Center for Agricultural Partnerships
California Walnut IPM Expansion Project

Executive Summary

The Center for Agricultural Partnerships (CAP) in cooperation with growers and their organizations, crop consultants, input suppliers, researchers and farm advisors has developed a project to commercially implement sprayable pheromone mediated-mating disruption of codling moth (CMMD) and new monitoring technologies on 900 acres of commercial walnuts in the second project year.

Once the decision was systematically made to initiate a project (year 1, 2001), project objectives were developed, the project architecture was designed and cooperators were identified. In year 2 (2002), a state-wide technical team of 3 regional coordinators and 4 pest management consultants was established. Subsequently, 8 grower cooperators were identified. The project then conducted extensive baseline assessments of this core cooperator team. Prior to the growing season, the technical team constructed their project work plans. At that point, field implementation of the target technologies on 900 acres throughout the San Joaquin/Sacramento valleys was initiated.

CAP, expanding upon research conducted by the Walnut Pest Management Alliance, networked project cooperators with pheromone industry representatives. This collaboration demonstrated that newly registered sprayable CMMD products could be used on a commercial scale without increasing risk of financial loss to growers. The project's cooperating pest management consultants also examined the season long use of kairomone baited (DA) traps and determined that they have potential to efficiently monitor codling moth (CM) in a pheromone disrupted walnut orchard. Project cooperators collected season-long experience with the commercial utility of these target technologies, experience that provided incentive to further examine and adapt uses in subsequent seasons. Finally, the project provided a practical, working model for future commercial scale implementation efforts.

Cooperators have concluded that, given current input costs, they must modify their use of sprayable pheromones to improve cost-effectiveness. This may include using significantly reduced rates over more applications or fewer but more targeted applications. Cooperators were encouraged by the ability of DA traps to outperform standard pheromone baited traps and plan to expand their commercial use of the DA technology. A carefully conducted approach to commercial implementation of CMMD was determined by cooperators to be feasible and additional research needs were identified.

Center for Agricultural Partnerships
California Walnut IPM Expansion Project
(WIPMEP)

Final Report

"Knowledge is of little use, when confined to mere speculation: But when speculative truths are reduced to practice, when theories, grounded upon experiments, are applied to the common purposes of life; and when, by these…the arts of living made more easy and comfortable, and, of course, the increase and happiness of mankind promoted; knowledge then becomes really useful." Charter Statement of the American Philosophical Society for Promoting Useful Knowledge, founded by Thomas Jefferson

Introduction

The Center for Agricultural Partnerships (CAP) "Process"

Implementation of new technologies and practices in agriculture, especially technologies that are farm-site specific, information intensive and unconventional relative to those being replaced, can be slow to implement commercially on any large scale. For growers to learn of new innovative technologies and practices they initially benefit from access to collective experience, i.e., credible research, extension and regional field demonstration of the innovation. This collective experience is currently provided by traditional research and education sources such as the land grant system and cooperative extension. For growers to ultimately adopt new technologies and practices they need to translate the collective experience to individual experience. In so doing they individually observe the *relative advantage* of the innovation to them, its *trialability* in their field, its *compatibility* with their other cultural practices and its *complexity* relative to their older practices (Rogers). In many cases, this individual experience takes place in a commercial context which is dominated by many forces and interests beyond the target innovations. These forces strongly influence grower decisions re. use of those innovations.

> This approach to grower implementation of new technologies is the core of the CAP "process". This process was incorporated into the initial planning for WIPMEP and throughout the tenure of the project (Appendix 1).

The CAP Mission

CAP seeks to bridge the gap between research, education, demonstration and individual grower's adoption of new practices. Furthermore, the CAP process supports building capacity within the agricultural community to effectively and economically adapt to rapidly changing regulatory and agronomic conditions. In short, CAP provides programs to assist farmers and their organizations in utilizing *collective experience* (i.e. general information) by efficiently incorporating that information into *individual experience* (i.e. site specific knowledge and decision making).

The Walnut IPM Implementation Project

Background

California produces 99% of U.S. walnuts and 38% of the world production. There are 207,520 acres of walnuts in the state. Over 90% of this acreage occurs in the Sacramento and San Joaquin valleys. In 2001, California growers produced over 300,000 tons of walnuts valued at over $346 million. (CASS 2000, Wulfert 2002).

Codling moth *(Cydia pomonella*) is the key pest of walnuts in California and the most economically important arthropod pest statewide. Two or more generations usually occur in California each summer. These later generations can be particularly damaging to harvested nuts. Summer larvae bore into the growing nut, damaging husk, shell, seed coat and kernel, and rendering the nut worthless for commercial use. In addition, infested nuts provide entry points for navel orange worm, *Amyelois transitella*, increasing the population of this pest in orchards while coincidentally increasing pesticide applications and costs (IPM for Walnuts 1987, Walnut Marketing Board 2000a).

Approximately 60% of walnut acreage is susceptible to codling moth (CM) damage. Damage is generally most severe on early season cultivars, although it has been increasing steadily over the years on some late cultivars such as Chandler. Left uncontrolled, codling moth infestation can result in serious economic damage that exceeds 40% of the harvested crop. In addition to direct yield and quality losses, higher costs for sorting in the warehouse may result in additional economic penalties for growers. Codling moth feed on the walnut kernel thereby reducing edible yield. Since edible yield is a basis of payment on shelling varieties, any level of damage reduces the grower's payment for the crop. Low levels of damage reduce or eliminate any quality bonus payments to the grower. Additional financial penalties are imposed when insect damage exceeds 5%. Any lot of walnuts with insect damage greater than 8% is disqualified from in shell shipment and the associated premiums (S. Wulfert 2002, Integrated Pest Management for Walnuts 1987.) As a result, walnut growers are experiencing $16 – 40 million in losses from CM annually, with losses in recent years at the upper bounds (Sibbett 2001, Stewart 2001).

Codling moth management relies on one to three chemical treatments per year. The primary conventional pesticides organophosphate (OP) insecticides of which chlorpyriphos is the most widely used being applied to more than 40% of the walnut acreage annually. To protect their crops from loss, walnut growers annually apply 1.5 to 2.2 lbs. AI/ac. of OPs to control CM in infested orchards. According to California's Department of Pesticide Regulation Pesticide Use Report Data Summary (2000) more than 145,000 pounds of chlorpyriphos were used on walnut production in 1999. Grower costs for these sprays may exceed $100/acre per season. Use of these pesticides often requires additional pesticide inputs to control secondary pests, which erupt when their natural enemies are suppressed by the CM sprays.

While OPs have provided a valuable mainstay of pest management in walnuts, problems associated with their use have also multiplied. CM resistance to OPs has been widely documented (Varella, 1993, Knight, 1994.) Furthermore, OPs disrupt natural enemies of secondary walnut pests, such as walnut aphid, dusky-veined aphid, web-spinning mites which often results in additional

pesticide applications (Ramos, 1985.) In short, the continued availability of the most widely used chemicals for control of the key pest of walnuts is in significant jeopardy due to biological and regulatory reasons.

In 2001, CAP initiated a study to determine the feasibility of conducting a large scale implementation project in California walnuts (Appendix 2). Through a systematic decision tree process (Appendix 3) it was determined that the potential existed within the California walnut industry to have large scale environmental and economic impact by commercially expanding upon successful ongoing efforts of the walnut industry to research, educate and demonstrate new biologically based systems of crop protection (The Walnut Pest Management Alliance Program). As a result, CAP initiated funding of the Walnut IPM Expansion Project (WIPMEP) in 2001. In 2002, the field project component was initiated statewide.

Project Objectives

The project had the following objectives:

Objective 1 - Implement a systematic process to further adoption of a sprayable mating disruption system on a wide scale in commercial walnut production.

Objective 2 - Document and communicate economic, biological and decision-making changes in the adoption of sprayable mating disruption at the farm and project levels on a wide scale in commercial walnut production.

2002 Project Design and Planning

Planning meeting, March 2002

In 2002, CAP initiated the first field year of the project. In February, a focus group with the core cooperators (Appendix 4) was conducted by a facilitator to develop the work plan for the 2002 field season. Participants were prompted to provide their views of what work needed to be conducted to successfully accomplish project objectives during the coming growing season. Data generated from this meeting were summarized and discussed to determine how the core team wanted to accomplish the project objectives. These results were then transcribed into a work plan format. The work plan was used throughout the season as the road map for project activities (Appendix 5).

As a result of this process, core project participants designed and took immediate ownership of their work plans for the project year. They conducted the work in a manner consistent with their existing commercial practices. They emphasized that, during this first field year, they needed to experience the operation of the project and test their individual experiences as they attempted to accomplish the project objectives. In evaluating this planning session, participants commented that the constructive amount of work and direction developed in this meeting far exceeded their previous experience in similar project development efforts.

Establishing Grower Cooperators and Orchard Sites

Cooperating consultants, in collaboration with their respective regional coordinators, secured client growers as commercial cooperators. As a result, the project consisted of two growers, two orchards totaling 520 acres in the northern region (Sacramento valley and northern San Joaquin valley), three growers, three orchards totaling 194 acres in the central region (northern San Joaquin valley) and three orchards totaling 175 acres in the southern region (southern San Joaquin valley). (Appendix 6)

Establishing Decision Making Baselines

CAP developed three instruments to survey cooperators; a grower survey, a grower interview and a consultant/PCA survey (Appendix 7). Each cooperating grower was interviewed and seven out of eight cooperating growers were surveyed. Each survey took about an hour of project management's time plus travel. Project management determined that growers should be interviewed at a second meeting subsequent to the introductory meeting. It was difficult, given busy schedules and geographical separation, to schedule one-on-one time with cooperators.

Data Management

Each cooperating consultant utilized his or her own documentation system with each cooperating grower-client. Project management with assistance from DJS Consulting, aggregated and summarized field results obtained from cooperating consultants. At least monthly, these results were presented to cooperating consultants and growers. Though an on-line data reporting system was originally planned, it was technically not manageable in 2002.

Project Management

(See Appendix 8 for a list of management task accomplishments in 2002.)

Project Results

Results of Baseline Surveys/Interviews

While 900 acres were specifically designated as CAP project acres, cooperating growers and consultants were collectively involved in the production of over 25,000 acres of walnuts. The major concerns and barriers to implementation of sprayable pheromones expressed by consultants and growers focused on the cost of sprayable pheromones relative to conventional controls, coupled with uncertainties about efficacy. The lack of efficient monitoring tools was a concern to the consultants. Growers often stated that they rely on their consultants for their IPM advice and that they heavily base their pest management decisions on that advice. Most of the cooperating growers are primarily interested in the viewpoints of their consultants. Thus, since the project design focused this year on consultants, the surveys and interviews confirmed that the focus was at least initially correct. (See Appendix 9 for a summary of the surveys and interviews.)

Sprayable Pheromone and other CM Treatments

Approximately 832 of the 900 project acres were treated with label rates of sprayable pheromones (the remaining acreage was used as comparison blocks). Approximately 663 project acres were treated with 3M MEC-CM® and 226 acres with Suterra's Checkmate® CM-F (Appendix 10). In Tulare County only, sixty project acres were designated "conventional" and not treated with pheromones. These blocks were used as a comparison with nearby pheromone treated blocks. Pheromone treatments were initiated soon after materials were available and, in all but the Southern Region, prior to peak flight of overwintering moths. Due to the early flights in the Southern Region, Lorsban was applied in the spring prior to application of pheromones.

In the South Region, supplemental chemical sprays were applied to two blocks. Confirm (tebufenozide) was applied to 20 acres (Vina variety) where May-June dropped nut counts averaged more than 12 nuts per tree. Lorsban (chlorpyriphos) was applied to a second orchard where the grower feared another potential worm pest (redhumped caterpillar, *Schizura cocinna*).

There were no attempts to determine differences between the two sprayable pheromone products and none can be inferred from the results of this year's field experience.

Cooperating growers and consultants agreed that the incorporation of sprayable pheromones into their pest management program in 2002 was technically feasible though prohibitively expensive in terms of out of pocket costs relative to their conventional pesticide program. Based on their use of sprayables in 2002, all consultants and all but one grower stated willingness to examine sprayables in 2003. These cooperators stated that the expansion in use of sprayables would be a function of the amount of sprayable product donation available in 2003 and the willingness of their clients to incur added costs of purchasing sprayables.

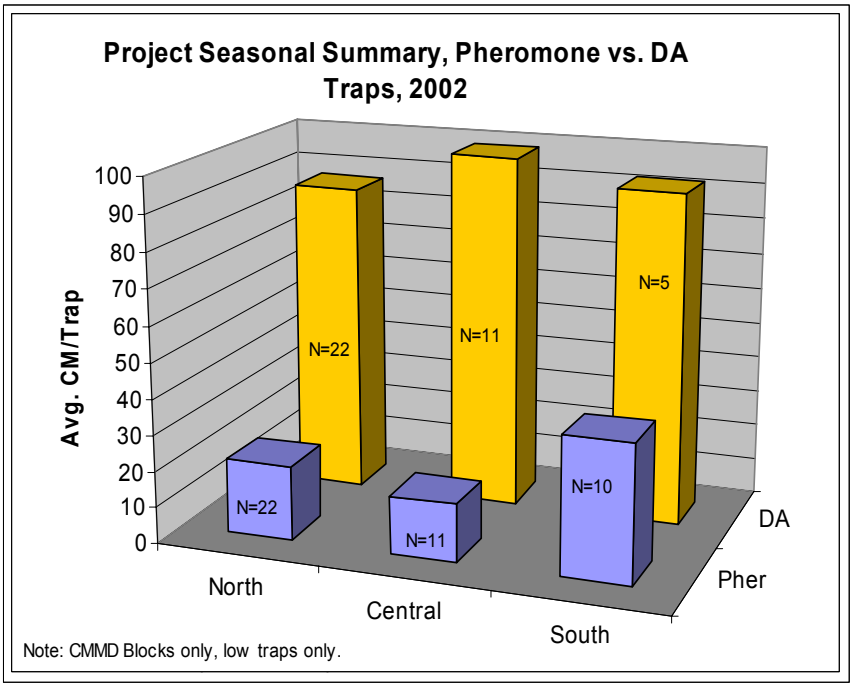
Codling moth trapping results

Field results represent the springtime period through the end of the codling moth flight in September.

Project orchards were all trapped with both 1X pheromone baited and kairomone baited traps donated by Trece, Inc. Most blocks received pheromone applications aimed to disrupt mating of the overwintering adults that emerged this spring and/or their offspring.

By the end of September, project cooperators had completed trapping of the codling moth populations, dropped nut evaluations and canopy nut count evaluations for codling moth damage. Certis sponsored harvest "wind row" nut samples of those project orchards that utilized 3M's CM-MEC sprayable pheromone.

Each cooperating orchard (with the exception of the "comparison blocks in the south region) received one or more sprayable pheromone applications and was trapped with both pheromone baited and kairomone (a.k.a. DA lure) baited traps. The purpose of this lure comparison was to evaluate the potential of the DA lure as a potential tool for monitoring codling moth adults in pheromone disrupted environments where pheromone traps are "masked" by the mating disruption treatment. Results of the trap counts are summarized in Fig. 1. (See Appendix 11 and Appendix 12 for individual orchard trap-lure comparisons.)



Pheromone vs. DA		
Seasonal Flight	Pher	Avg/trap DA
North	20.77	87
Central	16.09	98.81
South	38.3	92.4

Figure 1. CAP walnut project statewide seasonal summary of codling moth trap count averages in DA baited traps compared to pheromone-baited traps.

In most project orchards, once sprayable pheromones were applied, pheromone baited trap counts declined relative to DA traps. Through the end of the overwintering flight, DA trap captures, on average, exceeded pheromone traps by a ration of at least 4:1, 6:1 and 2.4:1 in the North, Central and South regions, respectively. Cooperating consultants expressed strong interest in the ability of DA traps to capture moths when pheromone traps were effectively shut down. See Appendix 12 for a graphic depiction of flight activity. As a result of this interest, cooperators plan to expand the use of DA traps in 2003.

Dropped nut damage evaluations

Dropped nut counts were taken in six participating orchards as the overwintering flight neared its end in late May and early June. Results generally demonstrated acceptable suppression of the overwintering CM flight. Average dropped nut counts ranged from 0 to 5 nuts per tree. The higher averages generally occurred in later samples. (See Appendix 13 for a table of average per tree dropped nut counts.)

Consultants were uncertain as to the ultimate benefit of dropped nut assessments. Because dropped nuts represent damage *after the fact*, they are valuable as an indication of past control failure and as an indication of the potential for increased damage risk in subsequent CM generations.

Canopy count damage evaluations

Systematic canopy count evaluations were conducted in the South and Central Regions. Results showed no substantial differences in CM damage levels between pheromone blocks and comparison blocks. CM infestations remaining on the trees at the end of the overwintering flight were generally less than 1%, well within acceptable damage levels. One Central Region orchard exhibited 4% infested nuts in a small area within a 25-acre block. Consequently, the crop consultant treated this area with chlorpyriphos in early July. Consultants agreed that, even though no direct correlation with harvest damage exists, canopy counts are, nonetheless, important in the assessment of harvest damage potential. (See Appendix 14 for a table of canopy count results.)

Harvest damage evaluations

Commercial harvest grading methodologies typically do not discriminate species-specific insect damage. In order to better determine the effectiveness of the 3M sprayable pheromone, Certis, in cooperation with project participants, conducted a series of windrow samples at commercial harvest to determine the species of Lepidoptera insects infesting harvested nuts.

In each of the 5 orchards where 3M pheromone was used, a series of four samples were collected, one sample each in the north, south, east, and west directions from the second tree away from DA baited codling moth traps. For each sample, two opposite swaths at 45º angles to the tree row were raked and a minimum of 100 nuts per sample were collected, hulled and immediately delivered to the Dried Fruit Association in Fresno, CA. From these collections, 100 nuts per sample evaluated for the number of "blows" (i.e. dried and/or shriveled nut meats), codling moth damaged nuts, codling moth larvae present, Navel Orange Worm (NOW) *Amylois transitella* damaged nuts and NOW larvae present. A total of 130 samples were taken from the 5 cooperating orchards.

The results of this survey demonstrated low infestation levels of CM and NOW in all harvest samples. Most insect damage resulted from NOW. There was no apparent correlation of harvest damage to earlier canopy or dropped nut damage assessments. (See Appendix 15 for individual orchard charts of harvest damage results.)

