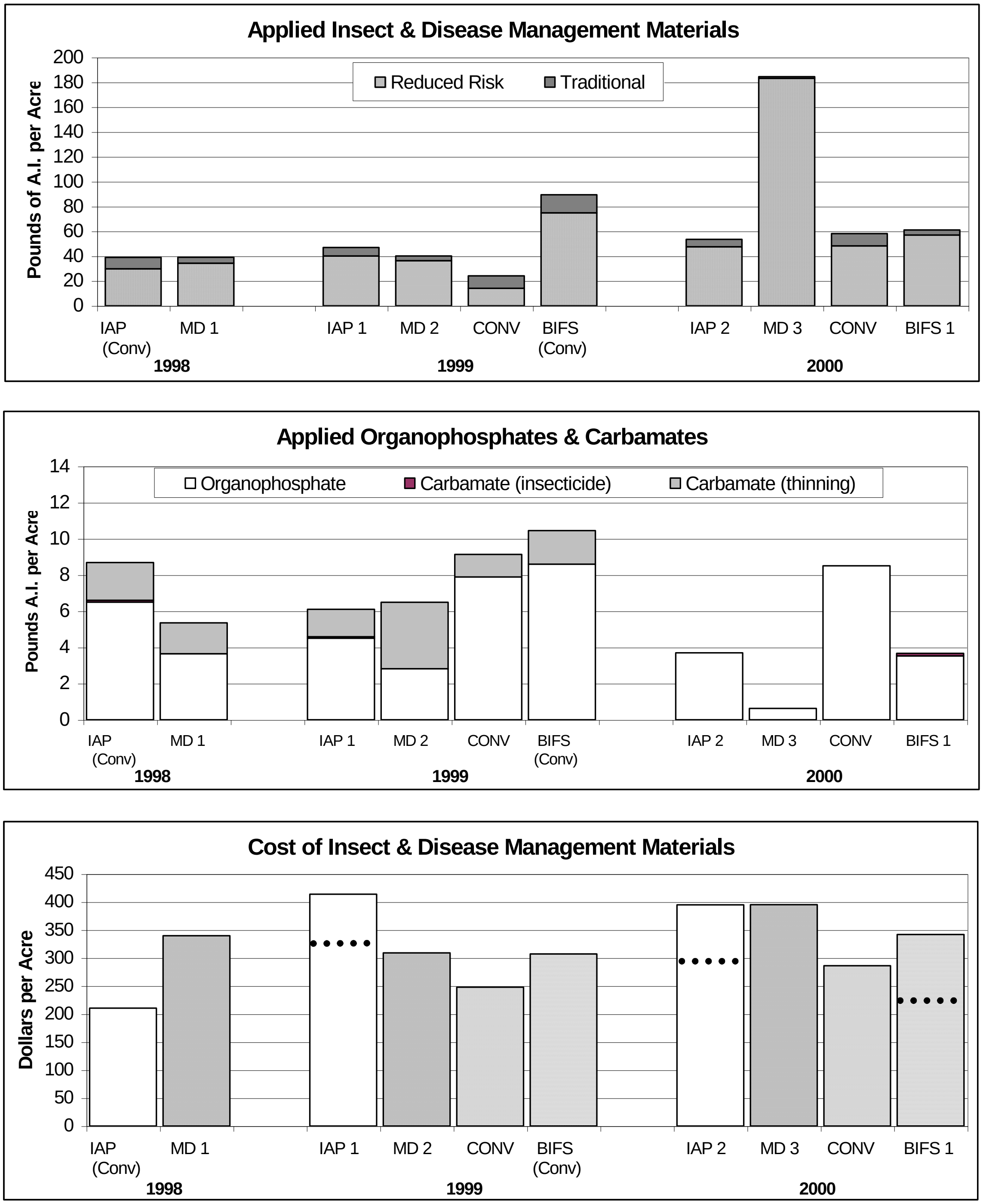
The BIFS orchards were able to reduce the use of organophosphates (OP) by 59 percent and carbamates (CB) by 92 percent in their first year. The IAP orchards reduced the use of OPs by 43 percent and the use of CBs by 100 percent. This is 14 percent lower than the previous year. The three Mating Disruption (MD) comparison orchards reduced OP use by 83 percent and CB use by 100 percent. The use of all traditional pesticides was reduced in the BIFS orchards by 72 percent, in the IAP orchards by 36 percent and in the MD orchards by 73 percent. The amount of reduced risk materials (pounds of active ingredient per acre) comprised 93 percent of all pest management materials in the BIFS orchards, 89 percent in the IAP orchards and 99 percent in the MD comparison orchards.

Pesticide Use Summary
The comparative quantity and cost of applied pest management materials among systems are shown in Figure 3.

The total amount of active ingredient (AI) applied has not typically gone down for most orchards transitioning from traditional to reduced risk (RR) pest management programs. It has increased by 37 percent in the IAP orchards, 472 percent in the MD orchards and decreased by 32 percent in the BIFS orchards since their last conventional year.

The increase in AI in the RR orchards is due entirely to an increase in RR materials. The large increase in the MD orchards this year is due to the repeated applications of Surround in the two orchards transitioning to organic. This is applied at high rates (50 lbs./A) and essentially all the ingredients are active. The moderate increase in the IAP orchards is due to the mating disruption coupled with supplemental sprays. The decrease in the BIFS orchards were due to a less intensive thinning and management program in these orchards in an effort to reduce input costs. For the RR orchards, 83-87 percent of the AI were from RR materials in their first year of transition. This increased to 89-93 percent in the second year of transition and to 99 percent for the MD orchards in their third year. It was surprising to note the high percentage of RR materials used in the conventional orchards: 58 to 83 percent of the active ingredients were from RR materials. This is primarily due to dormant oil applications which contain a high percentage of AI and are applied at a comparatively high volume.

Figure 3: Quantity and cost of applied pest management materials



1998: IAP orchards farmed conventionally, MD in first year of mating disruption
1999: IAP orchards in first year of mating disruption, MD orchards in second year of mating disruption, BIFS orchards farmed conventionally
2000: IAP orchards in second year of mating disruption, MD orchards in third year of mating disruption, BIFS orchards in first year of reduced risk

The RR orchards have steadily decreased the amount of AI of traditional materials used as they have progressed in their transition. The amount of AI of traditional materials has dropped in the IAP orchards by 36 percent, in the BIFS orchards by 72 percent and in the MD orchards by 73 percent.

Organophosphate (OP) use was reduced in the BIFS orchards by 59 percent and in the IAP orchards by 43 percent in comparison with their last conventional year. The MD orchards have reduced OP use by 83 percent in comparison with their first mating disruption year. The reduction in the second year IAP orchards was expected to be greater; however, due to the widespread migration of CM from outside orchards, more supplemental sprays were required than originally anticipated. In addition, in an effort to reduce OP use, some orchards with persistent populations opted to use border sprays or RR (less effective) supplemental sprays which did not adequately control the pest. Additional sprays were needed (or will be needed next season) to remedy this.

Carbamate use was reduced by 100 percent in the IAP and MD orchards and by 92 percent in the BIFS orchards. The majority of carbamate use in local apple orchards is not for insect control but for apple thinning. This drop in carbamate use is entirely due to the lack of any chemical thinning treatments applied in orchards this year. This was a cost cutting measure to deal with poor apple markets and may not be a lasting reduction.

Economics of Apple BIFS

The cost of the BIFS pest management program was $35/acre more than last year's conventional program and $56/acre more than this year's conventional comparison orchards. The cost share is estimated to bring costs down to $72/acre less than last year's program and $56/acre less than this year's conventional comparisons. The cost for the IAP orchards was $19/acre less than their first year of transition and $109 more than the conventional comparison orchards this year. The cost share is expected to bring actual grower costs down to $296/acre, which is only $10 more than the conventional cost. The cost for the MD comparison orchards in their third year was $86/acre more than their second year and $109 more than the conventional comparisons. The increase is due primarily to the transition to organic production for two of the three orchards. These orchards do not receive any cost share support.

Table 4C: Codling moth damage, trap counts and management summaries for the Mating Disruption Comparison orchards in their third season.

MD Comparison Orchards (Year 3)	Acres	CM Control 2000		Trap Counts 2000				CM Damage 2000			
		Pheromone Product	Supplemental Sprays	1st Gen	2nd Gen	3rd Gen	TOTAL	1st Gen	2nd Gen	3rd Gen	TOTAL
Jacuzzi Hill	25	4/1 Isomate 400/A 7/1 Isomate 400/A	6/21 2A:Surround/oil 6/28 2A:Surround/oil 7/12 2B:Surround/oil 7/19 2B:Surround/oil	23.1	17.6	15.6	56.2	0.7	6.2	7.3	13.5
Rosie Hill	35	4/1 Isomate 400/A 7/1 Isomate 400/A	6/21 2A:Surround/oil 6/28 2A:Surround/oil 7/12 2B:Surround/oil 7/19 2B:Surround/oil	22.5	48.3	35.6	106.4	0.9	4.6	5.7	10.3
Delta Rd	16	4/1 Isomate 400/A 7/9 Isomate 300/A	4/16 1A: Imidan -edge 6/22 2A: Confirm - full 6/22 2A: Guthion - edge	6.7	30.7	3.2	40.5	0.6	0.7	1.1	1.8
MD COMPARISON AVERAGE DAMAGE								**0.7**	**3.8**	**4.7**	**8.5**

Table 4D: Codling moth damage, trap counts and management summaries for the Conventional Comparison orchards for 2000.

Conventional Comparison Orchards	Acres	CM Control 2000		Trap Counts 2000				CM Damage 2000			
		Pheromone Product	Supplemental Sprays	1st Gen	2nd Gen	3rd Gen	TOTAL	1st Gen	2nd Gen	3rd Gen	TOTAL
Big Kami	50	NONE	4/16 1A: Guthion - full 6/10 2A Gen: Confirm - full 7/15 2B: Guthion - full 8/9 3A: Imidan - full	10.9	87.4	140.6	238.9	0.2	1.6	1.1	2.7
Grigsby 44	10	NONE	1st Gen: Guthion - full 1B Gen: Confirm - full 2nd Gen: Guthion - full 3rd Gen: Imidan - full	24.0	48.5	101.0	173.5	0.1	1.0	1.7	2.7
Pederson	45	NONE	4/19 1A: Imidan - full 6/1 1B: Guthion - full 7/8 2B: Confirm - full 8/18 3A: Guthion - full	14.3	39.7	42.0	96.0				0.6
CONVENTIONAL COMPARISON AVERAGE DAMAGE								**0.2**	**1.3**	**1.4**	**2.0**

MODIFIED EXERPTS FROM:

Rice BIFS Annual Report - November 17, 2000

Principal Investigator: R. Cass Mutters
Farm Advisor
University of California Cooperative Extension
2279B Del Oro Avenue
Oroville, CA 95965
Tel: (530) 538-7201
FAX: (530) 538-7140
rgmutters@ucdavis.edu

Introduction

The majority of rice grown in California is cultivated in the Sacramento Valley with over 550,000 acres (220,000 ha) of rice planted in 2000. The soils in this region are typically heavy clays with an underlying hardpan. This condition makes them good soils for growing rice but not suitable for other crops. Therefore, crop rotation is not an economically viable option for many rice growers.