Economics

- Input Costs

3M-Canada and Suterra have made significant contributions of their sprayable pheromone products to grower cooperators in 2002. Trece, Inc. has contributed all the DA trapping supplies. These contributions reduced the participation costs to growers and were favorable incentives for cooperators to be involved in the CAP project.

At the March planning meeting, the core participants determined that, during this initial project field year, they were primarily interested in tracking costs of materials and applications. Consequently, these costs to the grower have been calculated from their pesticide use in cooperating orchards. Input costs are calculated from the commercial price for products and applications reported by PCA cooperators. To compensate for the value of contributed pheromone product, the list cost (including estimated cost of sprayable pheromone) and the actual costs (excluding the value of contributed pheromone) are compared.

Where data allowed comparisons of the CMMD blocks with non-pheromone treated blocks (South Region only), list vs. actual costs of the pheromone program were substantially higher than the comparison blocks (Figures 3 & 4). On average, these cooperating growers actually spent $116 per acre more than their comparison blocks. Were it not for donated product, they would have spent $193 per acre more.

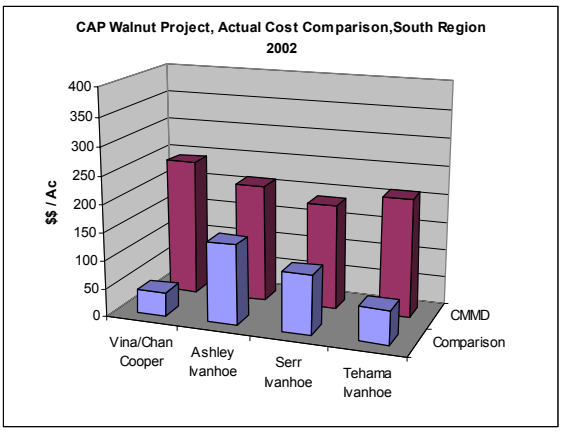


Figure 3. Comparison of *list* costs in the pheromone treated blocks vs. the comparison blocks in Tulare Co.

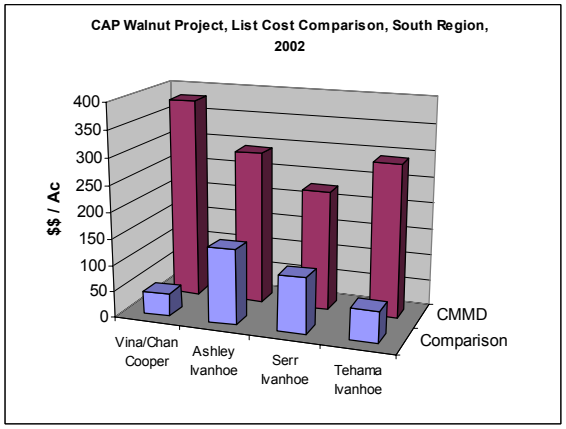


Figure 4. Comparison of *actual* costs in the pheromone treated blocks vs. the comparison blocks in Tulare Co.

Overall, CMMD potential (i.e. list) costs to growers averaged $ 283, $170 and $118 per acre in the south, central and north regions respectively. Because of product contributions, cooperators actually spent $207, $61 and $52 per acre, respectively (Fig.5).

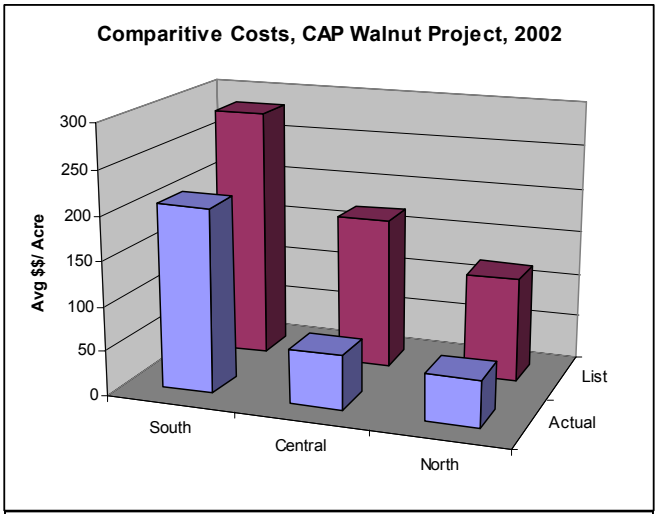


Figure 5. Regional comparison of average list costs vs. actual costs for sprayable pheromone treatments

As a result of the actual or potential costs to growers realized with sprayable pheromone this season, cooperators have determined that, for sprayable pheromones to be adopted, a more targeted approach to pheromone use will be required to minimize costs (See Appendix 16)

- Cost/benefit Worksheet

Input costs to control pests are only one component of an overall analysis of the economics of crop protection. Nonetheless, this is the one component over which growers can exert some control. Other components, such as impacts of other variables (e.g., weather) on quality and yield coupled with the price they receive for their final product, are relatively unmanageable. Consequently, as measured by the baseline surveys, growers and their advisors focus on input costs.

However, the comprehensive value of pest management inputs is best measured by calculating the *net revenue* derived from those inputs. In order to provide an example of this, a calculator was adapted from the Washington State Pear IPM Project (Appendix 17) to include the costs of inputs plus the value of yields and quality on bottom line income (i.e. net revenue). As the costs of managing walnut pests change, the use of net revenue calculation will provide a better measure of the economics of crop protection and pheromone use than evaluating input costs alone.

- Management Note on Economics

There is a common approach among walnut growers and some PCAs which focuses on controlling harvest damage levels rather than managing codling moth populations. This strategy was based on the ability of growers to use relatively inexpensive, late season "rescue treatment" chemical sprays when visible damage from the overwintering flight was detected either on the trees or as dropped nuts. In addition, where the previous season grade sheets suggested a problem, growers might program additional insecticide treatments the following season. With the advent of resistance to OP insecticides coupled with increasing regulatory constraints imposed on the use of most of OP insecticides, this "rescue" treatment/damage control approach is vulnerable to decreased efficacy and increased costs. The cost effectiveness of mating disruption, as an additional tool to *manage codling moth populations* vs. unilateral conventional pesticide rescue treatments to *control codling moth damage* will likely improve.

Outreach

In addition to published articles previously mentioned, project management conducted frequent face-to-face meetings and telephone contacts with project cooperators and many of the project sponsors. This management effort was aimed at keeping the project profile high among the cooperators by providing updated project information to those most intimately involved in the project. In doing so, this "high touch" approach demonstrated continued and frequent CAP involvement. By frequent interaction with project participants, project management developed a more clear insight into what is needed to make the project's work more effective and successful in the future. Concurrently, project management was able to keep cooperators informed of the CAP methodology.

Three major articles featuring the project were published in 2002. The first article, published in January 2002 by Diamond of California, the state's largest grower-cooperative walnut processor, in their quarterly newsletter. This article, published in the quarterly newsletter, introduced CAP and the walnut project to all Diamond cooperators.

A second article was published by the California Walnut Commission in its summer newsletter. This article described the CAP project in its context as an outgrowth of the Walnut Pest Management Alliance project and was sent to all California walnut growers.

A final article was published in the June 19 edition of The Sacramento Bee newspaper. This article highlighted CAP and the walnut project effort in the Sacramento Valley. (See Appendix 18-20 text of these articles).

As a result of these articles, all walnut growers and many Sacramento area citizens were provided detailed information about WIPMEP in its first field year.

End of Season Project Analysis

- ***Overview***

On November 5, 2002, an end of season meeting of the projects core participants was held to evaluate 1) the field results of the project and 2) the effectiveness of the project in achieving its objectives. The discussion and work plan from the March 14 planning meeting were used as the yardstick for assessing project efforts. Participants included the CAP executive, the project manager, all 3 regional project coordinators, all 4 regional pest management consultant cooperators, a representative of the Walnut Marketing Board and a project technical consultant. The facilitator, with support from CAP staff asked questions and solicited comments from the regional coordinators and consultants. (See Appendix 16 for the complete meeting results.)

Field results

- Sprayable Pheromones

Core participants believed that sprayable pheromones for codling moth mating disruption (CMMD) need to be explored as a component of a multi-tactic walnut pest management. With the entire end of season data in their hands, they then turned to their experiences of using pheromones in the field. The sprayables had worked better than anticipated in some fields, but had failed to provide adequate control in others. As participants had a chance to synthesize their experiences, several things became clear: although their confidence in being able to predict where pheromones would work was marginally lower, sprayable pheromones had the advantage of being compatible with existing systems and easy to apply. On the other hand, the cost of the materials is a disadvantage, particularly in comparison with cheaper OP alternatives.

However, far from being back at square one, the participants decided that they wanted to continue the use of sprayables, but possibly not expand their acreage in the coming year. Having seen that using pheromones as a wholesale replacement may not always be the best approach, they decided to reinvent part of the implementation effort to use sprayables as an adjunct to standard control programs in ways that will reduce CM populations and further decrease damage from codling moth in those control regimens.

- DA Lure

Core participant experience with the DA lure has compelled the crop consultants to incorporate the future use of this monitoring technology with diligence. Cooperating PCAs commented that the use of standard pheromone traps in CMMD orchards was “worthless” this year.

It was unanimously agreed that more needs to be known about how the DA technology will fit into walnut pest monitoring. In addition, consultants agreed that periodic nut damage assessments were important to the decision making process and, though added work and time are required, would be important components to incorporate when using pheromones and the DA lure.

- Field Protocol

In order to better determine the value added potential of sprayable pheromones cooperators discussed changing their field protocols. The need to compare blocks treated with pheromones against other similar blocks not treated with pheromone was suggested as an approach to better understanding the value of pheromones.

Conclusions

In 2002, CAP formed a network of stakeholders including growers, crop consultants, Diamond of California field staff, a large independent processor, industry consultants, product manufacturers, product distributors, commodity group personnel and university and cooperative extension personnel. Most importantly, PCAs were engaged in the implementation process.

The involvement of commercial PCAs was and is the most important factor for increasing the implementation of reduced risk technologies. Because of their involvement, the project was able to implement sprayables on 900 commercial acres in a short period of time. As they developed confidence in new practices they are able to spread their knowledge to other grower clients with whom they work, thereby expanding adoption. The PCAs in this project consult on 30,000 acres of walnuts so the impact of their participation extends well beyond the acreage formally in the project. Their work is the necessary step between experimentally designed research and wide scale adoption by growers. The engagement of the private sector accomplished in this project is the key to creating and sustaining adoption of new technologies after the project ends.

Project coordinators and consultants collaborated to design commercially practical field evaluation methodologies and protocols and, during the course of the season, conducted these agreed upon tasks. These cooperators began building an experience base relative to project objectives and CAP methodologies. Biological, economic and decision-making data collection was conducted in a planned and timely manner. Cooperators individually and collectively developed a critical sense about what was needed to implement the project's target technologies. This knowledge was captured in surveys and focus groups.

Conventional pest management in walnuts continues to rely on a variety of effective and inexpensive pesticides dominated by an array of organophosphate insecticides. Consequently, the baseline survey data showed that the cooperators had fundamental concerns about the cost and effectiveness of sprayable pheromones. However, as a result of their field experience with the project, cooperators determined that the use of sprayable pheromones and kairomone baited traps were potentially valuable tools in the future management of walnut pests.

This fact was particularly evident in the expressed desire of the core cooperators to continue the project work into a second field season (2003). As a result of their 2002 experience, these cooperators had initiated plans for modifying their use of the target technologies to better determine their fit into their commercial IPM programs. They stated that, depending on the availability of

donated product, they were considering expanding the use of the CMMD and DA lures on additional acreages in 2003.

Finally the project and its methodology are having influence far beyond the confines of the walnut industry. The project has been chosen as one of the initial case studies for presentation to the Committee to Advise on Reassessment and Transition (CARAT) (Appendix 21). Thus, the experiences in implementing reduced risk technologies and the process by which it took place will help to inform the larger discussion on how to support and facilitate the adoption of more environmentally sound farming practices in California and the rest of the country.

Appendices

Appendix 1.

THE CAP INTEGRATED IMPLEMENTATION PROCESS

Introduction

Involving participants in the design, implementation and evaluation of a project is the heart of the CAP process. It assures the adoption of new practices because it allows growers to integrate those practices into their existing management systems and to have confidence in the changes they are making. Participants identify what information they need in order to try a new practice and what results they need in order to decide if they want to continue the practice. Project activities can thus be designed to be manageable and straightforward. In addition, because participants document and evaluate their own results, they can see firsthand the benefits of a new practice.

Change depends on many factors; new practices that are clearly advantageous, compatible with existing systems and relatively simple to implement are much more likely to be adopted. With this in mind, and in the belief that change can only come from within, CAP has designed an implementation process which consists of five integrated steps: 1) Initiating a Project; 2) Designing Project Activities; 3) Establishing a Baseline; 4) Understanding and Assessing Industry Impact; and 5) Evaluating Results.

I. Initiating a Project

To initiate a project, CAP hires a project manager whose first task is to meet with the project partners, that is, the industry leaders and change agents in the public and private sectors who have expressed interest in and support for the work to be done. During this meeting, a work plan is developed and likely project participants are identified. Because project partners have many other responsibilities, the purpose of the work plan is to lay out the year's jobs in a clear, concise way so that everyone can stay on task.

II. Designing Project Activities

Once a project has been initiated, focus groups of growers and crop consultants help design project activities by addressing the following key questions:

1.)What information will project participants need in order to use the new practice? Specifically, what field information will participants need and what, if any, additional education, training, support or other resource would facilitate the adoption of new practices? Hearing directly from participants about what would be most helpful allows project staff to provide only the most useful information resources and to avoid burdening participants with unnecessary information.

2)What quantitative and qualitative information will participants need in order to determine whether a new practice has been worthwhile? It is important to understand at

the outset exactly what will need to be documented and how: what biological information, agronomic information, yield information, economic information and efficacy information will help growers decide whether or not a new practice has worked? Growers are asked to collect *only* the information they will need in order to decide about adopting a new practice. This makes the collection of results feasible, allows growers to have confidence in the new practice, and leads to a more conscious decision making style.

III. Establishing a Baseline

At the beginning of a project, project managers conduct a one-on-one interview with each participating grower and crop advisor. These interviews, which ensure that a documentation system is in place and serve to uncover any specific needs that particular farmers may have in relation to the adoption of new practices, are intended to establish a baseline of practices and decision-making processes. Participants identify what kind of information they have been relying on to make decisions in the past, and what processes they have used to make and evaluate those decisions. With this information—much of which may not have been articulated before—participants will be able to compare the changes in the way they make decisions with the way they did before.

IV. Understanding and Assessing Industry Impact

In order to ensure the widespread adoption of new practices, it is important to understand both current industry practices and attitudes to new practices. With the help of project participants and under the auspices of local organizations, industry wide surveys are designed to: 1) establish a baseline of current industry practices and industry awareness of new technologies; 2) determine the most appropriate communications messages, audiences and media to help increase industry-wide interest in new practices; and, 3) identify the best routes for increasing adoption. Since surveys are conducted through local organizations, there is both a good response rate and a way to inform local growers about survey results.

V. Implementing New Field Practices

Field implementation is carried out by the private sector in cooperation with research and extension staff. This makes it possible for participants to continue a new practice after the end of a project. While projects are running, CAP provides support as problems arise and connects project managers from different regions with each other so that they can compare notes about what works and what doesn't.

VI. Evaluating Results

Because growers identify at the outset what information they will need, and because the collection of relevant results is integral to the CAP process, an efficient method of evaluation is built into every project from the beginning:

First, growers and consultants compile season results and discuss these with project staff. As participants and staff document and evaluate important quantitative changes— yield, quality, production costs, net revenue, amounts of pesticides used, changes in pest and predator

populations--participants can determine if a practice has been worthwhile. They can identify what worked and what didn't, and decide whether they want to continue, expand, modify or abandon the new practice.

Next, project staff compile and analyze the individual results to evaluate the overall quantitative and qualitative success of each project. Once aggregated these results indicate the extent to which adoption has taken place within the industry, the ways in which the environment has been improved, and the efficacy of the new practices on a commercial scale. With this information, project staff can communicate with the industry to encourage further adoption and with the larger community to further understanding of environmentally sound agriculture.

Finally, when individual and aggregate results have been compiled and analyzed, the project staff convenes a discussion with project participants to review project results and refine project activities for the next season.

Conclusion

The steps in the process are interrelated so that the adoption of new practices is the result of deliberate attention to the way in which change takes place. The process is however flexible enough to be adapted to the needs and circumstances of individual projects. For example, if all project participants are present for the focus groups discussions described in Step 2, the one-on one interviews in step 3 can be forgone as redundant. The essential of every project is that change comes from within as a result of participants' involvement in every step of the process. As the process is refined and strengthened over the course of successive projects, the purpose remains to:

- Involve participants from the beginning in the design and evaluation of the project
- Provide a clearly defined set of changes to be implemented
- Ensure that the information and support necessary to implement those changes re provided
- Ensure that implementation is effectively carried out through the coordinated work of private and public sectors
- Ensure that the change and support are provided in a way that is compatible with current practices and important decisions
- Ensure that documentation is built in from the beginning so that the participants can see and confirm results so that project results can be collected
- Ensure that changes in decision-making are facilitated and documented as the fundamental and most lasting legacy of the project
- Provide a means for tracking the impacts of the project on the larger industry
- Provide a means for identifying potential adopters
- Provide a means for targeting communications as an integral part of project activities

Appendix 2.

Project Year 1 Final Report

Implementation

THE CALIFORNIA WALNUT IPM EXPANSION PROJECT
-Year 1-

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Keywords: Codling moth, *Cydia pomonella*, Navel Orangeworm, *Amyelois transitella,* walnut, mating disruption

Abstract: The Center for Agricultural Partnerships (CAP) in cooperation with growers and their organizations, crop consultants, researchers and farm advisors is developing a project to implement sprayable mating disruption and other new technologies on 25% of the walnut acreage susceptible to codling moth infestation (approximately 25,000 acres by the end of the third year).

Codling moth is one of the key pests of walnuts, infesting 60% of the more than 200,000 acres in California. Uncontrolled codling moth can lead to economic damage of up to 40 % of the crop. The walnut crop in California was valued at $278 million in 2000.