Rice yields in California are the highest in the world. Recent yields averaged 8037 lb/acre compared to 5358 lb/acre in the southern U.S. and about 2500 lb/acre in southeast Asia. This is due, in part, to the use of semi-dwarf rice varieties with high harvest indexes, input of chemical fertilizers and pesticides, and precision land leveling. The conventional rice system is water seeded, applies nitrogen (N) fertilizers pre-plant and as a midseason top dressing at total rates of 100 to 160 lb/acre N, and uses chemical control for pests.

Aquatic weeds are the key pests in California rice fields. The two most widely used herbicides are bensulfuron (Londax®) for broadleaf control and molinate (Ordram®) for watergrass (*Echinochloa* sp.) control. An increase in herbicide resistant weed populations accounted for the recent downward trend in use of these two compounds. Conversely, increased use patterns for other herbicides (e.g., thiobencarb, Bolero®) occurred to compensate for the loss of efficacy in the aforementioned compounds.

Rice water weevil (*Lissorhoptrus oryzophilus*) is the principal insect pest in California rice fields, and was traditionally controlled with carbofuran (Furadan®). However, in 2001 carbofuran will no longer be registered for use in rice. Growers will rely on new products, which require careful monitoring of weevil populations for effective and judicial use. Insecticide for weevil control is applied once per season and routinely on only 35 percent of the total rice acreage. Compared to many other crops, rice production is a small user of insecticides.

Synthetic N fertilizers represent significant chemical inputs. The imminent ban on rice straw burning due to air quality concerns resulted in increased operational costs associated with the straw incorporation. However, recent University of California research demonstrated that straw incorporation can reduce N input requirement by 30 lb/acre while maintaining significant yields if the fields are flooded soon after the preplant application. Otherwise significant N loss occurs through volatilization.

BIFS in Rice Objectives
Sustainable production practices afford the opportunity for the timely reduction in two key chemical inputs in rice: herbicides and N fertilizers. The rising cost of herbicides and their reduced efficacy, loss of crop subsidies, and international competition necessitates the use of cost-effective sustainable production strategies.

Thus, the objectives of the BIFS Rice project are to:
- Demonstrate alternative rice production strategies that address soil health, cultural control of weeds, and reduction of chemical inputs;
- Monitor trends in pesticide use;
- Compare the production costs of conventional and alternative cultural practices;
- Distribute information using a farmer-to-farmer extension model, newsletters, and a BIFS in rice Web site.

The second year of this three-year project is nearing completion. During the 1999 growing season eight growers participated in the project, nine in 2000. Demonstrations are conducted on over 1330 acres (532 ha) enrolled in the project. Collectively, participating growers manage over 14000 acres (5670 ha) of rice. Alternative practices focused on non-chemical weed control strategies and reduced use of chemical N fertilizer via use of alternative N sources. All demonstration fields were located next to a conventionally managed field of similar size for comparison.

An increase in herbicide resistant weed populations resulted in a decline in the application of widely used herbicides during the period of 1995 to 1999 (Figure 4). The loss of efficacy contributed to the increase of alternative herbicides to control the resistant weed population.

Some alternative production practices performed comparably to conventional management strategies, while others did not. For example, reduced nitrogen and straw incorporation produced yields similar to the standard rate of nitrogen application. Organically managed rice fields, in contrast, consistently yield less than the conventional rice. However, the price premium commanded by organic rice economically compensated for the lower yields.

Environmental challenges
Rice culture in California faced many environmental challenges over the past several decades. Currently, rice straw burning is being phased down due to air quality and health concerns, but this has been an important issue for over 25 years (Williams, et. al., 1972). Movement of herbicides from rice fields into the Sacramento River in the 1980’s led to public pressure for growers to hold water in their fields to allow the break down of herbicides. Water holding duration is now strictly regulated. Another concern to rice growers is herbicide resistance of weeds, first observed in 1992. The number of resistant fields increased from 4 to almost 6000 between 1992 and 1995 (Hill et. al., 1997). The

result is that herbicide application per acre, which fell during the early 1990's, is again increasing due to lowered effectiveness of widely used herbicides. Injury to nearby crops from herbicide (e.g., phenoxy) drift, led to the regulation of such chemicals within certain distances of sensitive crops. These issues led to the reduction of herbicide availability and reluctance of herbicide producers to manufacture new chemicals for weed and pest control for use in rice. Additionally, Food Quality Protection Act (FQPA 1996) implementation will likely affect the availability of several herbicides currently in use. These include carbaryl, fenoxaprop-ethyl, molinate, and triclopyr.

Molinate (Ordram®) is the most widely used control for barnyardgrass and watergrass (*Echinochloa* spp.), the principal weeds in California rice, and accounts for 26 percent of all pesticides used (Anonymous, 1995). Two products are currently available for use in rice for the control of rice water weevil, diflubenzuron (Dimilin®) and lambda-cyhalothrin (Warrior®). The latter is extremely toxic to fish. Carbofuran is no longer registered for use in rice, effective in 2000, although growers were permitted to use any stored carbofuran that was purchased in previous years.

Economic Concerns

It costs on average approximately $800/acre ($324/ha) to produce rice in California (Hill et. al., 1997) with the cost of pesticide inputs accounting for about 8 percent of this amount. At this rate, yields must be at least 8500 lbs./acre (9520 kg/ha) in order for a grower to recover production costs. That is assuming $9.40 per 100 lb of paddy rice. Also, as a result of the Rice Straw Burning Reduction Act, growers are required to implement alternative straw management practices. This additional expense is not recuperated in the price of rice. Moreover, government programs traditionally subsidized rice production. The 1996 Freedom to Farm Act eliminates this source of income by 2003. Subsidies in 1996 were $2.79 per 100 lb (45.4 kg) of paddy rice or over $200 per acre ($81/ha) for a yield of 7500 lbs./acre (8400 kg/ha). This money is considered by many to represent the profit gained from farming rice. Market forces may, in time, offset this loss of income, but reduction in input costs could contribute to maintaining profitability in the short and long term.

Alternative Farming System Overview

The alternative farming systems, many based on UC research, were employed to address whole-system concerns, including long term soil health issues, cultural control of weeds, reduction of external inputs, and integration of regional rice cultivation into the larger landscape. UC research established that winter flooding, straw incorporation, cover cropping, summer water depth management, and drill-seeded rice can reduce the need for synthetic N and pesticide inputs.

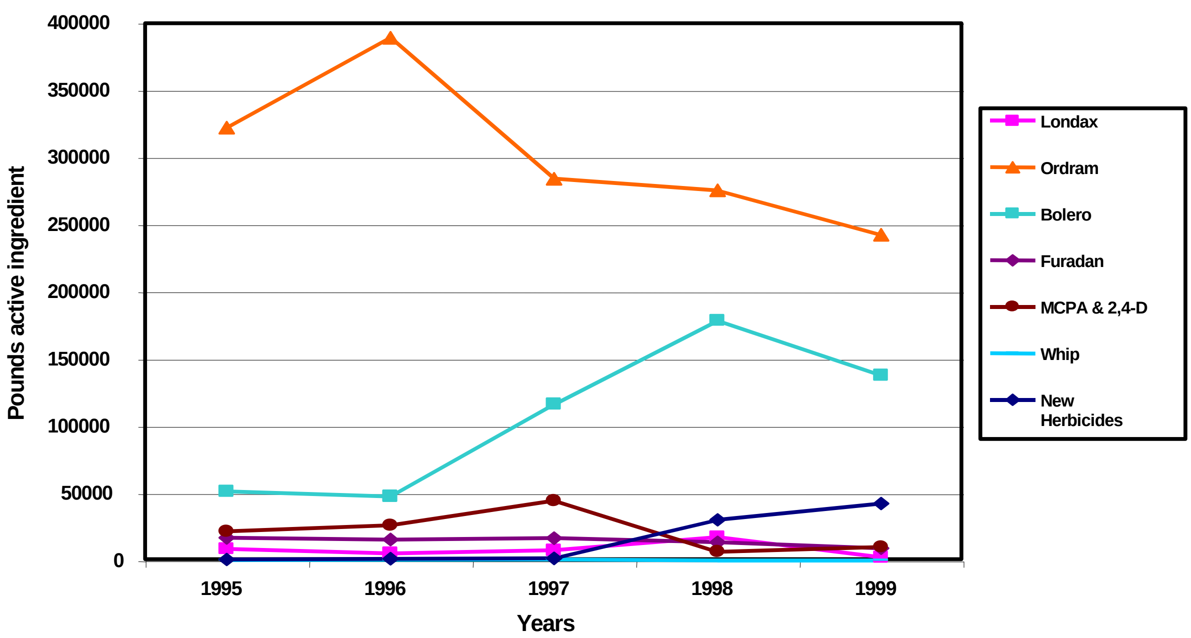
Long term research demonstrated that straw incorporation and winter flooding reduced populations of rice water weevil (Godfrey, et. al., 1998), and reduced stem rot inoculum numbers at a site on the west side of the Sacramento Valley (Webster, et. al., 1997). The same straw management techniques could also reduce chemical N inputs especially since over 60 percent of N uptake by the rice plant is from soil organic matter (Horwath and van Kessel, 1997). Also, winter cover cropping can reduce synthetic N inputs by supplying some or most of the N required by the summer crop (Pettygrove and Williams, 1997).

Increased water depth during the early part of the season can effectively control water grass (Williams, et al., 1994). Conversely, grower experience demonstrated that an extended dry down of rice fields effectively controlled broadleaf weeds. Both methods reduce the need for herbicides if employed in a timely and consistent manner.

Arrowhead is an early season short-lived annual weed in California rice fields. University of California small plot research has indicated that California arrowhead does not affect rice yield even at high density. If arrowhead is the only broadleaf weed of concern then there may be the opportunity to eliminate a broadleaf herbicide application. If successful this would reduce labor, machinery use and herbicide applied. This would translate to monetary savings to the grower.

These BIFS alternative management practices are being evaluated to determine if they reduce chemical inputs (i.e., production costs) while maintaining high yields, thereby contributing to long-term sustainability.

Figure 4. Pounds of active ingredients of selected pesticides applied to rice in Butte County from 1995 to 1999. (Use of trade names does not constitute a product endorsement).