Year 1, Project initiation

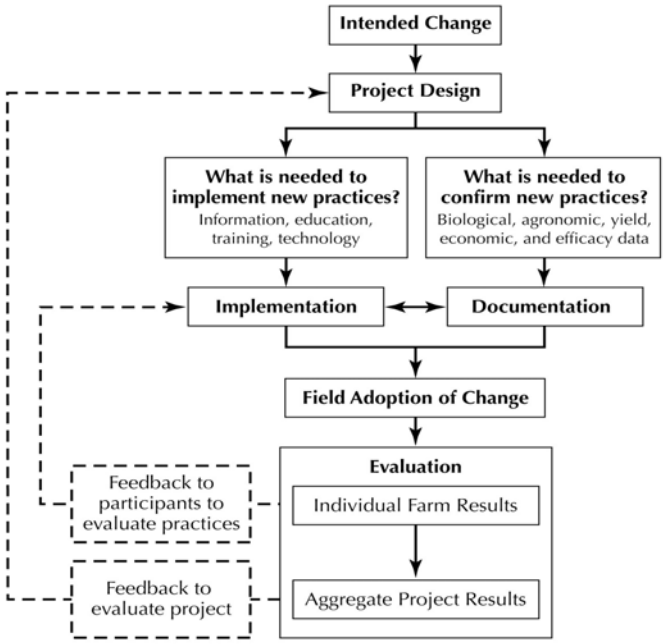
The Center for Agricultural Partnerships (CAP) is initiating, through a cooperative effort with growers and their organizations, crop consultants, researchers, farm advisors and the Walnut Pest Management Alliance program, a commercial implementation project designed to increase use of mating disruption on at least 25% of the walnut acreage susceptible to codling moth infestation (approx. 25,000 acres by the end of the third year) by:

- Implementing a systematic process to further on farm adoption of mating disruption and other novel insecticides on a wide scale in commercial walnut production over three years;
- Documenting and disseminating economic, biological and decision making changes in the adoption of new codling moth management technologies on the farm, project, and industry levels;
- Implementing and validating the effectiveness of kairomone-based lure as a key component in the use of mating disruption on a wide scale in commercial walnut production.

Methodology

Initial project design, organization and funding occurred in year 1 (2001). Field initiation will occur on approximately 1000 acres in three growing regions during the 2002 growing season (Year 2). Cooperator and acreage expansion will occur in subsequent years.

The diagram below shows the integrated process used by CAP in this project:



CAP will coordinate oversight of the entire effort and work with participants among the three cooperating walnut growing regions. Frequent written updates will be provided to grower and PCA participants regarding trap counts, pest pressure, economics and other information identified as important in initial participant group discussions. During the season, educational meetings will be organized in each region in cooperation with cooperating industry organizations and other interested stakeholders. CAP and the participating organizations will carry out communications within the walnut industry about the project and its results through newsletters, presentations, and electronic means.

At the beginning of the second project year, a baseline survey of the walnut industry will be conducted. The survey will 1) establish a baseline of current industry codling moth management practices and industry awareness of the new technologies; 2) determine the most appropriate communications messages, audiences and media to help increase industry-wide interest in new practices; and, 3) identify the best routes for increasing adoption within the industry as the project continues.

Implementation of the technologies will be done during the growing season by cooperating growers with the support of their crop consultants. Crop consultants will conduct field monitoring, provide training for the growers, and collect and interpret data to make it possible for the growers to master the new technology and the information necessary to successfully use it. To ensure consistency among grower and consultant efforts, the project' regional coordinators will assist CAP in organizing field implementation, analyzing results, facilitating learning and sharing of results among participants in the three different growing regions. In addition, collaboration with participants in the Walnut Pest Management Alliance (PMA) and companies providing pheromone and monitoring products will provide technical information on protocol design and field implementation. In year one, implementation sites totaling approximately 1000 acres will be established in each of three major walnut growing regions

throughout the Sacramento-San Joaquin valley. Collaborating crop consultants and growers will adapt protocols, developed by the PMA and the pheromone companies, to the implementation sites. Treatment protocols will be designed based on site-specific considerations of historical pest pressure and any other site pertinent characteristics. Each implementation site will receive applications of pheromone for CM control and, depending on site-specific considerations, supplemental insecticide sprays, only as necessary to prevent unacceptable crop damage. Where possible, reduced risk insecticides will be used. Where sites are 20 acres or larger, the orchard may be divided into two comparable blocks. One block will receive the pheromone treatment protocol and the other a "standard" or conventional treatment. Pheromone baited traps and an equivalent number of DA2313 baited traps will be placed in each pheromone implementation site, both pheromone treated and, where available, the "standard" site. A documentation system will be carried out for each site and region and will measure multiple parameters including environmental conditions (i.e., weather,) spray records, trap counts, pest phenology, supplemental monitoring data and other pertinent information as determined to be important to implementation. CAP with cooperation from the regional coordinators will tabulate the weekly data and provide weekly summaries to grower and PCA cooperators.

At the end of each growing season, crop consultants will compile biological, yield, economic and pesticide use results to review with each of the growers. They will be able to evaluate 1) quantitative changes such as yield, quality, production costs, net revenue, amounts of pesticides used and changes in pest and predator populations; and 2) the effectiveness of mating disruption technologies and how growers want to continue, expand, or modify their use. Since this project recognizes that new practices have to be economically viable, results will be presented for each cooperating grower in terms of net revenue as well as changes in direct costs.

Following harvest, participants will also meet as a group in each of the regions to review project activities, compare results, and set out plans for the coming season. Project staff will then compile results from all of the farms, summarize the results and prepare an annual project report. The results of that report will be used in communications throughout the walnut industry, trade publications, and presentations at industry and grower meetings. Just as important, CAP will conduct press and media relations to the wider agricultural community and general public to increase awareness and support for improving water quality through environmentally sound agricultural practices.

In the second and third years, the crop consultants will expand the number of acres and growers involved in implementing the sprayable technologies. The intended outcome of the project is that 25,000 acres (one quarter of the acreage susceptible to codling moth infestation) will have implemented the sprayable mating disruption technology by the end of the project's third growing season. At the end of the project a series of focus groups will be used to assess farm and project level results. In addition, a final industry survey will be conducted to assess changes in the industry as a result of the project.

Background

California produces 99% of U.S. walnuts and 38% of the world production. There are 207,520 acres of walnuts in the state, Over 90% of this acreage occurs in the Sacramento and San Joaquin valleys. In addition, this region is where the most severe arthropod pest problems exist with highest damage pressure in the southern valley.

Codling moth *(Cydia pomonella*) is the key pest of walnuts in California and the most economically important arthropod pest statewide. Two or more generations usually occur in California each summer. These later generations can be particularly damaging to harvested nuts. Summer larvae bore into the growing nut, damaging husk, shell, seed coat and kernel, and rendering the nut worthless for commercial use (USDA, 2001). In addition, infested nuts provide entry points for navel orange worm, *Amyelois transitella*, increasing the population of this pest in orchards while coincidentally increasing pesticide applications and costs (IPM for Walnuts, 1987, Walnut Marketing Board, 2000a).

Approximately 60% of walnut acreage is susceptible to codling moth (CM) damage. Damage is generally most severe on early season cultivars, although it has been increasing steadily over the years on some late cultivars such as Chandler. Left uncontrolled, codling moth infestation can result in serious economic damage that exceeds 40% of the harvested crop. In addition to direct yield and quality losses, higher costs for sorting in the warehouse may result in additional economic penalties for growers. Codling moth feed on the walnut kernel thereby reducing edible yield. Since edible yield is a basis of payment on shelling varieties, any level of damage reduces the grower's payment for the crop. Low levels of damage reduce or eliminate any quality bonus payments to the grower. Additional financial penalties are imposed when insect damage exceeds 5%. Any lot of walnuts with insect damage greater than 8% is disqualified from in shell shipment and the associated premiums (S. Wulfert, 2001, Integrated Pest Management for Walnuts, 1987.) As a result, walnut growers are experiencing $16 – 40 million in losses from CM annually, with losses in recent years at the upper bound (Sibbitt 2001, Stewart 2001).

Codling moth management relies on one to three chemical treatments per year. The primary conventional pesticides organophosphate (OP) insecticides of which chlorpyriphos is the most widely used being applied to more than 40% of the walnut acreage annually. To protect their crops from loss, walnut growers annually apply 1.5 to 2.2 lbs. AI/ac. of OPs to control CM in infested orchards. According to California's Department of Pesticide Regulation Pesticide Use Report Data Summary (2000) more than 145,000 pounds of chlorpyriphos were used on walnut production in 1999. Grower costs for these sprays may exceed $100/acre per season. Use of these pesticides often requires additional pesticide inputs to control secondary pests, which erupt when their natural enemies are suppressed by the CM sprays.

While OPs have provided a valuable mainstay of pest management in walnuts, problems associated with their use have also multiplied. CM resistance to OPs has been widely documented (Varella, 1993, Knight, 1994.) Furthermore, OPs disrupt natural enemies of secondary walnut pests, such as walnut aphid, dusky-veined aphid, web spinning mites which often results in additional pesticide applications (Ramos, 1985.) In short, the continued availability of the most widely used chemicals for control of the key pest of walnuts is in significant jeopardy due to biological and regulatory reasons.

The Center for Agricultural Partnerships (CAP) is a 501(c)(3) nonprofit organization whose mission is to create programs that solve important agricultural problems by helping farmers increase the use of economically and environmentally sound practices.
CAP projects serve to bridge between the vast body of research in farming practices and the practical implementation of these innovations in the field.

In the last five years CAP has worked with partners involved in the production of lettuce,

celery, apples, pears, cotton, soybeans, corn, and peanuts, in California, Michigan, Minnesota, North Carolina, Virginia, and Washington. Since its inception in 1996, CAP projects have put new farming practices in place on more than 100,000 acres nationwide.

Headquartered in North Carolina and supported by foundations, corporations, individuals, state, and federal government, CAP is a leader in designing and implementing solutions for difficult agricultural and environmental problems.

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Appendix 3.

Center For Agricultural Partnerships
Go/No Go Pre-Project Evaluation
Situation Analysis Stage of The CAP Implementation Project Model
WALNUT IPM EXPANSION PROJECT

Industry/Primary cropping system:	WALNUTS
Locations for implementation – state(s), region(s):	CALIFORNIA, SAN JOAQUIN-SACRAMENTO VALLEYS Yuba/Sutter Co., San Joaquin Co., Tulare Co.
Innovation(s) being considered – technology, product, practice, hardware/software:	New reduced-risk insecticides, new formulations of mating disruption for CM, new trap attractants for improved trapping efficiency in disrupted orchards
Intended start date for implementation (i.e. for funding and recruiting/hiring purposes):	Spring, 2001 pending funding
Intended start date for baseline data collection (i.e. for funding purposes):	Spring, 2001 pending funding

Key potential funders - financial, in-kind (i.e. potential stakeholders who might need to be recognized in funding proposals and/or direct funders):	
Name	Potential Contribution
?	
?	
Rohm & Haas/3M	?
Walnut Marketing Board	?
Diamond of California	In kind harvest damage evaluation, PR support

Potential project personnel (identify any on-the-ground individuals who might be willing and able to participate in the project):	
Project Manager	CAP/WHA, Inc.
Project Coordinator	Selected independent consultants in each region
Technician	Randy Hansen (WHA)
Economist	Jeff Connor
Evaluation	CAP and others
Communications	Diamond, Walnut Marketing Board, CAP and others
Other	

Potential stakeholders (provide specific names of people and/or organizations)	
Farmers/Growers	Clients of project coordinators
Crop consultants	Project coordinators
Research	UC and USDA-ARS
Extension	PMA, UCCE
Grower/industry organizations	Walnut Marketing Board Diamond of California
Related or complimentary projects	PMA BIOS (San Joaquin Co.)
Private businesses	Consulting firms in three regions listed in draft proposal
University, colleges, professional schools	UC Berkeley See proposal

What are their concerns, needs, barriers, resources, logistics, etc.? (e.g. specific issues that need to be addressed and/or recognized in order to ensure a successful project)	
Farmers/Growers	Economically competitive adoption of mating disruption for management of CM
Crop consultants	Increased field monitoring required to make mating disruption an economic alternative to conventional pesticides
Research	Researchers are slow to develop comfort with a "trialable" program Sprayable pheromone technology not proven effective in walnuts Limited use of new trapping technology
Extension	Engaged in research and demonstration as part of PMA
Grower/industry organizations	Still learning about these. Probably the usual political constraints for which we hope to compensate in project regionalization
Related or complimentary projects	Concerns that PMA does not perceive project as competition but rather as collaboration
Private businesses	Rohm & Haas has virtually no field experience with MD in CA walnuts. R&H has few good field oriented employees in state. Rick Geddes is exception in Sutter/Yuba
University, colleges, professional schools	No comment here yet

Please check the box that most closely corresponds to your feelings on each of the following statements.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Industry appears to have vocal or manifest concerns sufficient to initiate a change process.					XX
Industry concerns are not so strong to prevent members from being open to systematic problem solving and coherently planned change processes.				XX	
Concerns by various industry members are sufficiently in harmony that attaining consensus on a change effort seems possible.				XX	
The industry's previous experience(s) with change efforts is positive enough that it supports consideration of other opportunities for change.				XX	

With respect to the industry's internal networks and cohesion, they can be described as: ❑ Strong enough that effective communication and overall recognition of the need for change is possible ❑ Sufficiently "loose" and "open" that there is room and receptivity for (outside) interventions from change agents (or anyone else)				XX XX	
Industry possesses the internal capacity to analyze situations and diagnose problems constructively.			XX		
Industry possesses initiative/desire to analyze situations and diagnose problems constructively.				XX	
Even though the industry is experiencing such a level of turmoil regarding primary concerns, it is able to examine or define the problem constructively.			XX		
The industry is not so fixated on a solution(s) that it is incapable of considering the real nature of the problem.			XX		
Industry members adequately trust each other and/or CAP to open up on the really serious problems that are plaguing them.			XX		
The industry has acquired or is able to acquire adequate resources, financial or otherwise, to support a change effort.				XX	
The industry is sufficiently linked to outside resource systems for knowledge, innovation models, expertise, or financial support.				XX	
The industry is both able and willing to commit to trying out a specific change activity.				XX	
The industry is not presently committed to or about to attempt a change activity which is poorly conceived, will have little or no impact, is too ambitious and will likely fail; thus, has little likelihood of gaining long-term acceptance, will not lead to further renewal efforts.				XX	
The industry has experienced on-farm implementation and has the motivation and capacity to disseminate it to others and to extend its impact.			XX		
The industry is aware of the need to evaluate its experience regarding the on-farm implementation and its outcomes to determine whether to continue the innovation and extend it to others.			XX		
The industry has adequate recognition/appreciation of the need for continuing to adapt the innovation until it is fully accepted as integral to the production system.				XX	
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The decision makers accept the need to make room for the change in their line item annual budget and/or farm management practices.			XX		
The change will lead to a continuing desire for change and on-going efforts to bring about other changes.			XX		
Summary Check List	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
This implementation project will yield an impact that can be felt and measured during the life of the project.				XX	
This implementation project will produce a measurable legacy(ies) that will last beyond the life of the project.				XX	

The scope of the implementation project does not exceed the intended resources to match it.			XX		
The project is of sufficient size and scope that its impact will be appreciated.				XX	
The project will be meaningful to many stakeholders within the following: ❑ Industry ❑ Funders (current and potential) ❑ CAP ❑ Future projects ❑ Political arena				XX	
The project can be subjected to constructive analysis: ❑ Economics ❑ Decision-making processes ❑ Rate and extent of adoption				XX	
The project will leverage existing/accessible application of information and other resources.					XX
Successful completion of the project will lead to other opportunities for the industry and CAP (i.e. multiplier effects).					XX

Appendix 4.

List of Core Participants

Name	Business Name	Street number	City	State	Zip
Regional Consultants					
Michael Devencenzi	Agricultural Consultant	338 Valley Oak Place	Woodbridge	CA	95258-9323
John Post	Agricultural Advisors, Inc	3995 East Butte Rd.	Live Oak	CA	95953
Jim Stewart	Pest Mgmnt Assoc., Inc	P.O. Box 712	Exeter	CA	93221
Judy Stewart	Pest Mgmnt Assoc., Inc	P.O. Box 712	Exeter	CA	93221
Regional Coordinators					
Steve Wulfert	Diamond of California	P.O. Box 3828	Chico	CA	95927
Joe Grant	U.C. Coop. Extension	420 S Wilson Way	Stockton	CA	95205
Steve Sibbett	U.C.C.E. Emeritis	2909 Village Ct	Visalia	CA	93277
Project Management					
Pat Weddle	Center for Ag Partnerships	P.O. Box 529	Placerville	CA	95667

Appendix 5. Walnut IPM: Core Participant Work Plan Structure

Walnut IPM: Work Plan Responsibility Matrix and Project Timeline

Work Package \ Responsible Party		Crop Cons	Grower	Reg Cord	Proj Mgnt	CAP	Frequency/ Deadline	Status
1.01	Economic analysis variables identified	D		D	D		03.14.02	complete
1.02	Future costs variables identified					D	Post harvest	
1.03	Training						03.14.02	complete
1.04	Damage assessment variables identified	D		D	D		03.14.02	complete
2.01	Document standard procedures for sprayable pheromone use	A		A	D		03.14.02	complete
2.02	Field education sessions			H	D		ongoing	underway
2.03	Mechanism to deal with failures	D	D	H	A	H	ongoing	
3.01	Data collection for economic and damage analysis	H	H	D	H			ongoing
3.02	Create online data dictionary and database				D		04.01.02	
3.03	Doug's protocol for field data collection			H	D		03.15.02	
3.04	Online field data submission	D		H			weekly	
3.05	Economic data submission	D		H	H		ongoing	
3.05	Conduct baseline surveys	H			D	D	April	
3.06	Baseline surveys with growers, CCs and industry on field data (UC data)							Collected but not analyzed
3.07	Baseline decision making data—secondary analysis					D	May/June	
4.01	Ongoing discussion of effectiveness of technology	D	D	D	D	D	Ongoing	underway
4.02	Weekly field updates—summary?				D		Ongoing	
4.03	Internal project communication	H	H	H	D		Ongoing	
4.04	Regional communication—post harvest reports			H	D		As needed	As needed
4.05	Industry communication (ag and non-ag)				D		As needed	As needed
5.01	Data analysis at individual level	D		D			ongoing	ongoing
5.02	Data analysis at project level	H		H	D	H	Post harvest	
5.03	Project expansion—decide on methodology			H	D		Post harvest	

Key: D: Does A: Approves H: Helps

Appendix 6. Cooperator Survey and Interview Instruments:

Cooperating Grower Interview Instrument
Walnut Grower Interview Questions *(to be asked by Pat in a face-to-face situation)*

Q1. When considering new pest management tools, which ONE of the following is the MOST important to you:

A. Reducing costs
B. Increasing revenues
C. Effectiveness of the tools
D. Other (please specify): _____

Q2. What are your main concerns about using sprayable pheromones?