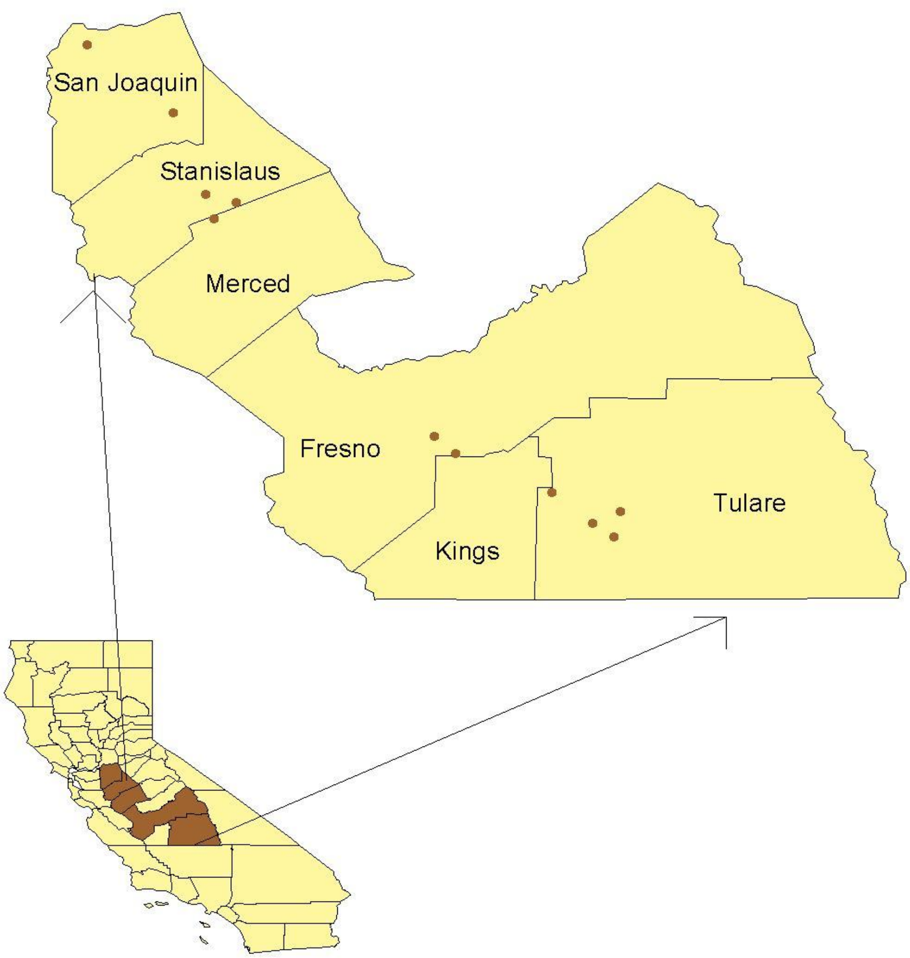


MODIFIED EXERPTS FROM:

Dairy BIFS Annual Report - August 11, 2000

Principal Investigator: G. Stuart Pettygrove,
Extension Specialist
Land Air and Water Resources, UC Davis
One Shields Avenue, Davis, CA, 95616
Tel. (530)752-2533, FAX (530)752-1552
gspettygrove@ucdavis.edu

Locations of BIFS Dairy Participants



Introduction

Potential groundwater contamination with salts and nitrate (NO_3^-), the cost of chemical fertilizer and its application, and environmental regulations all contribute to the growing concern of California dairy producers about dairy manure application to agricultural fields. Although producers have expressed the desire to improve manure management by reducing excess application of both manure and fertilizer nutrients, the tools needed for this improved management have not been widely adopted. The typical grower utilizing dairy manure does not know the plant nutrient value of the manure that is applied to the field. Often the result is excess nutrient application.

The BIFS dairy manure and forage production project seeks to address these concerns by working with 11 dairy producers throughout the San Joaquin Valley to develop and demonstrate improved manure management practices. The cooperators were chosen in part for their current use of some of the improved practices needed. Additional components of the improved system are needed. These components include soil sampling for nutrient availability, measurement of flow and nutrient content of the liquid manure applied to forage fields, and monitoring of nutrient uptake by the forage crops. The goal for the producers is to emerge with better tools to enable them to be better stewards of their land, reduce chemical fertilizer expenses, and better understand nutrient flows on their own farms.

Cooperating growers are participating in the project for a number of reasons. The potential to reduce fertilizer inputs and costs is a big drawing card. Fertilizer savings could contribute significantly to covering the infrastructure costs that have been incurred. Project growers are anxious to make the best use of this resource. The growers also desire to be better stewards of the land they are using for growing crops, and to reduce the potential for a negative impact on ground water quality.

Accomplishments

The project management has been working with each of the participating growers to develop a demonstration of a package of practices that will be used by them after the project is completed as well as to provide new knowledge on system performance to other dairies in the Central Valley. Most participants have selected and purchased flow meters to be used for lagoon water measurement. Field sites have been selected, and monitoring and sampling of soil, plants, and lagoon water application has begun on all of the dairies. At two of the sites, the focus is on integration of storage lagoon water applications and overseeding of alfalfa fields with berseem clover and annual ryegrass. On the other nine dairies, the focus crop is silage corn, with lagoon water supplying all or the majority of needed crop nutrients.

Data collected so far has shown that it is feasible to measure lagoon water nutrient flow during irrigation of the forage crop. In two spring 2000 irrigations, Dairy 9 applied 76 lbs. N/acre, 36 lbs. P_2O_5/acre and 143 lbs. K_2O/acre. Nitrogen application to silage corn at Dairy 5 ranged from 209 to 628 lbs. total N/acre, with high variability in the field. Lagoon water nutrients were successfully used to grow silage corn at Dairy 8 in 1999 with yields (29.7 tons/acre) similar to where commercial fertilizer supplied needed nutrients (27.6 tons/acre). Corn silage yields from the other project dairies will be available by the end of summer 2000. At Dairy 9, overseeding with berseem clover decreased weed pressure and increased total yield from five harvests by 0.6 tons/acre.

Work during the first year has included collection of information on the current manure management system, decision-making regarding methods of measuring flow rates for dairy lagoon water, and discussion with the cooperators on the improved techniques to be demonstrated during the project. During the winter, spring and summer of 2000, project personnel have conducted monitoring activities at all project dairies. The growers are very interested in seeing how they can increase the value of their manure water nutrients through monitoring, thus potentially reducing the amount of fertilizer needed. They are also concerned with environmental impacts and wish to reduce the potential for harm by their cropping and manure management practices to ground and surface water quality.

Two of the participants are focussing on application of lagoon water to alfalfa stands, a practice generally not practiced by most dairy forage growers. They are demonstrating the use of the lagoon water on older stands of alfalfa, which have been overseeded with berseem clover or annual ryegrass. The expected benefit of this overseeding is increased hay production, especially in the earlier spring when alfalfa doesn't produce a large amount of biomass. Increased biomass production in the spring may also mean that nutrient uptake is increased, and thus lagoon water could be applied and utilized well in this system. Replicated experiments have been established at these two sites comparing both overseeding versus no overseeding and manure water application versus no manure water application. Yield measurements have been made at both sites and nutrient uptake and forage quality comparisons will be made when forage laboratory analyses are complete.

The other BIFS participants have decided to work with a corn silage/winter forage rotation where lagoon water is either the primary or a very important nutrient source for the crop. Field locations have been identified at all dairies. Soil and lagoon water sampling is underway, and cultural practices and crop growth calendar notes are being kept. Initial soil sampling has been completed on all but one site, and records are being maintained as to seeding, harvest, irrigation, and other field operations. Treatment comparisons comparing conventional practice with increased monitoring and reduced chemical fertilizer inputs began at one location in 1999 and at the remaining eight locations during the 2000 corn silage crop.

Table 3. Flowmeters installed at Dairy BIFS sites. Flowmeters are critical for measuring the amount of nutrients applied to fields. Flowmeters typically can cost more than $3,000 each.

Dairy	***Type of Flow Meter***	***Date of meter installation***	***Comments***
D1	Danfoss	February 2000	
D2	none	n/a	Using portable flow meter at present
D3	none	n/a	Used siphon tube measuring
D4	Water Specialties	July 2000	Used portable Doppler meter prior to permanent installation
D5	Water Specialties	August 2000	Used portable Doppler meter prior to permanent installation
D6	Water Specialties	August 2000	
D7	Marsh McBirney	July 2000	
D8	Marsh McBirney	June 1999	Currently using a meter owned by UCCE
D9	Water Specialties	August 2000	Used portable Doppler meter prior to permanent installation
D10	Water Specialties	July 2000	Used pond drop for calculations prior to meter installation
D11	Propeller	June 1999	Removed propeller meter July 2000, ordering mag meter, using Marsh McBirney in interim

MODIFIED EXERPTS FROM:

Strawberry BIFS Annual Report - November 14, 2000

Principal Investigator: Carolee T. Bull
Research Plant Pathologist
USDA/ARS
1636 E. Alisal St., Salinas, CA 93905
Phone: (831) 755-2889
FAX: (831) 755-2814
CTBull@aol.com

Introduction

Except for a few organic farmers, strawberry growers rely on methyl bromide, chloropicrin and other synthetic pesticides for disease, weed and insect control. Until recently, growers were reluctant to experiment with biologically-based alternatives. With the signing of the Montreal Protocol, however, methyl bromide—a class I ozone depleter—is scheduled for a 100 percent use reduction by 2005. In addition, the use of methyl bromide and chloropicrin, as well as other chemicals important for insect and disease control, is under review by the US-EPA as part of the Food Quality Protection Act (FQPA) of 1996. The imminent loss of these chemicals threatens the maintenance of current yields and profits. As a result, the strawberry industry has been increasingly interested in shifting research toward developing alternative cropping systems.

The BIFS funding has provided a framework for designing, testing, and improving a biological system that would reduce reliance on pesticides. Growers, researchers, and industry representatives came together to begin to design biologically based production systems. The project has built upon the experience of both organic and conventional farmers and used results from research conducted in conventional systems. Through trials and demonstrations, project participants are determining the cropping system components that need to be tested and they are evaluating practices that have the potential of being integrated into successful biologically-based production systems.

Strawberry BIFS Activities

October 1, 2000 ended the second year of the BIFS project. The BIFS model requires a high level of participation and interaction between growers and researchers. In the first year of the project, we developed strong relationships between cooperating growers and scientists and in the second year we focused on improving information exchange among project researchers to improve project integration and coordination. Over the two years, we developed a series of alternative practices that can be adapted to the needs of conventional as well as organic growers. The alternative practices include: use of resistant cultivars, cover crops, early testing of a new site for *Verticillium dahliae*—a major pathogen, broccoli mulches for areas susceptible to disease, mycorrhizal or other beneficial microbial inoculants, trap crops, farmscaped borders, monitoring of insects and diseases, and flaming of weeds.