Q3. What do you need to find out throughout the growing season that will help you decide whether or not sprayable pheromones work for you in walnuts?

Q4. What do you need to find out after harvest that will help you decide whether or not sprayable pheromones work for you in walnuts?

Q5. If you wanted to convince a neighbor or fellow grower to use sprayable pheromones in walnuts, what information or data would you need to make your case?

Q6. Assume it is the end of the season and you and your crop consultant are discussing the crop yield, revenue, and insect damage levels. You have added the DA lure and sprayable pheromones to your pest management tool box for part of your producing walnut acreage and maintained some form of last year's (i.e. traditional) codling moth pest management program on your remaining producing walnut acreage. For each of the following two scenarios, please indicate which action you would likely take.

Scenario #1:
The two pest management strategies yielded nearly identical results in terms of yield and quality. Given that it was the first year of the sprayable strategy, start-up and monitoring costs proved to be somewhat higher than other strategy, how would you proceed for next year's pest management program and WHY?

A. Use traditional pest management strategy on 100% of acreage.
B. Repeat combination of these two strategies in same ratio of acreage.
C. Increase sprayable strategy acreage somewhat but still maintain significant proportion of acreage in traditional strategy.
D. Use sprayable strategy on 100% of producing acreage.

Scenario #2:
The two pest management strategies were nearly identical in terms of costs to implement. However the acreage using sprayable pheromones appears to have slightly higher (1-2%) damage levels than the strictly traditional blocks. How would you proceed for next year's pest management program and WHY?

A. Use traditional pest management strategy on 100% of acreage.
B. Repeat combination of these two strategies in same ratio of acreage.
C. Increase sprayable strategy acreage somewhat but still maintain significant proportion of acreage in traditional strategy.
D. Use sprayable strategy on 100% of producing acreage.

Cooperating Grower Survey Instrument

Introduction

This survey is being conducted to determine project impact on cooperators, assist project management in the continually improving the conduct of the project and to improve CAP's design of future projects. Your responses will be anonymous and you will be provided the summarized results of the survey. Please answer each question and return to Pat Weddle.

PERCEPTION AND SCOPE OF CURRENT PROBLEM

Q1. Compared to other cultural practice challenges in walnuts (e.g. disease, insects, weeds), how much of a problem is codling moth management?

A. Less of a problem
B. Equal problem
C. More of a problem

Q2. In general, has codling moth historically been a problem (i.e. caused economic damage) in your orchard(s)?

A. Yes
B. No

Q3. How often, in your best recollection, have you observed yield/quality reducing damage due to codling moth that affects your economic bottom line?

- Number of years within the past 10 years. _____
- Percent of hull/nut damage on those blocks. _____

DECISION MAKING FACTORS

Q4. How important do you believe each of the following factors is in dealing with codling moth in walnuts? Please check the box that best indicates your view.	Not Important 1	Somewhat Important 2	Very Important 3
• Overall orchard history of codling moth damage (more than last year)			
• Last year's codling moth pressure and problems			
• Maintaining same codling moth pest management program as last year			
• Efficacy of current insecticides/miticides			
• Cost of making insecticide/miticide applications			
• Availability of current insecticide/miticides			
• Number of codling moth adults trapped during growing season			
• Variety selection			
• Profit robbing potential of codling moth			
• Potential effect on yield			
• Price received for walnuts			
• Quality grade			
• Hull damage			
• Ease of application of sprayable pheromones			
• Cost of sprayable pheromones			
• Other			

Q5. Please check the box indicating how important each of the following individuals/groups of people are in INFLUENCING codling moth pest management decisions for your walnut orchards?	Not Important	Somewhat Important	Very Important
• Extension/University			
• Independent crop consultant			
• Input supplier (i.e. pesticide, seed, ag chemical dealer)			
• Input Supplier PCA			
• Neighbors and other walnut farmers			
• Family member(s) of farmer			
• Banker/Lender			
• Landowner (if not primary individual doing farming)			
• Other (please identify):			

Q6. Please check the box indicating who MAKES the codling moth treatment decisions for your walnut orchards?	Never	Sometimes	Always
• You			
• Extension/University			
• Independent crop consultant			
• Input supplier (i.e. pesticide, seed, ag chemical dealer)			
• Input Supplier PCA			
• Neighbors and other walnut farmers			
• Family member(s) of farmer			
• Banker/Lender			
• Landowner (if not primary individual doing farming)			
• Other (please identify):			

Q7. During the 2001 growing season, approximately how many hours per month would you estimate the following individuals spent monitoring your bearing walnut acreage for pests (weeds, insects, disease, etc.)	Hours Per Month	Did Not Monitor
• You		
• Your employee(s)		
• Your PCA		

Q8. Who maintains the insect pest monitoring records for the walnut orchards you advise?	Never	Sometimes	Often	Always
• You				
• Your independent crop consultant				
• Both you and your PCA				
• Other (please specify):				

Q9. What percentage of codling moth damage do you consider to be "acceptable" before there are economic consequences to your walnut orchard revenues?

- <1%
- 1% - <5%
- 5% or greater

Q10. Do you work with your crop consultant to measure and evaluate codling moth damage at harvest?	Never	Sometimes	Often	Always
• Drop nut counts				
• Harvest sample counts				
• Grade sheet follow-up analysis				
• Visual inspections				

• Other (please specify):				

PHYSICAL BARRIERS TO ADOPTION

Q11. Following is a list of factors related to the adoption of sprayable pheromone based codling moth management practices in walnuts. For each one, please indicate whether you view it as a Major Barrier, Minor Barrier, or Not A Barrier to further adoption of sprayable pheromones within the walnut industry.	Not A Barrier	Minor Barrier	Major Barrier
• Impact of weather on pheromone efficacy			
• Uncertainty of efficacy of sprayable pheromones			
• Lack of effective pesticides to supplement sprayable pheromones			
• Shortage of professional crop consultants			
• Lack of availability of trained orchard scouts for pest monitoring			
• Inadequate level of applied research on sprayable pheromones			
• Need for more biological information accompanying the use of sprayable pheromones			
• High quality standards required by processors and consumers			
• Cost of sprayable pheromone product (relative to other pest management products)			
• Potential increase in other pest species (e.g. walnut husk fly)			
Other (please specify):			

MENTAL BARRIERS TO ADOPTION

Q12. To what extent do you feel each of the following factors is a barrier to growers changing their current insect pest management practices? (Please check one box for each statement.)	Never	Sometimes	Often	Always
• Your time available				
• Your budget				
• The skill level of the your orchard employees to monitor and identify pests				
• The expertise of your independent crop consultant				
• Your level of insect pest management expertise				
• The quality and quantity of block/orchard records				
• The fear of economic loss				
• Your interest level in modifying existing insect pest management practices				
• Other (please specify):				

Q13. Please circle the response that indicates your level of agreement with each statement.	Not True	Very True	Don't Know
• I have heard about sprayable pheromones. (if you check "not true", please skip to **Question 6)**			
• I have heard about sprayable pheromones but don't use them.			
• I know how to use sprayable pheromones.			
• I use sprayable pheromones.			
• I know other walnut farmers who uses sprayable pheromones			
• I feel that the potential effectiveness of sprayable pheromones in controlling or reducing codling moth infestations is commercially viable.			
• The use of mating disruption (Isomate C+ or Checkmate) is effective in controlling codling moth.			
• Use of mating disruption is cost effective.			
• It's worth using practices that reduce my overall chemical and fertilizer use even when it might take a little more time or expense.			
• Increasing the population of natural enemies/beneficials in or near a walnut orchard can help manage pests.			

INFORMATION SOURCES

Q14. To what extent do you use EACH of the following sources when considering codling moth pest management decisions?	Never	Sometimes	Often	Always
• University researchers and publications				
• Cooperative extension meetings and field days				
• University sponsored short courses				
• Farm publications				
• Diamond Walnut sponsored meetings and publications				
• Chemical company suppliers and representatives				
• Other walnut growers (networking, consulting with peers)				
• Internet and web services				
• Special Projects (e.g. Walnut PMA project)				
• Orchard records				
• Agricultural television and radio programs				
• Participation in field trials and on-farm testing				
• Other (please specify):				

BACKGROUND

Q15. What is the highest level of school you completed?

A. High school diploma
B. Associate degree
C. Four-year college/university degree
D. Graduate degree
E. Other: _____

Q16. How many years have you been farming in the walnut industry?

A. Less than 5 years
B. 5 to 15 years
C. 16 to 25 years
D. More than 25 years

Q17. How many years have you been making the pest management decisions for walnut orchards?

A. Less than 5 years
B. 5 to 15 years
C. 16 to 25 years
D. More than 25 years

Q18. How many acres of producing walnuts (i.e. more than 5 years old) to you own/manage?

	Conventional	Organic
Total bearing walnut acres owned		
Total bearing walnut acres leased		
Total bearing walnut acres in organic production		

Q19. Where is the majority of your walnut acreage located?

A. Sacramento Valley
B. Northern San Joaquin Valley
C. Southern San Joaquin Valley
D. Other: _____

Appendix 7

Cooperating Pest Management Consultant Survey Instrument

Introduction

This survey is being conducted to determine project impact on cooperators, assist project management in the continually improving the conduct of the project and to improve CAP's design of future projects.

PERCEPTION AND SCOPE OF CURRENT PROBLEM

Q1. How in often, in your best recollection, have you observed yield/quality reducing damage due to codling moth?

- Number of years within the past 10 years. _____
- Number of orchard operations per year. _____
- Percent of hull/nut damage on those farms. _____

(QQ 2-4 Omitted)

DECISION MAKING FACTORS

Q4. How important do you believe each of the following factors is in dealing with codling moth in walnuts? Please check the box that best indicates your view.	Not Important 1	Somewhat Important 2	Very Important 3
• Overall orchard history of codling moth damage (more than last year)			
• Last year's codling moth pressure and problems			
• Maintaining same codling moth pest management program as last year			
• Efficacy of current insecticides/miticides			
• Cost of making insecticide/miticide applications			
• Availability of current insecticide/miticides			
• Number of codling moth adults trapped during this growing season			
• Variety selection			
• Potential impact of codling moth on yield			
• Potential impact of codling moth on grade			
• Price growers received last year for walnuts			
• Price anticipated for this year's walnuts			
• Ease of application of sprayable pheromones			
• Cost of sprayable pheromones			
• Availability of sprayable pheromones			
• Other			

Q5. Please check the box indicating how important each of the following individuals/groups of people are in INFLUENCING codling moth pest management decisions for your walnut clients?	Not Important 1	Somewhat Important 2	Very Important 3
• Extension/University			
• Other independent crop consultant			
• Input suppliers (i.e. pesticide, seed, ag chemical dealer)			
• Input supply affiliated PCA			
• Company technical representative			
• Neighbors and other walnut farmers			
• Family member(s) of farmer			
• Banker/Lender			
• Landowner (if not primary individual doing farming)			
• Other (please identify):			

Q6. To what extent does each of the following MAKE the treatment decision to control for codling moth.	Never	Sometimes	Often	Always
• You				
• Your client(s)				

Q7. Who maintains the insect pest monitoring records for the walnut orchards you advise?	Never	Sometimes	Often	Always
• You				
• Your client(s)				

Q8. What percentage of codling moth damage do you consider to be "acceptable" before there are economic consequences to your clients' walnut orchard revenue?

- <1%
- 1% - <5%
- 5% or greater
- Other
  Comment:_____

Q9. Do you provide codling moth damage assessments to your clients at harvest?	Never	Sometimes	Often	Always
• Drop nut counts				
• Harvest sample counts				
• Grade sheet follow-up analysis				
• Visual inspections				
• Other (please specify):				

Q10. What do you feel growers need to know to evaluate the effectiveness of sprayable pheromones and become more confident in their use?

Q11. In your opinion, what are the best ways to assist growers to move to increased utilization of sprayable pheromones?

Q12. Following is a list of factors related to the adoption of sprayable pheromone based codling moth management practices in walnuts. For each one, please indicate whether you view it as a Major Barrier, Minor Barrier, or Not A Barrier to further adoption of sprayable pheromones within the walnut industry.	Not A Barrier	Minor Barrier	Major Barrier
• Impact of weather on pheromone efficacy			
• Uncertainty of efficacy of sprayable pheromones			
• Lack of effective pesticides to supplement sprayable pheromones			
• Shortage of professional crop consultants with pheromone experience			
• Lack of availability of trained orchard scouts for pest monitoring			
• Inadequate level of applied research on sprayable pheromones			
• Need for more biological information accompanying the use of sprayable pheromones			
• High quality standards required by processors and consumers			
• Cost of sprayable pheromone product (relative to other pest management products)			
• Availability of sprayable pheromone products			
• Potential increase in other pest species where pheromones are used (e.g. walnut husk fly)			
• Other (please specify):			

KNOWLEDGE AND INFORMATION BARRIERS TO ADOPTION

UNDERSTANDING CURRENT USE OF PHEROMONES

Q13. Please check the box that indicates your level of agreement with each statement.	Not True	Very True
• Most of my walnut clients have heard about sprayable pheromones. (If you check "not true", please skip to Question 14)		
• Most of my walnut clients have heard about sprayable pheromones but don't use them.		
• Most of my walnut clients know how to use sprayable pheromones.		
• Most of my walnut clients use sprayable pheromones.		
• I believe that the potential effectiveness of sprayable pheromones in controlling or reducing infestations is commercially viable.		

Q14. To what extent do you believe each of the following factors is a barrier to growers adopting sprayable pheromones? (Please check one box for each statement.)	Never	Sometimes	Often	Always
• Your time available to work with grower clients				
• Growers' budgets				
• The skill level of the growers and/or their orchard employees in executing a pest control recommendation				
• Growers' level of insect pest management expertise				
• The quality and quantity of block/orchard records				
• Growers' fear of economic loss				
• Growers' interest level in modifying existing insect pest management practices				
• Other (please specify):				

Q15. To what extent do you use EACH of the following sources when considering codling moth pest management decisions?	Never	Sometimes	Often	Always
• University researchers and publications				
• Cooperative extension meetings and field days				
• University sponsored short courses				
• Farm publications				
• Diamond Walnut sponsored meetings and publications				
• Chemical company suppliers and representatives				
• CAPCA (California Association of Pest Control Advisors)				
• Other consultants (networking, consulting with peers)				
• Internet and web services				
• Special Projects (e.g. Walnut PMA project)				
• Growers' orchard records				
• Agricultural television and radio programs				
• Participation in field trials and on-farm testing				
• Other (please specify):				

(QQ 16 Omitted)

INFORMATION SOURCES

BACKGROUND

Q17. How many years have you been working as a PCA in the walnut industry?

E. Less than 5 years
F. 5 to 15 years
G. More than 15 years

Q18. What percentage of your time is spent on walnuts?

A. < 33%
B. 33-66%
C. 67% - 99%
D. 100%

IMPACT VIA P.C.A.

Q19. For about how many acres of walnuts did you provide pest management consulting services or recommendations in the 2001 growing season?

_____ acres of walnuts

Q20. During the 2001 crop year, how many walnut orchard operations did you advise?

_____ number of farming operations

Q21. Where are the majority of your clients located?

E. Sacramento Valley
F. Northern San Joaquin Valley
G. Southern San Joaquin Valley
H. Other: _____

PREDICTED BEHAVIOR

Q22. Assume it is the end of the season and you and your client(s) are discussing the crop yield, revenue, and insect damage levels. You have added the DA lure and sprayable pheromones to your pest management tool box for part of your client's producing walnut acreage and maintained some form of last year's (i.e. traditional) codling moth pest management program on your client's remaining producing walnut acreage. For each of the following two scenarios, please indicate which recommendation you would be inclined to make.

Scenario #1:

The two pest management strategies yielded nearly identical results in terms of yield and quality. Given that it was the first year of the sprayable strategy, start-up and monitoring costs proved to be somewhat higher than other strategy, how would you proceed for next year's pest management program and WHY?

E. Increase the use of sprayable pheromones on more acreage
F. Decrease the use of sprayable pheromones
G. Apply sprayable pheromones on about the same acreage

Scenario #2:

The two pest management strategies were nearly identical in terms of costs to implement. However the acreage using sprayable pheromones appears to have slightly higher (1-2%) damage

levels than the strictly traditional blocks. How would you proceed for next year's pest management program and WHY?

A. Increase the use of sprayable pheromones on more acreage
B. Decrease the use of sprayable pheromones
C. Apply sprayable pheromones on about the same acreage

Appendix 8. List of Program & Project Management Accomplishments 2002

The goal for Project Year 2 (2002) was development and testing of the CAP process and the project's field components. The following list describes the initial accomplishments of the project.