Project Results

The project has gone from seven participating growers with about 10 acres in the first year, to 14 growers with a total of 21 acres in the second year.

A significant accomplishment this year was the evaluation of commercially available strawberry cultivars for performance under organically managed conditions. Trials showed that Aromas, Pacific, and Seascape were the top performing cultivars in organic conditions. The identification of these cultivars will help growers select cultivars appropriate to non-fumigated and organic conditions. The trial results will also help breeders understand which genotypes are more desirable in alternative cropping systems.

The project evaluated management techniques for insect pests, and a series of alternative practices to control weeds and soilborne diseases (Table 1). Trials with annual trap crops were conducted to determine its efficacy in the control of the Lygus bug—the major insect pest of strawberry. The trap crop accumulated five to 10 times more Lygus bugs than the controls (strawberries at the edge of a different plot and adjacent strawberries within the same plot) and they attracted beneficials. The trap crops were found to be very useful in predicting outbreaks of Lygus bug activity in the adjacent strawberries, and thus improved decision-making regarding control measures. Perennial hedgerows have been planted but their influence on insect pests will only be measured once the rotation patterns bring strawberries back to the location that have been farmscaped.

The trials on weed and disease control are on-going and preliminary results show that the various practices provided consistent weed control while results were more varied for the control of pathogenic fungi. The effect of the various treatments on yield during the two years varies widely from farm to farm with both increases and decreases recorded. This variation may be due to the different fumigation history in each ranch and different initial levels of pathogens. Results in the third year may help to understand the factors determining success of the practices. Many growers were enthusiastic about arbuscular mycorrhizae (a beneficial fungus), but no benefits in yield were seen in six of seven trials conducted in the last two years. Brown tarps, ozone, and solarization are additional alternatives that may be added to the menu of alternatives useful in weed management.

Evolution of the strawberry BIFS approach

The participatory nature of the project means that grower's practical concerns are considered throughout the project. For example, the project initially focused on the use of native perennial hedgerows to attract beneficials for the control of insect pests such as the Lygus bug. We found, however, that most of our participating growers plant strawberries in rotation with other crops and perennial hedgerows do not reach peak attractiveness to beneficial insects until they are at least two years old. Thus, hedgerows planted adjacent to existing strawberries reached their peak effectiveness the following year, when adjacent strawberries were no longer present. Realizing that the successful introduction of perennial hedgerows requires the type of planning and investment in resources that is not yet acceptable to growers, we shifted our focus away from this practice. We will continue to measure the impact of native perennial hedgerows on pest and beneficial arthropod populations where these are already established, but we will not plant new hedgerows.

Table 1. Alternative practices for management of below-ground pests.

Treatment	Theoretical role of the treatment	Preplant applications	Postplant applications
Compost (15 tons/acre)	Nutrient bases for plants and microorganisms	Yes	No
Herman II	Compost digesting microbes	Yes	No
Spectrum	Bacterial biological control agents	Yes	Yes
MPXA	Humic and Fulvic acids to increase soil permeability	Yes	Yes
Pepzyme	Enzymes to help break down compost into a form usable by microbes	Yes	Yes
Corn Gluten Meal	Nitrogen source and weed control material	Yes	No
Eloroot	Nutrient source for microbes and plants	Yes	Yes
BioEndo Inoculant	Mycorrhizal treatment for strawberry roots	Yes	No
Themx 70	Improve soil infiltration	Yes	No

The project also had to modify the way it conducts experiments and demonstrations on alternative disease and weed control methods because of the lack of unfumigated land. This year, it is very likely that the amount of methyl bromide use will increase because of the restrictions due to take effect next year. Since this year is the last year to use methyl bromide, growers are reluctant to leave any portion of their fields unfumigated. To circumvent this problem, we will continue our work with growers by using buffer zones that are left unfumigated.

Future

In June 2000 we started planning for the third and final year of UC SAREP's support of the project. Over 15 new field evaluations are being established in October and November. For the 2000-2001 season, we may loose one or two growers because they will fumigate every portion of their fields before the 50 percent ban on methyl bromide is implemented. Trials and demonstrations on the various alternatives will continue and based on the results, the project will eventually develop an organic strawberry production manual.

California strawberry producers can attribute their current high yields and profits to the use of a highly perfected chemical intensive production system that relies on certified disease-free transplants, sophisticated soil preparation, intensive hand labor, a specialized fertilization regime, and intensive management of foliar diseases and insect pests. Preplant fumigation is the most important tool used and guarantees high strawberry yields in fruiting fields and disease-free transplants from nursery fields. In light of the fact that it has taken 50 years to develop this system, it is unrealistic to think that a similarly productive system based on biological methods of control will be developed in a short period of time. For example, all commercially available strawberry cultivars have been selected from fumigated fields and have produced plants that have little resistance to plant disease and are poorly adapted to non-chemical growing conditions. The BIFS project has already begun to identify cultivars that are better adapted to non-chemical conditions and it has initiated a process to use available scientific literature and grower experience to design a biologically based strawberry production system with optimum performance. By continuing this process, we will be able to propose a menu of biologically based alternatives for widespread implementation by strawberry growers.

MODIFIED EXERPTS FROM:

Citrus BIFS Annual Report - May 25, 2000

The author of this report is Mark Freeman, Farm Advisor in Fresno County, who resigned as the Principal Investigator as of August 31, 2000.

Current Principal Investigator: C. Thomas Chao
Assistant Extension Horticulturist
Department of Botany and Plant Sciences
University of California-Riverside
Riverside, CA 92521-0124
Tel. (909) 787-3441
FAX (909) 787-4437
ctchao@citrus.ucr.edu

This report summarizes the first year of the Citrus BIFS project, which started in 1999 with eight participating growers located in Fresno and Madera. Four of the growers had cover crops during the 1999-2000 winter. Surveys of insect populations and weeds were done in the following spring. A management team was formed which met monthly starting in December and helped to guide the project. Three successful grower meetings were held, with over 50 attendees for each meeting. A number of articles have been written in the local and statewide press, and also covered on local agricultural radio shows.

Growing citrus has not been profitable for most growers during the past two years. A severe freeze in December 1998 destroyed the citrus crop for most San Joaquin Valley growers. As a result, most citrus growers were in a survival mode in 1999, cutting back on any non-essential operations. There was a much larger crop in 1999-2000, but unfortunately much of the crop was sold at lower than the cost of production. Many of the growers have thus suffered through two bad years and are searching for methods to lower input costs while maintaining marketable quality. We are currently assisting with that effort through irrigation system evaluations, grove maps of trees, and customized packout sheets.

Baseline data was collected to assist in project evaluation. The chemical usage on citrus was collected for the 1999 year through the Geographical Information System (GIS) used by Fresno County. This data included total chemical usage along with the chemicals used only in the cooperator's fields. A conventional citrus cost study was completed in December 1999, and a BIFS citrus cost study is currently being developed. We have compiled economic packout data for five of the fields, showing the grower returns by different grades, sizes, etc.

A citrus BIFS project faces many challenges. Citrus growers have farmed citrus "traditionally" for many years. Bare soil without weeds is "perceived" to be good management. It is also a very low cost approach. A BIFS approach to insect management (using softer and shorter residuals) involves more and careful monitoring, and many citrus PCAs cover large acreage (hundreds of acres). There is much emphasis by the packinghouses on producing fruit with few to no blemishes on the peel in order to receive the higher grades (and revenue). During this year, we started the long process of creating the awareness that alternative practices exist to the traditional ways of farming citrus.

On farm demonstration of an alternative farming system

There are eight growers participating in the project with two demonstration fields each. Our two systems of management, conventional and BIFS, are listed in Table one.

Table 1. Two Citrus Farming Systems

Parameter	Conventional System	BIFS System
California Red Scale	OPs, Carbamates Applied	*Aphytis* releases, insect growth regulators, oil
Citricola Scale	OPs, Carbamates Applied	Intensive monitoring, OPs only if needed
Thrips	Baythroid, Carzol, Dimethoate	Success, Veretran, Agrimek
Weeds	Preemergents in fall or spring, Roundup for any “escape” weeds	Cover crops, use of short residuals, Roundup, weed species identification
Nematodes	OPs, Carbamates	Use of chemicals only when thresholds exceeded
Phytophthora	Ridomil, Alliete	Water management, use of chemicals only when thresholds exceeded
Nitrogen fertilizer	One or two soil applications	Multiple soil applications, annual leaf analysis, use of foliar sprays
Snails, ants, katydid, grasshopper, cottony cushion scale, other worms and mites	Will be monitored for presence/absence	Will be monitored for presence/absence

NEXT STEPS IN THE BIFS PROGRAM

The year 2001 is the final year for five projects (prunes, walnuts, rice, citrus, and strawberries) and 2002 is the final year for the two remaining projects (apples and dairies).

Main BIFS Program Goals and Activities for the Next Two Years

- Analyze pesticide use trends of the seven current BIFS projects and compare to county and statewide commodity-based use patterns.

- Evaluate the synthetic fertilizer use and impacts of BIFS alternative fertilization practices.

- Use the BIFS Workgroup to increase University of California engagement in the BIFS program.

- Increase statewide outreach for BIFS projects, starting with the conference "Partnerships for Sustaining California Agriculture: Profit, Environment and Community," March 27-28, 2001. Please see http://www.sarep.ucdavis.edu/agpartners/

- Conduct local and statewide surveys of BIFS commodities to evaluate the impact of the BIFS program.

- Continue to provide and coordinate technical support to BIFS projects in the areas of outreach and participatory extension, economic analysis, statistical analysis, and biological farming.

- US-EPA intends to continue support of the BIFS program, but this money will not be enough to fund completely new BIFS projects. We need to secure additional state funding for new and/or expanded BIFS projects. No new funding for additional or expanded BIFS projects has been identified at this time.

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ATTACHMENTS

1. Assembly Bill 3383 (AB 3383)

2. Assembly Bill 1998 (AB 1998) – extension of AB 3383

3. Newsletter of the BIFS Forage Production and Dairy Manure Management Project. Vol. 1, No 3. April 2000,University of California Cooperative Extension.

4. Printout of the Prune BIFS Website- IPFP Integrated Prune Farming Practices, www.agresearch.nu/ipfp.htm

5. Fresno Bee newspaper article on the Citrus BIFS project from March 29, 2000. "Running for Cover: cover crops provide a good environment for bugs that fight orchard pests." By Dennis Pollock

6. Swezey and Broome. 2000. "Growth predicted in biologically integrated and organic farming systems" in California Agriculture (July-Aug 2000 pp. 26-35), also available for download at http://danr.ucop.edu/calag/JA00/toc.html