Project Organization & Planning

- Developed project field budgets, January
- Designed survey and interview instruments, February
- Conducted project planning meeting and focus group with core technical cooperators, March 14

Education & Outreach

- Formal Presentation introducing the project to the Western Orchard Pest and Disease Management Conference, Portland, OR (Jan 10)
- Formal Presentation introducing the project to the Walnut Research Committee Annual Conference, Bodega Bay, CA (Jan 24)
- Co-sponsored mating disruption technical seminar, AAIE Annual Conference, Berkeley, CA (Feb 5)
- Formal presentation on the project to Cal-EPA, Dept. of Pesticide Regulations, Pest Management Alliance Annual Workshop, Sacramento, CA (March 12)
- Formal presentation introducing project to Tulare Co. growers at UCCE grower meeting, Hanford, CA (April 2)
- Formal presentation on mating disruption in walnuts and the CAP project to Diamond Walnut Technical Staff Meeting, Stockton, CA (May 30)
- Two meetings with UC-IPM Area IPM specialists, one in Yuba City and one in Parlier to review project and statewide UC-IPM pheromone data (June)
- Conducted industry education meeting for project stakeholders to report project results (November)

Establishment of Cooperators

- Established three Regional Coordinators (January)
- Established three Regional Consultants (January)
- Established 8 grower cooperators with 9 orchards representing 900 acres (February, March)
- Secured sprayable pheromone donations from 3M Canada and Suterra LTD
- Secured trap and lure donations from Trece, Inc. (April)
- Field trapping by cooperators was initiated (March-April)

Project Evaluation

- Collaborated with UC-SAREP on walnut industry survey to be conducted in 2002
- Conducted interviews and surveys of Regional Consultants (April)
- Conducted interviews and surveys of grower cooperators (May-June)
- Conducted interim project field evaluation to determine effectiveness of new trapping technologies, sprayable pheromones and project communications with Regional Coordinators and Consultants (June 5-6)
- Conducted monthly visits with cooperators to periodically assess cooperator perceptions of target technologies

- Conducted an end of season project wrap-up meeting with regional coordinators and consultants to document project outcomes (November)

Field Data Management

- Initiated on-line field data management system with UC-IPM (April)
- Established and verified field trapping methodology with Regional Coordinators and Regional Consultants (April-May)
- Established data management coordination with DJS Consulting (May)
- Provided updated summaries to Regional Coordinators, Consultants and other key project cooperators (June)
- Initiated economic analysis data collection (June)
- Supported Certis' design and execution of comprehensive harvest sample damage analysis (September)
- Summarized field data for industry presentations (October)

Communication

- Published industry solicited article on project description, goals and objectives in Diamond Walnut Newsletter, January. This newsletter is sent to approximately 50% of California walnut growers
- Published industry solicited article on project history, design, goals and objectives in Walnut Marketing Board Newsletter, June. This newsletter is received by all California Walnut Growers
- Field meeting with Sacramento Bee to develop a newspaper article highlighting the CAP
- walnut project, Marysville, CA, May 21
- Sac Bee newspaper article "Pheromones are in the air" published June 9

Appendix 9.
Summary results of surveys and interviews

CAP Walnut IPM Expansion Project
Walnut Grower Survey Analysis
2002

SUMMARY AND FINDINGS

Background

Seven growers were surveyed (all but one face-to-face). These are seasoned growers. Over half have farmed walnuts longer than 15 years and most of these over 25 years. Most have been making pest management decisions for 5 to more that 25 years. There is a wide range of acreage represented by respondents. Two cooperators farm in the Sacramento valley, four cooperators farm in the Northern San Joaquin Valley and three cooperators farm in the Southern San Joaquin Valley (one not surveyed).

Perception and Scope of Problem

Most (all but 1) believed CM to be more of a problem than other cultural challenges. Most (all but 1) stated that CM was historically a problem. Respondents stated that losses due to CM occurred in at least half of the last 10 years and that those loss levels averaged about 5%.

Decision Making Factors

Last year's damage assessments and grade quality were unanimously very important followed by overall history and price received for walnuts. Ease of application was somewhat important. University/Extension and independent PCAs ranked very important by most or at least somewhat important. Input suppliers and bankers were unanimously not important.

The growers, followed by their independent consultants were always the treatment decision makers. PCAs do most of the orchard monitoring. The PCA always maintained orchard records. Of these, half maintain grower records in collaboration with the grower-client. Most growers consider less than 1% or less damage acceptable and all consider less than 5% acceptable. Growers always evaluate post harvest grade sheets with consultants.

Physical Barriers to Adoption

Uncertainty regarding efficacy and cost of sprayables were the most frequent major barriers or at least a minor barrier followed by impacts of weather (which may go to "efficacy"). Lack of trained orchard scouts was the most frequent minor barrier followed by the need for more biological information re. sprayables.

Mental Barriers to Adoption

All have heard about and are currently using sprayables. Most believe pheromones can help manage CM, believe in reducing chemical inputs even if it costs more and believe in the benefits of natural enemies. Most don't yet know if MD is cost effective. Most believe that the fear of economic loss is always a barrier in changing practices. Most believe that their lack of pest

management expertise is sometimes a barrier. Most believe that orchard record quality is never a barrier.

Information Sources
Growers unanimously never use ag television as an information source. Otherwise, they most often use the walnut PMA followed by a wide range of information sources. The question should have asked about PCAs.

CAP Walnut IPM Expansion Project
Walnut Grower Interview Analysis
2002

Interviewer: P.W. Weddle, Senior Consultant, Walnut IPM Expansion Project Manager, Center for Agricultural Partnerships

Interviewer's comments on the interview instrument
Eight project grower cooperators were interviewed with the questions provided below. The interview was conducted face-to-face with each grower during June through August 2002. This interview took approximately 5-10 minutes to conduct, an amount of time that posed no time burden to the interviewer or interviewee. This interview could easily be given in the initial CAP contact with a grower.

CAP staff and consultants to determine relevance to the CAP process should critically analyze the results of this interview, i.e. did it provide the desired information? A comparative analysis with the Grower Survey should be also be conducted by individual(s) who skilled at survey methodology and analysis. A comparable "exit" interview should be developed.

Interviewer's summary findings and comments

75% of the growers interviewed were evenly divided on the factors most important to them when considering the use of new pest management tools. Reducing costs, increasing revenues and effectiveness of the new tools were the most important items to consider. Question 1 might be reworded to specifically characterize the "new" tool in question as one in which they have had "no previous experience".

Specific to the use of sprayable pheromones, most growers (63%) were primarily concerned about efficacy of the product. Longevity, i.e. the residual effectiveness was a primary concern of 25% of the respondents. This concern also relates to product "efficacy". Thus, "product efficacy" is a primary concern. Costs were mentioned as a secondary concern by 25% of the respondents.

In general, all but one grower suggested that periodic, in season damage assessments are the most desired information they need to help understand whether or not sprayable pheromones are working.

Grade sheets and the information they provide are the main things all interviewees said they needed after harvest to determine the effectiveness of sprayable pheromones. Two respondents stated they wanted to know their damage infestation by species.

Costs and grade sheets were almost equal in importance when growers considered trying to convince fellow growers to use sprayable pheromones. This suggests that when growers are talking to each other about using novel pest management tactics, costs and harvest damage results are the primary topics they discuss. If the terms "damage results", "grade sheets" and efficacy can be interpreted to be functionally related, his question seems to reinforce the previous questions because it repeats the primary importance of product efficacy and secondary importance of product costs.

5 of 8 respondents (63%) stated that, yield and damage being equal they would repeat the combination of sprayable pheromone acreage and conventionally sprayed acreage in the same ratio even if they determined the costs to be "somewhat higher" with the pheromone strategy. 3 interviewees (38%) said they would actually increase the acreage use of sprayables. This suggests that even with some increased level of expenditure, these growers are willing to continue building experience with sprayable pheromones. The fact that no grower mentioned neither returning exclusively to the traditional strategy nor changing completely to the sprayable strategy suggests a cautious willingness to explore new and promising pest management technologies.

6 of 8 respondents (75%) stated that they would repeat the combination of pest management strategies in the same ratio of acreage even if damage were slightly (1-2%) higher in the sprayable pheromone blocks. Only one grower would eliminate sprayables and another would actually increase the use of sprayables. This again suggests that these growers are progressive in their desire to explore promising new pest management strategies and tactics.

SUMMARY
CAP Walnut IPM Expansion Project
Walnut Consultant PCA Survey Analysis
2002

All 3 consultants have experienced damage in past 10 years. Damage ranged from 0.5 to 18%.

All consultants ranked last year's CM pressure, efficacy of current pesticides, seasonal trap data, potential impact of CM on grade, cost of sprayable pheromones and availability of sprayable pheromones as very important considerations in dealing with CM.

Consultants generally did not consider most of these to be very important influences on them. Family members of the farmers were very important to two of the three consultants.

Typically the consultant and the client make the CM treatment decisions.

The consultants stated that they always maintained orchard records.

Most of the consultants provide grade sheet follow up analysis with clients. Otherwise, assessments of drop nut counts; harvest damage samples and visual inspections were sometimes or often supplied.

To evaluate the effectiveness of sprayable pheromones growers need to know information on efficacy (photo degradation, rain fastness, field life), and understand economic feasibility as it relates to costs and damage.

Consultants believed that the best way to assist growers in adopting increased use of sprayable pheromones was to make them economically feasible and demonstrate through field experience in monitoring and damage evaluation that quality and yield will be preserved without increases in control costs. In other words, the value of pheromones beyond current conventional inputs for managing pests needs to be demonstrated.

Cost and availability of sprayable pheromones was unanimously ranked as a major barrier to adoption within the walnut industry. Most consultants believed the shortage of crop consultants with pheromone experience and an inadequate level of applied research on sprayables were major barriers. All consultants believed that impacts of weather on efficacy and the need for more biological information re. the use of sprayables were minor barriers.

All consultants responded that most of their clients do not know how to use pheromones and most do not use them. Most consultants believe in that the potential effectiveness of sprayable pheromones in controlling or reducing infestations is commercially viable.

All consultants responded that the grower's pest management expertise and skills nor those of their employees in executing pest control recommendations was never a barrier to pheromone adoption. Growers' budgets were either sometimes, often or always a barrier.

Consultants use a range of information sources when considering codling moth management. All consultants used university research publications, information from suppliers, and knowledge gained from special projects. None of the consultants used farm publications, CAPCA or agricultural television and radio.

All consultants spend between one third and two thirds of their time on walnuts.

Consultants advise on between 2 thousand and up to 20 thousand acres of walnuts

Consultants advised on between 20 and 75 different orchard operations.

Consultants were spread across the state's major walnut growing regions (by design)

All things being equal but costs, our cooperating consultants would typically use sprayables again but change the strategy to equalize the cost component.

If there were slightly more damage associated with sprayables and costs were equal consultants typically would apply pheromones on about the same acreage just to test the knowledge for another season. One consultant would increase the use but modify use to improve the results.

Appendix 10.
Pesticide Treatments

North Region

	Application date	Material	Rate/ac
Deseret Farms	17-Apr	3M MEC	15 g AI
Sligar Ranch- Ashleys	6-Jun	3M MEC	15 g AI
	26-Jul	Guthion	1.5# AI
Sligar Ranch-Chandlers	6-Jun	3M MEC	15 g AI
	26-Jul	Guthion	1.5# AI
Farmland Management	13-May	Asana	.05#AI
Wendt-Ahsleys	25-Apr	3M MEC/Suterra CM-F	15 g AI
	6-Jun	3M MEC/Suterra CM-F	15 g AI
	6-Jul	Penncap-M	.25# AI
Wendt-Serrs	13-May	Asana	.05# AI
	25-Apr	3M MEC	15 g AI
	6-Jun	3M MEC	15 g AI
	6-Jul	Penncap-M	.25# AI

Central Region

Chiappe Farms

Site: **Ashley/Chandler Block, Stanley Road**

Treatments:

Date(s)	Material(s), Rate(s)
4/23/2002	3M MEC, 20 g AI/A
6/12/2002	3M MEC, 20 g AI/A
7/31/2002	3M MEC, 20 g AI/A

Grower: **Locke Ranch**

Site: **F3 Chandler**

Treatments:

Date(s)	Material(s), Rate(s)
6/15/2002	Suterra CM-F, 20 g AI/A
7/25/2002	Suterra CM-F, 20 g AI/A

Grower: **Locke Ranch**

Site: **F20 Chandler**

Treatments:

Date(s)	Material(s), Rate(s)
6/15/2002	Suterra CM-F, 20 g AI/A
7/25/2002	Suterra CM-F, 20 g AI/A

Grower: **Terry Prichard**

Site: **Ashley/Chandler/Vina**

Treatments:

Date(s)	Material(s), Rate(s)
4/21/2002	Suterra CM-F, 10g AI/A (alt. row)
5/2/2002	Suterra CM-F, 10g AI/A (alt. row)
6/15/2002	Suterra CM-F, 20g AI/A (every row)
8/1/2002	Suterra CM-F, 20g AI/A (every row)
7/2/2002	Lorsban 4E, 2 lb AI/A (to Ashley/Chandler area only)

Grower: **Locke Ranch**

Grower: **Locke Ranch**

Site: **F4 Chandler**

Treatments:

Date(s)	Material(s), Rate(s)
6/15/2002	Suterra CM-F, 20 g AI/A
7/25/2002	Suterra CM-F, 20 g AI/A
8/1/2002	Lorsban 4E, 2 lb. AI/A
8/27/2002	Lorsban 4E, 2 lb. AI/A

Site: **F9 Serr**

Treatments:

Date(s)	Material(s), Rate(s)
5/1/2002	Suterra CM-F, 20 g AI/A
6/13/2002	Suterra CM-F, 20 g AI/A
7/24/2002	Suterra CM-F, 20 g AI/A
8/5/2002	Lorsban 4E, 2 lb AI/A

South Region

All Pheromone applications = 20 gms.AI/A
All Lorsban 4E applications = 2#AI/A
All Confirm applications = .25#AI/A

SANCHEZ
SERR WALNUTS
20 Acres
4/24-3M pher.
6/5-3M+Lor

BLAIN FARMING IVANHOE
4/11 - Lorsban

SOUTH TEHAMA M.D. WALNUTS
11.4 acres
5/1 - 3M pher.
5/28 - 3M pher.
7/3 - 3M pher.
8/22 - 3M pher.

BLAIN FARMING IVANHOE
6/17 - Conf/Lor

NORTH TEHAMA CONV. WALNUTS
12.9 acres

BLAIN FARMING IVANHOE
4/11 - Lorsban

SOUTH SERR M.D. WALNUTS
36.0 acres
5/1 - 3M pher.
5/28 - 3M pher.
7/3 - 3M pher.

BLAIN FARMING IVANHOE
6/17-Conf/Lor

NORTH SERR CONV. WALNUTS
25.2 acres
8/2-Confirm

BLAIN FARMING IVANHOE
4/11 - Lorsban

SOUTH TEHAMA M.D. WALNUTS
11.4 acres
5/1 - 3M pher.
5/28 - 3M pher.
7/3 - 3M pher.
8/22 - 3M pher.

BLAIN FARMING IVANHOE
4/11 - Lorsban

SOUTH ASHLEY M.D. WALNUTS
5/1 -3M pher.

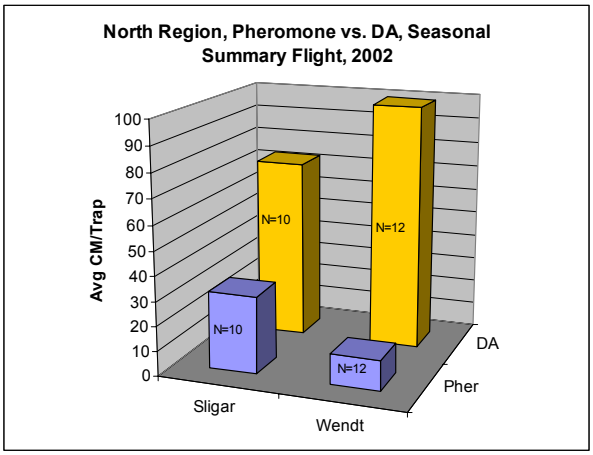
BLAIN FARMING IVANHOE
4/13 - Lorsban

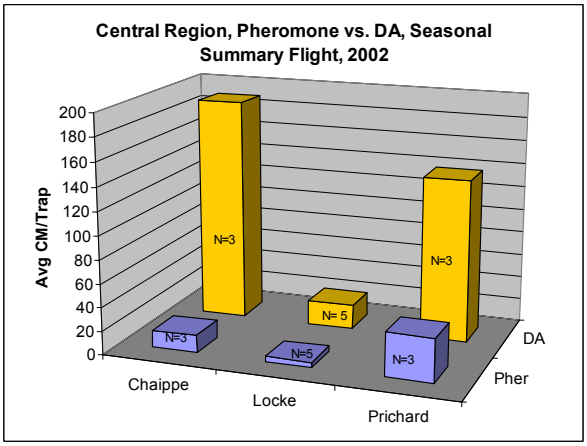
HARRELL COOPER RANCH
18 AC. CHANDLER
6/14-Confirm

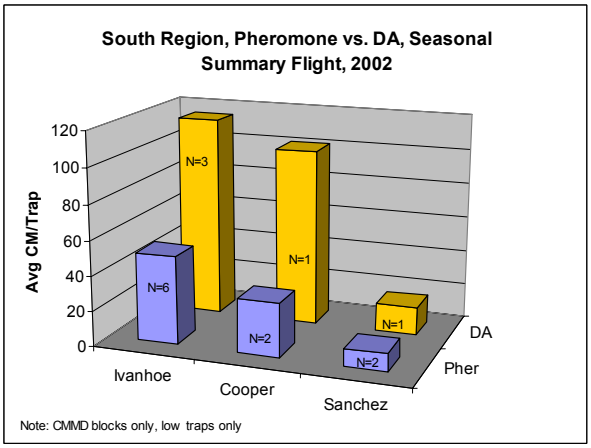
HARRELL COOPER RANCH
VINA
19.3 acres
4/12 - 3M pher. Applied
5/6 - 3M pher.
6/6 - Confirm/3M pher.
7/6 - 3M pher.
8/21 - 3M pher.

13.3 acres	5/28 - 3M pher. 7/3 -3M pher. 8/20-3M pher.

Appendix 11.
Individual Orchard Comparisons of DA vs. Pheromone Baited trap Captures

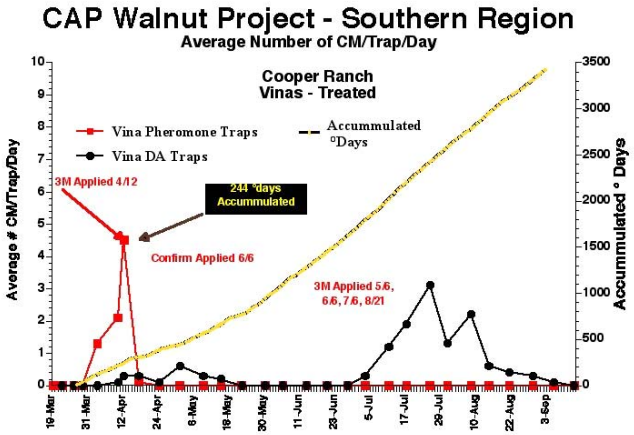


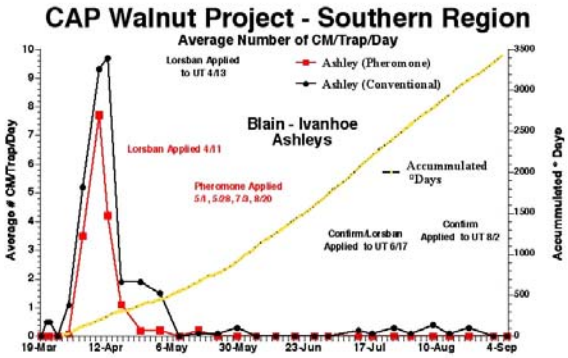


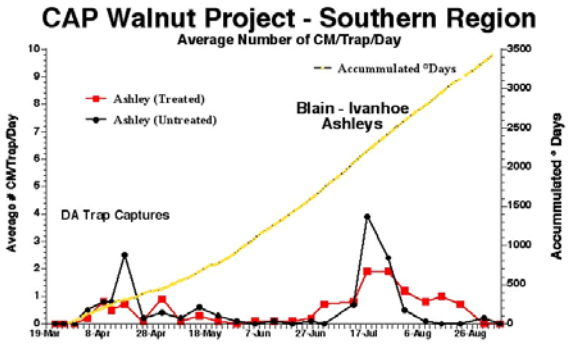


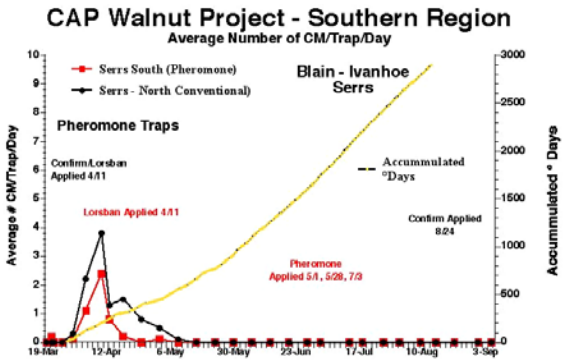
Appendix 12.
Graphs of Seasonal Trap Captures

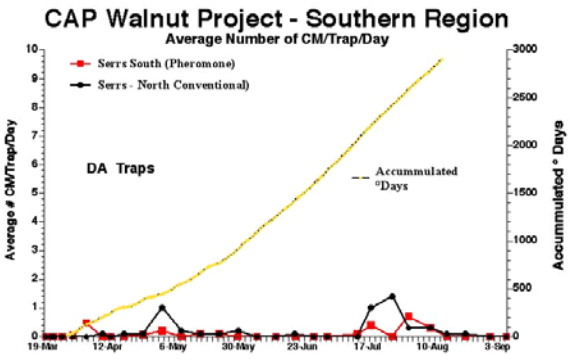
Southern Region











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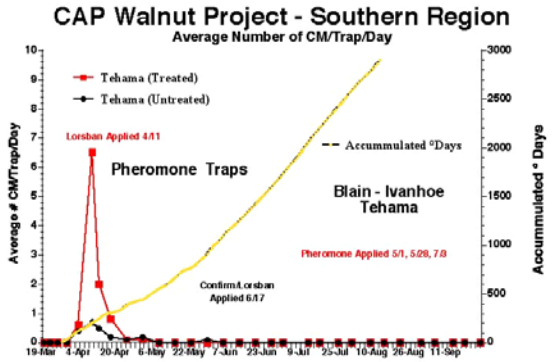
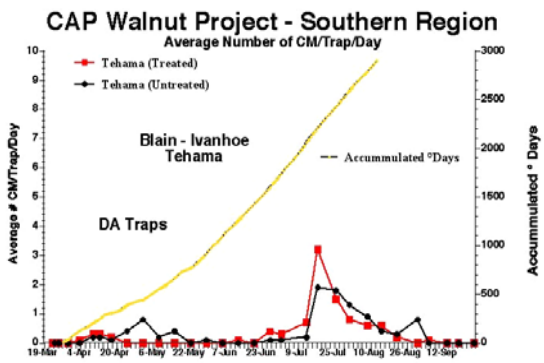
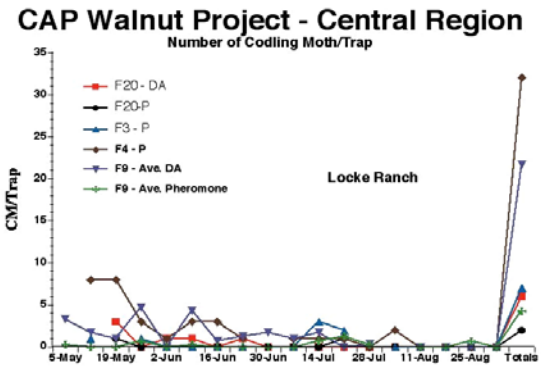
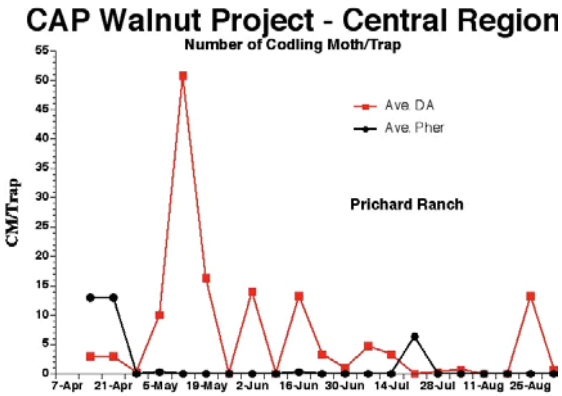
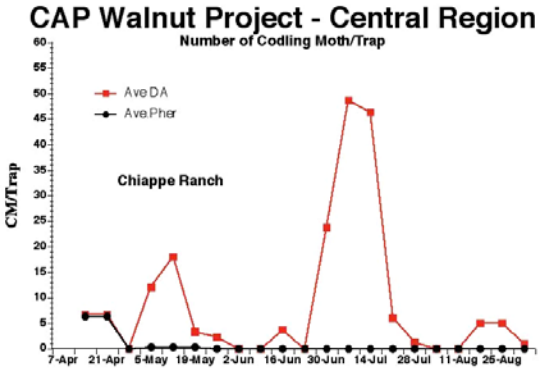




Central Region







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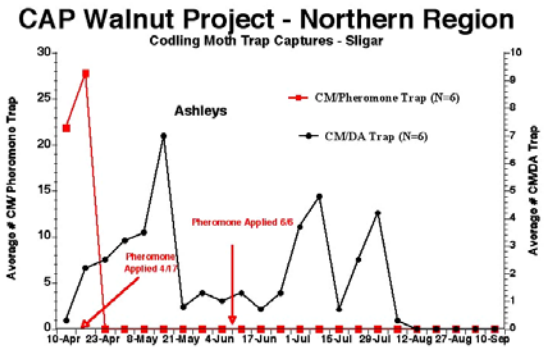
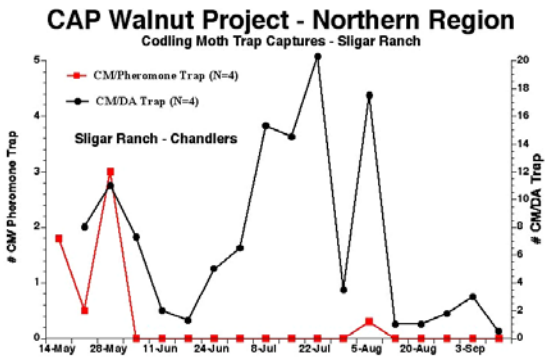
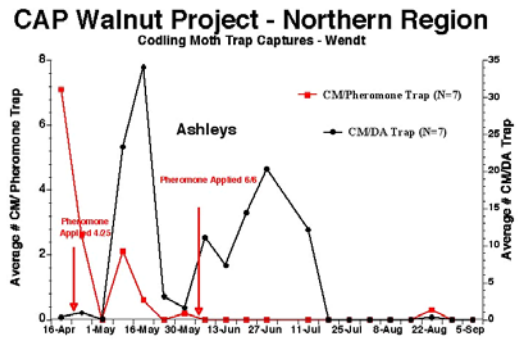
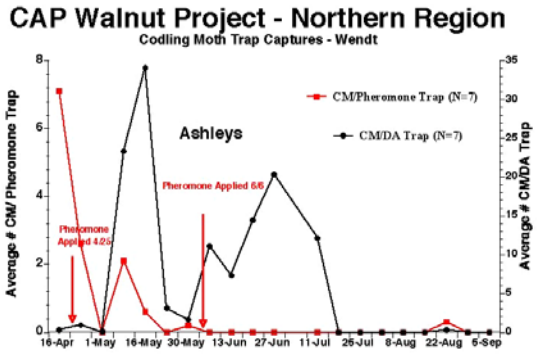
Northern Region









Appendix 13.
Table of Dropped Nut Evaluation Results

Dropped Nut Evaluations			CMMD			Comparison		
Region	**Date**	**Orchard**	**Variety**	**Avg/Tree**	**N**	**Variety**	**Avg/Tree**	**N**
South								
	15-May	Harrell	Vina		8	Chandler	0	8
	22-May	Harrell	Vina	1	8	Chandler	0.875	8
	30-May	Harrell	Vina	4.5	8	Chandler	2.5	8
	15-May	Blain	Ashley	0	8	Ashley	0.125	8
	22-May	Blain	Ashley	0.375	8	Ashley	0	8
	29-May	Blain	Ashley	0	8	Ashley	0	8
	3-Jun	Blain	Ashley	0.625	8	Ashley	0.5	8
	15-May	Blain	Serr	0	8	Serr	0	8
	22-May	Blain	Serr	0	8	Serr	0	8
	29-May	Blain	Serr	0	8	Serr	0	8
	3-Jun	Blain	Serr	0.625	8	Serr	4	8
	15-May	Blain	Tehama	0.125	8	Tehama	0	8
	22-May	Blain	Tehama	0.75	8	Tehama	2.75	8
	29-May	Blain	Tehama	0	8	Tehama	3.375	8
	3-Jun	Blain	Tehama	0.125	8	Tehama	5	8
Central								
	7-Jun	Chaippe	Ashley	1	10		NA	
	7-Jun	Prichard	Ashley	1.2	10		NA	
	11-Jun	Prichard	Ashley	2	5		NA	
North		Sligar						
	28-May		Ashley	1.5	10		NA	
	4-Jun		Ashley	5.1	10		NA	
		Wendt						
	6-Jun	block 3	Ashley	0.2	10		NA	
		block 3	Ashley	1.2	10		NA	
		block 6	Ashley	0.3	10		NA	
		block 7	Serr	0	10		NA	

Appendix 14. Canopy Count Damaged Nut Evaluations

Central Region **Canopy Counts**

Chappie

Visual from ground by Devencenzi:

Date	Variety	No. nuts inspected	% CM Damage
6/7/2002	Ashley	600	0.50%
7/9/2002	Ashley	600	0.50%
7/17/2002	Ashley	600	0.30%
7/23/2002	Ashley	150 (E)	1.30%
	Ashley	150 (M)	0.60%
8/7/2002	Ashley	100 (E)	3.00%
	Ashley	100 (M)	0.00%
	Ashley	100 (W)	0%
8/20/2002	Ashley	100 (E)	1%
	Ashley	100 (M)	0%
	Ashley	100 (W)	0%

Using pruning tower by Devencenzi:

Date	Treatment		No. nuts inspected	% CM Damage
6/11/2002	Ashley	3M MEC, 20 g AI/A	1400	0.20%
	Chandler		300	0.30%
7/29/2002	Ashley & Chandler	3M MEC, 20 g AI/A	1300	0%

Locke F3 Chandler

Visual from ground by Devencenzi:

Date	Treatment	No. nuts inspected	% CM Damage
6/5/2002	Suterra CM-F	200	0%
7/19/2002	Suterra CM-F	200	0.50%
7/24/2002	Suterra CM-F	100	0%
8/22/2002	Suterra CM-F	1100	0.30%

Locke F 20 Chandler

Visual from ground by Devencenzi:

Date	Treatment	No. nuts inspected	% CM Damage
6/5/2002	Suterra CM-F, 20 g AI/A	100-200	0%
7/24/2002	Suterra CM-F, 20 g AI/A	100	1.00%
8/22/2002	Suterra CM-F, 20 g AI/A	1200	0.10%

Locke F4 Chandler

Visual from ground by Devencenzi:

Date	Treatment	No. nuts inspected	% CM Damage
6/10/2002	Suterra CM-F	400	0%

Using pruning tower by Devencenzi:

Date	Treatment	No. nuts inspected	% CM Damage
8/22/2002	Suterra CM-F, 20 g AI/A	600	5.50%

Locke F9 Serr

Using pruning tower by Devencenzi:

Date	Treatment	No. nuts / no. trees inspected	% CM Damage
6/18/2002	Suterra CM-F, 20 g AI/A	300/ 6	0.30%
8/22/2002	Suterra CM-F, 20 g AI/A	600/ 6	4.30%

Prichard

Visual fron

Date	Varie
6/7/2002	Ashl
6/11/2002	Ashl
	Vin
7/9/2002	Ashl
7/17/2002	Ashl
	Vin
7/23/2002	Ashl
	Ashl
	Ashl
	Vin
7/31/2002	Ashl
	Ashl
	Ashl
	Vin
8/6/2002	Ashl
	Ashl
	Vin
8/27/2002	Ashl
	Ashl
	Ashl

Using prun

Date	Vari
6/14/2002	Ash
	Chan
	Vir
8/8/2002	Ash
	Vir
	Chan

South Region

RANCH: HARRELL COOPER RANCH

DATE	VINA M.D.	M.D. %	CHAND CONV	CONV %	TOTAL	Avg. % Inf. Nuts
19-Jun	2	0.0025	2	0.0025	4	0.0025
30-Aug	5	0.00625	1	0.00125	6	0.00375
14-Aug	8	0.01	4	0.005	12	0.0075
21-Aug	7	0.00875	6	0.0075	13	0.008125
		0		0	0	0
		0		0	0	0
Total	22	0.0275	13	0.01625	35	0.021875

RANCH: SANCHEZ RANCH

DATE	TOTAL	Infe C nu
26-Jun	0	
31-Jul	2	0.
14-Aug	0	

Notes:

6/19 - Infested nuts in the canopy from the first generation.

RANCH: BLAIN FARMING IVANHOE

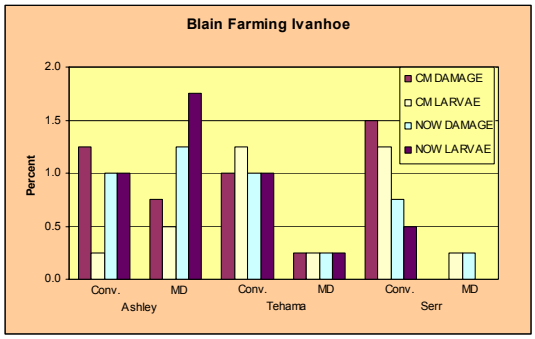
DATE	N. Ash Conv.	N. Ash %	S. Ash M.D.	S. Ash %	N.Serr Conv.	N.Serr %	S.Serr M.D.	S.Serr %	N.Teha Conv.	N.Teha %	S.T M
19-Jun	5	0.00625	4	0.005	5	0.00625	0	0	0	0	
30-Jul	10	0.0125	8	0.01	7	0.00875	0	0	3	0.00375	
14-Aug	17	0.02125	14	0.0175	14	0.0175	2	0.0025	3	0.00375	
21-Aug		0	8	0.01		0	5	0.00625		0	
		0		0		0		0		0	
		0		0		0		0		0	
		0		0		0		0		0	
TOTAL	32	0.04	34	0.0425	26	0.0325	7	0.00875	6	0.0075	

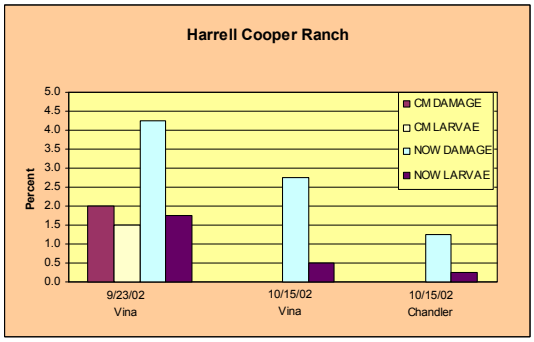
Notes:

6/19 - Counts reflect first generation nut infestation.
8/21- Counted nuts in mating disruption blocks only

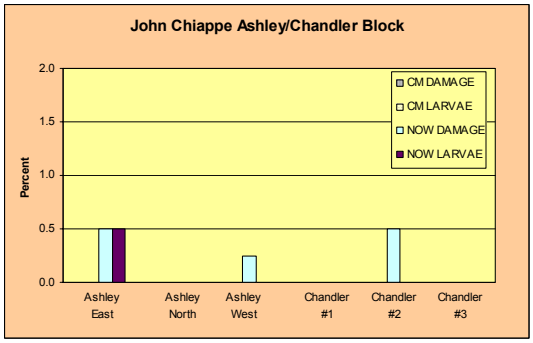
Appendix 15. Results of Certis' Harvest Damage Evaluation

South Region:

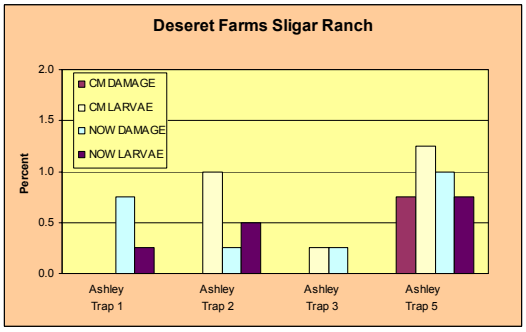


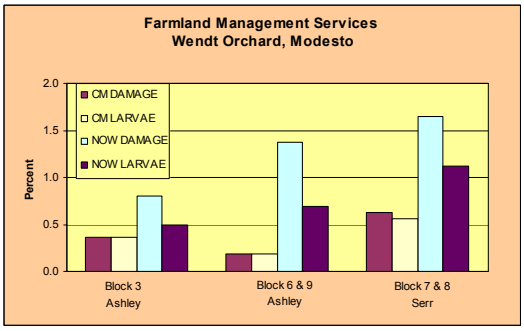


Central Region:



North Region:





Appendix 16.
Results of End of Season Wrap up Meeting

November 5th CAP Walnut Wrap-up Meeting
Notes on Focus Group Session

Attendees:

Larry Elworth, Pat Weddle, Steve Wulfert, Joe Grant, Steve Sibbett, John Post, Mike Devencenzi, Jim Stewart, Judy Stewart-Leslie, Don Thomson, Dave Ramos

Facilitator:

Jennifer Scherer

Preface

On March 14, 2002, prior to the beginning of the walnut growing season, the core team of cooperators in the Center for Agricultural Partnership's (CAP), Walnut IPM Expansion Project (WIPMEP) met for 4 hours as a focus group to develop a work plan for conducting the field component and evaluation of the project in its pilot year. The meeting was conducted by a facilitator and participant responses documented in the form of a project work plan.

On November 5, 2002, at end of the growing season, a second meeting of these participants was held to discuss the results of that work plan. The following documentation represents the results of that 4 hour meeting. Participants included the CAP executive, the project manager, all 3 regional project coordinators, all 4 regional pest management consultant cooperators, a representative of the Walnut Marketing Board and a project technical consultant. The facilitator, with support from CAP staff, asked questions and solicited comments from the regional coordinators and consultants. The responses and comments were recorded and are annotated herein.

November 5, 2002 Meeting Summary

<u>Overview</u>
Participants were unanimously agreed that the project work provided a unique opportunity to experience the use of sprayable pheromones and kairomone lure technologies in a practical, field implementation setting. "Networking" with their fellow project cooperators was viewed as a significant benefit to cooperation. Participants wanted more streamlined inter-project communication of real time information. The availability of donated pheromone and trapping products was a substantial incentive to grower cooperators and supported the project crop consultants' efforts to try the products in the field. The project accomplished most of the work as outlined in the March 14th meeting. Participants wanted the project to continue in 2003 with emphasis on improving information transfer, monitoring efficiencies and incorporating strategies that would demonstrate the potential value added contribution of mating disruption.

<u>Sprayable Pheromones</u>

Participants believe that sprayable pheromones for codling moth mating disruption (CMMD) need to be explored as a component of a multi-tactic walnut pest management. Currently, the cost of sprayable pheromone products is a major limiting factor to their commercial implementation. Cooperators' work with pheromones this year did not provide sufficient experience or insight into product efficacy to warrant expanded pheromone use in 2003. However, participants want to continue to examine sprayables in future seasons to learn what advantages, if any, they might contribute.

DA Lure

Codling moth traps baited with DA lures significantly outcaptured pheromone traps in pheromone treated orchards. Consequently, cooperator experience with the DA lure has compelled the crop consultants to further pursue their use of DA lures. It was unanimously agreed that more needs to be known about how this technology will fit into walnut pest monitoring. In addition, consultants agreed that periodic nut damage assessments were important to the decision making process and, though added work and time are required, would be important components to incorporate when using pheromones and the DA lure.

Discussion about Economic Variables

Value of Product Donations

- Donation of product made costs more difficult to capture.
- Product contributions allowed for more applications and incentives to experience.

Application Costs

- Application costs based on commercial applicator prices. Cost of monitoring additional to conventional program.

Monitoring Costs

- Using DA was investment in future.
- Attendees believed they needed to conduct much more monitoring in the pheromone program.
- There was extra cost in the sprayable blocks. Devencenzi said it cost much more because he used more traps and they took more time to service. Also, canopy counts from towers were big time consumer.
- Post said he probably spent the same amount of time. John said it didn't cost much more in time though more traps would cost more. He stated that he spends a lot of time in the orchards anyway and conducts the same monitoring in his other orchards as he did in project blocks.
- There was no out of pocket cost for traps as they were all donated. Cooperators stated that they don't know yet how to use DA. Until they know how effective these traps are it is hard to assess their value.

Cost of controlling secondary pests

- Aphid populations were high in some of Mike's orchards. He had to treat for aphids and husk fly which negated some benefits. Stewart, no secondary pest issues. No secondary problems for Post.

(Note: Jennifer asked the question; "Did we collect the variables we outlined in the work plan?" Cooperators stated that, in general, the answer was yes. However, they said that some of the damage assessment work was not needed)

Miscellaneous Discussion on Costs and Damage Assessments

Post stated that the cost of pheromone application and cost of damage are important economic considerations.

Mike D. said the cost of monitoring will be an important variable in marketing sprayable pheromones.

Judy said the cost of monitoring is very important and that, based on this years experience, she would charge differently for MD vs. conventional. At current fee structures, they can't afford the extra monitoring. Current monitoring requirements may be way too costly for chemical company sales rep.

Question from Jennifer:

Do we have the information needed to determine future costs? All said "NO". Cooperators unanimously agreed that this seasons experience was not enough to understand the potential role of the target technologies in their crop protection programs.

Are there more training needs? There is no recipe for how to use sprayables. There has been no trialable program. Sprayables did not work as well as expected in 2 "volatile" spots (Post?). Some were finding damage 1 month after application. Technology may only work where there are low populations. Knowing population level is a key.

Field assessments of pheromone efficacy were "gut level". There is still a level of discomfort re. where this technology has value. Judy wishes she would have periodically collected canopy nuts and cracked them out to determine what worms were present.

Canopy counts were conducted by all consultant cooperators. Only Mike and Judy documented these counts. Mike did canopy counts from ground and tower. Others did canopy assessments by ground only. Diamond harvest damage results did not correlate with cooperators' canopy counts. There are various opportunities for visible worm damage on trees to go undetected in harvest samples. In addition, canopy counts can be very time consuming. Cooperators are doing all these canopy counts to get "physically closer" to the pest so as to make better decisions. Mike likes the tower but regardless, everything is after the fact. In other words, one doesn't know there is a problem until damage shows. DA trap counts are variable and cooperators really don't know what they mean.

Real time data was not readily available project-wide. This task might be better accomplished with better computer equipment and a dedicated data manager. More opportunity to communicate project data or discussion over the computer was suggested. Specifically, e-mailing updates or using a list server might have worked well. Post said he would simply have benefited from hearing about others experiences more frequently. Some project wide knowledge in real time about DA lures would be helpful. However, for decision making purposes, data is often hindsight. Even if available in summary, availability occurs after decisions have been made. Don Thomson's hands on, one to one meetings with cooperators was beneficial. Don's inputs provided a comfort level to Judy re. what she was doing in the field. Some data may be

helpful but it can be overwhelming, especially when things are busy in the field. A little chat room or mini newsflash by e-mail was suggested. More informal communication was needed.

When asked how the cooperators might go about "educating" others about the new technologies Judy said she couldn't educate on something she didn't know about. Others agreed.

Mechanisms to deal with failures;

Guthion was discussed in its role as a "rescue treatment" to reduce otherwise increasing populations of CM. Post stated that he had mixed results with Guthion probably due to resistance. All pheromone blocks had to be sprayed out and John didn't get the pest suppression he wanted.

Wulfert thinks the chemical companies will target initial sprayable pheromone sales in Chandler cultivar orchards because Chandlers don't have a lot of CM pressure and success is more easily obtained in Chandlers. Once Chandler acreage is exhausted, control problems will likely occur in other varieties. Company PCA's will initially work in low pressure orchards to ensure both sales and success.

There currently is no single person who can train PCAs in pheromone use in walnuts.

Relative advantage of sprayable pheromones.

John was satisfied that pheromones do a good job on low to moderate populations. On other moderate to high populations he was dissatisfied with the results. John saw a lot of visual evidence of successful mating soon the application of MD. In past years it was hard to find damage under the same scenarios as this year. This year, there was worm infestations occurring within the time that CMMD should have been working. In past years, in pheromone blocks the worms had a harder time successfully infesting compared to conventional blocks.

Was there any difference between Suterra and 3M products? Post said up until this year the only failure he experienced with sprayables was with Suterra. This year he found both performed similarly. Mike D couldn't say definitively. Mike had successes and failures with both products. Cooperator use of sprayables was a function of how much contributed product was available. Mike applied more Suterra because he got more free product.

Based on field trials Don doesn't think there is much difference between the two products. Welter will have more data this winter. Judd has some data showing better trap shut down with 3M (?).

Jim Stewart thought sprayables were particularly successful in his small isolated 25 acre orchard. That cooperator sprayed pheromone in April and May prior to applying Lorsban for a non-existent red humped caterpillar population (grower had red hump last year so sprayed prophylactically this year). This grower used puffers in 2001 after having suffered heavy losses (35%) to CM in 2000. So pheromone applications appear to have provided a population suppression advantage. Diamond damage results were better than the DFA results conducted by Certis. Last year's grades were mostly class 2 vs. class 1 grade this year. Cooperator is happy.

Perhaps there is added advantage the second year of pheromone use. Is there a long term population management benefit?

John used sprayables mostly in year one orchards. Where he had 2 years of pheromone use populations in those orchards were low to moderate prior to using pheromones. Thus, he could not say that there was a relative advantage this year where he used pheromones.

Mike said no, he could not determine any relative advantage. Mike's question was; will cost reduce or eliminate relative advantage? Best success with CMMD was downwind of the PMA project where pheromones may have migrated. Field results this year were highly variable, ambiguous and inconclusive. More experience with technologies is needed.

Mike stated that if pheromone product was priced properly and there was better monitoring efficiencies there might be some relative advantage. He noted, however, that one year not enough time to critically evaluate the technology. Big, shady walnut blocks might provide an advantage to sprayable pheromones compared to blocks which have more open canopies due to UV protection. There may be more relative advantage in blocks where conventional programs are not working anymore due to resistance. Resistance may impart more relative advantage. Some growers are starting to rely more heavily on Penncap-M. Thus, there may be some long term advantage to pheromone use but this is currently not certain. In those few walnut orchards where there has been 3-4 years of walnut CMMD, growers say they don't have a problem anymore. However, this information is strictly anecdotal.

Compatibility: How do sprayable pheromones fit into current practices?

Sprayables are user friendly and compatible with grower practices. Judy says the pheromones are more risky and more work for the PCA. One cooperating grower really liked spraying the pheromones because he could travel through the orchard very fast and complete the job quickly compared to conventional, coverage intensive sprays. However, another cooperator is sensitive to nearby neighbors concerns and is reluctant to use his sprayer.

Complexity—how difficult is it to learn to use?

The results so far are not consistent and not dependable. There are too many unknowns. Spray decision points for sprayable pheromones are not known. The relationship of monitoring to making decisions is unknown. Complexity is high as measured by these factors.

Trialability:

When asked if it would be easy to revert to old practices the answer was "yes". Is it easy to recover from mistakes or correct mistakes? Mike: By the time he decided to spray it may have been too late. The spray decisions were always made after damage was detected. Once damage was seen the tendency was to revert to conventional practices. Thus, it is difficult to try pheromones.

Observability:

Attendees believed that observability, trialability and complexity were interrelated.

Miscellaneous Comments:

Growers are more willing to take a risk on something that is cheap vs. expensive to use. The current cost of sprayable pheromones is big disincentive.

The only advantage to currently working with sprayables is in learning how to use them in the event they will someday be needed. Because pheromones must be applied prophylactically, it is hard to know if the money spent was really necessary. John had people who sprayed pheromones and with the benefit of hindsight, really didn't need to.

The relevant question needs to be asked; "In low population orchards when do I need to spend the money on pheromones and when can I skip this expenditure?" Until growers have no other alternative they won't want to spend the dollars on pheromones as long as an array of cheap conventional alternatives is available and work.

Factors impacting future use considerations:

Currently sprayables are not cost effective relative to other pest management conventions. Provision of donated pheromones encourages learning. Donated material will increase use. Otherwise, the technology is too premature for much expanded use. It is important to learn how to use sprayable pheromones in walnuts but the recent experience suggests that the out of pocket costs to learn are a strong disincentive.

There may be two implementation scenarios; one if products must be purchased, and one if products are donated.

Pheromone puffers or mops are cheaper than sprayable pheromones and at least equally effective based on preliminary results.

Price of MD has to be able to at least compete with Confirm. Cost should be no more than half of current costs.

Good arsenal for a few years with conventional pesticides.

Thomson on pheromone costs: Regarding prices for CMMD products; the cost of technical pheromone used in all formulations is not going down significantly in the near future. Technical pheromone is the most expensive component in all the CMMD formulations. Thus, the cost to growers of formulated products will not likely decrease in near term (2-4 years.

What will you do next year?

Jim Stewart and Judy Stewart-Leslie will each do one full cost sprayable program in a client orchard. They may conduct a second sprayable trial if there is donated material. Judy wants to be able to use pheromones in the future. She just wants to be able to assess the risks and address economics better.

Mike D. said that there is a lot of interest among growers in sprayable pheromones. His future examination would depend on cost and the amount of donated product. Mike says the need to monitor is critical. He believes there needs to be research on monitoring. Research isn't going to be done at a dollar cost to growers. PCAs and growers need to learn how to use the pheromones and the monitoring systems. Mike would concentrate efforts on one ranch. Welter would be the person to coordinate research on the relationship of DA lures to pheromone MD environment.

John will probably look at about the same level of examination on the same acreage.

Steve Wulfert: The overall crop of walnuts this year graded out at a one percentage point higher class this year vs. last. No one got seriously "burned" this year. CM damage has been relatively low so it will be hard to evaluate if pheromones have any value. If we had a year with higher worm pressure it could make a difference in the relative results of pheromone use and demonstrate added value?

The comment was made by some that they had a relatively easy year with CM this year and still had trouble with the sprayable products. Maybe the research emphasis should be on monitoring systems in CMMD orchards. We really don't know how to use DA. There is no need to use pheromone traps in MD orchards. The comment was made that pheromone traps in disrupted orchards are "worthless" based on this year's experience. All said that they want to do project another year. Communication with Don helped. It would be a mistake to break the continuity established by the project.

PMA and WIPMEP may be "merging. Dave believes there should be a more coordinated effort between the two projects. People tied to PMA can address many of the questions raised in this meeting, especially Doug Light and Steve Welter.

Learning how to use pheromone traps in tree fruit and walnuts took a long time. Learning how to use DA traps will also require time.

Walnut people don't have to move into this right away unlike the Randall Isl. Pear Project. Pear growers were facing a crisis with CM control due to resistance. This is not the case in walnuts. Walnut growers still have Lorsban, Guthion and Penncap-M, relatively inexpensive and effective products for CM control.

Joe Grant: The CAP project should exercise close cooperation with companies selling MD products to growers. Those growers should be project cooperators. PCAs who are working with growers could also work with project regional coordinators.

Don thinks the project should actually shrink with less acreage involved. He suggested a more focused project. He did not recommend attempting season long pheromone strategy due to costs. Rather, he suggested doing early season MD applications then follow through with conventional control strategies. Success still comes down to how extensive one plans to monitor.

Jim S. thinks consultants need to examine CMMD in more than one block (contrary to Mike D).

Dave Ramos believes that what we have done here is provide a commercial bottom line for implementation. The project has reinforced this bottom line. There are things that need to be addressed. Serious things such as costs and monitoring. Project scope should not be restricted too much. Growers typically gravitate to this stuff, i.e. new and promising technologies?
Any use of sprayables should be under careful scrutiny of consultants. We do not want growers having failures with no answers as to why.

QQ. Are there any circumstances where you would categorically use sprayable MD?

John wants to continue to "play with it".
This year's work got consultants asking questions.
If economics were not an issue folks would embrace pheromones more readily.

QQ. Would it be possible or advisable to develop some guidelines based on what we did this year?
The message for industry is "do not try at home, for professional use only"—Wulfert
There needs to be some minimum scouting protocols
The CAP project could develop the guidelines.
Write this meeting up as a consensus of core team.
We could get the message out in terms of what questions the growers need to ask.—Wulfert
This is similar to the BIFS project.

Field level in 2003:

1. Figure out monitoring and

2. Develop some strategies for field use. Important to communicate more often.

Dave cautions to keep in mind that there are 2 parallel programs. The Walnut PMA was originally interested in education and implementation. Due to circumstances, the Walnut PMA has been research focused. PMA year 1 was a "looser" because the program to be implemented didn't work. Then the program switched to research. There still remain too many researchable questions. The Walnut PMA is trying to move beyond research. WIPMEP and Walnut PMA programs are complementary. PMA was never equipped to do implementation on a commercial scale. Growers are going to be hit by multiple sources of information from multiple directions. This information has to have continuity and WIPMEP needs to cooperate with PMA to accomplish that continuity. Growers are getting more skeptical about the PMA and their research expenditures into CM management. They are saying a lot of dollars have been spent on reduced risk efforts with little to show for it. We need to put a positive spin on this work and be cautious with how we present it to growers. Dave thinks the 2 programs are intertwined. PMA has mostly been a Sacramento valley effort. WIPMEP moved progress further south geographically.

Sibbett wants to continue to "fiddle around" with the technology.

We need to choose more clear monitoring strategy. The DA is a potential tool along with canopy counts and dropped nut counts.

Block by block data from all regions should be collected and provided to all cooperators.

Respectfully Submitted:

Pat Weddle
Project Manager
Center for Agricultural Partnerships
Walnut IPM Project

Appendix 17. Cost Benefit Analysis Worksheet

Pest Management Cost and Benefit Worksheet for Walnuts*

[See accompanying instruction sheet]

Yields

Total Acreage Harvested = **A** _____Acres

Total Tons Harvested = **B** _____Tons

Tons per acre (B/A=C) = **C** _____ **Tons per acre**

Input Costs **(include materials and application)**

Codling moth

Mating disruption $_____ per acre

Other CM insecticides **$_____ per acre**

Sub Total **D $_____ per acre**

Husk-fly insecticides **E $_____ per acre**

Other insecticides **F $_____ per acre**

Miticides **G $_____ per acre**

Percent Damage (from grade sheets or other harvest damage assessments)

	% Damage
Codling moth	**H**
Husk-fly	**I**
Other insects	**J**
Mites	**K**

Crop Value

(FOB price per ton) $_____

X (Tons per acre) = $_____

Total crop value

(FOB x Tons/ac) **L $_____per acre**

Per Acre Losses

Codling moth	**[L – (H x L)]**
Husk-fly	**[L – (I x L)]**
Other insects	**[L – (J x L)]**
Mites	**[L – (K x L)]**
Total (M)	Sum of above

Net Revenue

Net $$ Per acre	
Crop Value (L) minus Per Acre Losses (M)	
= **Net $$ per acre $_____**	

*to calculate net revenue after arthropod pest management costs and damage losses only

Instruction Sheet for Worksheet

Introduction

Extensive economic analysis obtained from CAMP programs in Washington apples, Michigan apples and Yakima pears has shown that the cost of pest management inputs alone is not necessarily a good measure of the potential or actual benefits associated with those costs. Often, increases in input costs result in disproportional higher net revenues. The cheapest pest management program is not necessarily the most profitable program. This form is adapted for walnuts based on a similar worksheet developed for pears

Purpose

The purpose of this worksheet is to assist growers and pest control advisors in calculating the approximate value of their crop protection investment. In order to keep the worksheet simple factors such as monitoring costs have not been included. The user can, however, include these costs if desired. The net revenue calculated only considers pest management inputs and does not provide comprehensive net revenue.

How to use this worksheet

Use one sheet for each block, treatment or orchard for which the desired net revenue calculation related to your crop protection investment is desired. For example, if you have a block in mating disruption or other reduced risk program and a block in a more conventional, chemically intensive program, use two worksheets and compare the net revenue results.

The user needs to know the following for each block to be analyzed:

1. Acreage of block
2. Tonnage yield of block
3. Input costs for crop protection inputs. Ideally this could be broken out according to which pests the insecticides were targeted against i.e., codling moth, leaf rollers, psylla and mites. You may wish to include application cost for a more realistic calculation. If a given product is used for two pests (i.e. one chemical for both mites and psylla) divide the cost proportionally according to your estimate of the proportional importance of the input to your pest management
4. Percent damage attributed to codling moth, walnut husk-fly, other insects and mites. You may request some of this information from your processor. You may need to conduct your own harvest samples and record the damage from each pest category
5. Price per ton or an equivalent value of the nuts
6.

This is all you need to calculate a reasonable approximation of the true net revenue value of your crop protection investment.

You can print out the worksheet, fill in the boxes and do the simple mathematical calculations.

Appendix 18

CULTURAL TIPS

New IPM Implementation Project Initiated in California Walnut Orchards

By Steve Wulfert and Pat Weddle

Steve Wulfert

Codling moth has been a serious pest of walnuts in California for as long as the crop has been grown in the state. While some varieties are more susceptible than others, all varieties can be damaged when conditions are favorable for codling moth development.

Historically, growers have relied on chemical sprays to control this pest. Over the years, chemicals such as nicotine sulfate, lead arsenate, DDT, organophosphates and carbamates have been used to control codling moth in walnuts. As each of these materials was used, codling moth either became more tolerant of its use and efficacy was lost or the chemical was removed from the market because of environmental or worker safety concerns.

Codling moth resistance to many of the organophosphate insecticides used in walnuts has been demonstrated. This resistance has been shown to cross over to some insecticides not yet registered for codling moth such as certain insect growth regulators (IGRs).

Relentless regulatory pressure against the use of organophosphates important to walnut pest management continues. Recently, US-EPA proposed a four-year phaseout of azinphosmethyl (Guthion®) in walnuts. Further regulatory actions are likely. Consequently, walnut growers will be availing themselves of new pesticidal technologies including mating disruption for codling moth.

IPM Strategies

Integrated Pest Management (IPM) strategies have included the research and testing of several nonchemical interventions to control codling moth, including mating disruption techniques. Mating disruption relies upon the same codling moth pheromone that growers have used for the past three decades to detect and monitor codling moth activity in their orchards. Using a small dose of the pheromone in a sticky trap enables growers to attract and capture male codling moths in their orchards. This knowledge of codling moth flight activity provides a decision-making tool for the necessity and timing of chemical sprays. Rather than applying long-residual cover sprays, the grower can target peak flight activity.

Mating Disruption

In California, control of codling moth with pheromone mating disruption began in the early 1990s on apples and pears. Growers were experiencing increasing difficulties managing codling moth in their orchards due to emerging resistance to organophosphates. By the late '90s mating disruption was being successfully used on approximately 20% of California pear acreage. In 2000, 95% of the pear acreage in the state's largest pear-growing region, the Sacramento–San Joaquin Delta, managed codling moth by using pheromones supplemented with conventional insecticides.

Currently there are several formulations of mating disruption products that are or soon will be commercially available for walnut. Isomate C+® from Pacific Biocontrol Ltd. is a "twist tie" hand-applied formulation that is widely used in tree fruit. This formulation must be placed in the tops of trees for optimum effectiveness. 3M Canada is developing and Suterra

HOT LINKS

www.ipm.ucdavis.edu for a wealth of information on walnut pests and pest management

www.trece.com for information on ordering a wide variety of pest-monitoring traps and other tools

www.agcenter.org for the Center for Agricultural Partnerships, a nonprofit organization whose mission is to help working farmers improve productivity and profitability

Ltd. (formerly Consep) is currently providing sprayable formulations of mating disruption materials that can be applied with conventional spray equipment. 3M expects to have registration of its sprayable mating disruption product in 2002. In addition, Suterra also has a "puffer" formulation available.

New Lure Catches Both Male *and* Female Codling Moths

During the past two years, Trece, Inc., a Salinas, Calif. company specializing in insect monitoring products, in conjunction with Drs. Doug Light and Allen Knight of the USDA-ARS, have developed a codling moth attractant that is based on a "kairomone" or host-plant attractant rather than a pheromone or sexual attractant. This new lure, the "DA lure," will provide walnut growers with an effective tool to monitor codling moth in traps where pheromone-mediated mating disruption would otherwise compete with the typically used pheromone-baited codling moth trap. In addition, the DA lure captures both male and female codling moths, allowing the pest manager to further refine spray timing.

The Walnut Pest Management Alliance Project (PMA)

The Walnut Pest Management Alliance (PMA), a research and field demonstration project jointly supported by the Walnut Marketing Board, UC Cooperative Extension, UC-Berkeley, USDA-ARS and the California Department of Pesticide Regulation, has shown much promise for the use of mating disruption as an economically viable tool in the management of codling moth. Additionally, the PMA has demonstrated the viability of the DA lure as an effective monitoring tool in disrupted orchards. As the Walnut PMA enters its fifth year, many involved have expressed interest in providing its benefits to more walnut growers by expanding commercial implementation of PMA findings.

The Walnut IPM Expansion Project (WIPMEP)

A project to expand implementation of new pest management technologies in California walnuts has recently been initiated by the Center for Agricultural Partnerships (CAP). Dubbed the California Walnut IPM Expansion Project, CAP, in close cooperation with pest control consultants and their grower-clients, will be conducting "ground-up" orchard-based implementation of new pest management technologies emphasizing the use of mating disruption for codling moth and adoption of new monitoring strategies such as the DA lure. Specifically, the project will support walnut PCAs and their growers to optimize their commercial use of these new technologies in their individual orchards.

CAP's walnut implementation project will work with key growers and their pest control consultants throughout California to understand their specific pest management needs and customize PMA findings to meet these needs. This will be done by applying a proven process of:

- understanding growers' needs;
- learning what growers require to implement new technologies;
- understanding how pest management decisions are made;
- gathering the information necessary to support the desired change;
- measuring progress in real time;
- providing a constant flow of information between and among growers; and
- evaluating what works and what doesn't while adapting to the constantly changing farm environment.

The initial project will encompass about 1,000 commercial walnut acres throughout the state. Once the implementation process is tested and refined on this initial acreage, the project will expand to at least 25,000 acres in subsequent years.

CAP, in cooperation with Weddle, Hansen and Associates, Inc., a California-based agricultural consulting firm specializing in orchard implementation of IPM, will manage WIPMEP. Currently, three well-known walnut experts have agreed to serve as the WIPMEP's regional coordinators: Steve Wulfert of Diamond of California in the Sacramento Valley; Joe Grant of UC Cooperative Extension in the northern San Joaquin Valley; and Steve Sibbett, UC Cooperative Extension Emeritus in the southern San Joaquin Valley. These regional coordinators will identify key grower and PCA cooperators who will be the core of the implementation effort. In addition, the coordinators' expertise is providing important insight and guidance for CAP's

continued on next page

Annual Tri-County Walnut Day

Thursday, Feb. 7, 2002
Visalia Holiday Inn

Hear industry experts address the latest on irrigation scheduling, codling moth management, marketing and more

Registration: 7–8 a.m.
Program: begins promptly at 8 a.m. and runs through lunch (included in nominal registration fee)

For information, call **559-582-3211, Ext. 12731**

CULTURAL TIPS *continued from page 11*

management of WIPMEP.

Communication
WIPMEP findings and knowledge will be shared with cooperators through frequent personal communication and e-mail among project participants. Small regional grower/PCA meetings will be important to broader project communication and expansion. Finally, the walnut industry will learn of the project's activities through industry newsletters and field days.

More About CAP
The Center for Agricultural Partnerships (www.agcenter.org) is a 501(c)(3) nonprofit organization whose mission is to help working farmers improve the productivity and profitability of their farms through the use of environmentally and economically sound growing practices that reduce pesticide risks, improve water quality, create healthier ecosystems and improve the well-being of the farm community.

For further information contact Pat Weddle at (530) 622-9061, e-mail pweddle@agcenter.org.

About the authors:
Wulfert is Diamond's field representative for the Northern Sacramento Valley.

Weddle is founder and president of Weddle, Hansen and Associates, Inc., an agricultural consulting firm established in 1975 to develop and implement strategies, tactics and policies that emphasize biologically intensive IPM. In 1999, the firm received the California Department of Pesticide Regulation's IPM Innovator award. Weddle holds bachelor's and master's degrees in entomology from UC-Berkeley.

He's *Nuts* About Diamond!

WRITES DIAMOND fan and photographer Charlene Oswald of Pennsylvania, these photos were taken on summertime camping trips. "The squirrel approached us from the woods at our camp. We tempted him with your walnuts. He would come down out of the woods when we would shake the can. Unfortunately his mother must have had a little talk with him and he stopped coming to see us after a few months. P.S. By the way, this summer we have a raccoon that has taken a liking to your walnuts too! Unfortunately we feed him at night and the pictures are not quite as clear." Oswald also writes that her photos of "Rocky" netted a blue ribbon at the local fair!

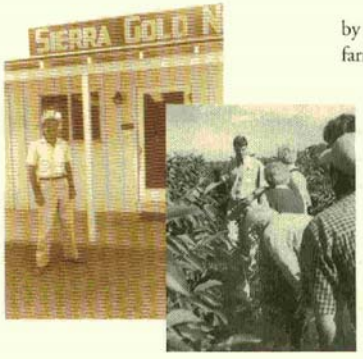
Observed Consumer Affairs Manager Donna Samelson, who fields letters such as this for Diamond, "It is always a pleasure to see satisfied consumers, no matter what species."

CHARLENE OSWALD

Sierra Gold Celebrates Golden Anniversary

IN OCTOBER, DIAMOND MEMBER Sierra Gold Nurseries hosted a tour and open house luncheon celebrating 50 years in business. The event kicked off with a bus tour of the nurseries' Sutter county growing grounds and budwood orchards and included a budding and grafting demonstration. Afterwards, guests mingled among historical and education displays where they learned about new varieties.

Sierra Gold was founded in 1951 by Walter and Ellen Berg. Today, it farms nearly 1,000 acres just south of Yuba City. Walter Berg is still president after 50 years, and with son Brian Berg, general manager of operations, and son-in-law Jack Poukish, general manager of business and sales, manages the company.



Photos: Founder Walter Berg in the early years; Brian Berg explained dormant budding to guests at the anniversary celebration.

Appendix 19

Production and Post Harvest Research Update

IPM Project Seeks to Expand the PMA's Success with Sprayable Pheromone

Patrick W. Weddle, Senior Consultant, Center for Agricultural Partnerships

What are the growers best chances for economic success in this day of ever increasing pressures against America's agricultural profitability? How can farmers control costs yet capture the value of new, often more expensive pest management practices and technologies? These were two key questions the **Center for Agricultural Partnerships** (CAP) asked when evaluating the potential for funding and initiating a farm-based project to improve agriculture's economic viability in California while addressing agriculture's environmental impacts. In early 2000, thanks to the highly successful joint efforts of the **Walnut Marketing Board** and the **Walnut Pest Management Alliance** (PMA), CAP identified a significant opportunity to fund, organize and conduct the Walnut Integrated Pest Management Expansion Project. The objectives of the project are simple:

1. To implement a systematic process to enhance the successful adoption of sprayable pheromone-mediated mating disruption technology on a wide scale by commercial walnut growers

2. To measure, document, evaluate and communicate economic, biological, and decision-making changes in the adoption of sprayable mating disruption at the farm, project, and industry levels

Historically, codling moth, a key pest of California walnuts, has been controlled with an array of conventional insecticides. Currently, regulatory pressures including FQPA coupled with resistance to many of the available insecticides have made control of codling moth more difficult and costly. The use of pheromones to control codling moth in pears and apples has become commonplace (e.g. see Figure.1).

The Walnut PMA has demonstrated that many of the techniques for successful pheromone-mediated mating disruption of codling moth, while effective in walnuts, are often economically impractical. With the recent registration of a *sprayable* formulation of codling moth pheromone by **3M-Canada Company** (distributed in California by **Certis USA**) and with pending registration of a sprayable product by **Suterra Ltd.** (Bend, Oregon), walnut growers now have the potential to economically incorporate mating disruption into pest management strategies while reducing the potential negative effects of conventional insecticides on the environment, on worker health and safety and on the beneficial species that suppress other orchard pests.

BUT BEWARE! Mating disruption does not, repeat, DOES NOT kill codling moth. Mating disruption only modifies the behavior of the pest. Mating disruption DOES NOT always prevent mating. But, it can *delay* mating, and that delay can have a powerful negative impact on codling moth populations. A female codling moth that mates late in her life lays fewer eggs. Fewer eggs laid equal fewer worms and less damage. When coupled with effective conventional pesticides, the efficacy of pheromone-mediated mating disruption is further enhanced. If mating disruption technology is carefully implemented, populations of codling moth are reduced to such low levels that very little threat of damage remains and pest control costs are significantly lowered. However, this only works *so long as vigilance in the form of intensive pest monitoring is strictly practiced.*

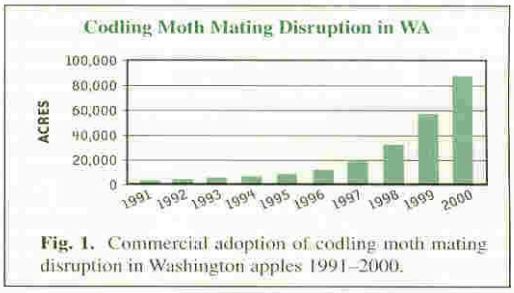


Fig. 1. Commercial adoption of codling moth mating disruption in Washington apples 1991–2000.

Extensive experience in pears and apples throughout the west has shown that monitoring is the key to successful commercial adoption of mating disruption. Unlike conventional pesticides, applying pheromones with insufficient monitoring (i.e. merely assuming that control has been achieved) has led to disastrous results. To ensure that California walnut growers have access to the technology and information needed to successfully implement mating disruption strategies on a commercial scale and avoid the potential pitfalls of this new technology, CAP has established a state-wide network of expert cooperators to assist walnut growers. **Pat Weddle**, a consultant to CAP and a California-based agricultural

consultant specializing in biologically intensive IPM will mange the statewide project. **Steve Sibbett** (UC Cooperative Extension, Emeritus), **Joe Grant** (UC Cooperative Extension) and **Steve Wulfert** (Diamond of California) located in the southern San Joaquin Valley, northern San Joaquin Valley and Sacramento Valley, respectively, will coordinate CAP's activities. These regional coordinators will work closely with well-known walnut pest management consultants in the different regions including **Jim Stewart** and **Judy Stewart-Leslie**, Pest Management Associates, Inc. of Exeter, CA; **Michael Devencenzi** Consulting, Woodbridge, CA and **John Post**, Agricultural Advisors, Inc. of Yuba City, CA. The Center for Agricultural Partnerships is funding this team to work closely with walnut growers to carefully implement sprayable pheromone technology on approximately 1000 acres during 2002. CAP has plans to expand the project acreage to 25,000 acres during subsequent years.

CAP's project cooperators are deploying both pheromone-baited codling moth traps and the new "kairomone lure" baited traps developed and marketed by **Trece, Inc**. Unlike the pheromone lure that attracts males to traps utilizing the same sexual communication chemicals as those used by female moths, the kairomone lure is a host plant volatile that attracts both male and female codling moths independent of any pheromone - mediated sexual communication or mating disruption interference. Because the effectiveness of pheromone-baited traps is reduced in pheromone-disrupted orchards, the kairomone-baited trap has the potential to provide growers and their pest control advisors with an effective tool for monitor codling moth activity in disrupted orchards. Project cooperators will utilize the kairomone-baited traps in conjunction with pheromone traps to learn first hand the effectiveness of this new tool. With on-line web support from **UC-IPM**, cooperators are systematically communicating their trap counts, pest management inputs and experiences with their colleagues across the regions of the CAP project. This "cross-regional" real time information transfer enhances the quality and quantity of learning among project participants. This enhanced learning increases the potential for building confidence in the new technologies being implemented while supporting the successful and economic adoption of those technologies. Because the CAP project works closely with cooperators of long standing commercial involvement in their individual communities, a legacy of commercial adoption is ensured long after project funding has ceased.

Project documentation and evaluation is a cornerstone objective. Not only will CAP evaluate the effectiveness of the target technologies but, more importantly, they will evaluate the impact adoption of those technologies has on cooperating walnut growers' net revenues.

Finally, CAP's methodologies will be employed to assess changes in decision making at the farm level. This understanding provides to project management the knowledge necessary to improve and successfully expand implementation of project objectives in subsequent years.

The Center for Agricultural Partnerships (www.agcenter.org) is a 501(c)(3) nonprofit organization whose mission is to create and implement technology and programs to solve agricultural problems by helping farmers adopt more environmentally sound and profitable practices. CAP's programs improve the productivity and viability of farming operations while improving the well-being of farm communities, reducing pesticide risks, and improving water quality in growing regions across the country.

For further information about the Walnut IPM Expansion Project or The Center for Agricultural Partnerships, please contact Pat Weddle (pweddle@agcenter.org)

Walnut PMA Project Concludes Year 3 with Promising Results for Sprayable Pheromone

The Walnut Pest Management Alliance (PMA) Project has been successful in identifying effective, reduced-risk practices that eliminate or reduce the need for insecticide applications to control codling moth in walnuts. Now in its fourth year, the PMA has validated the efficacy of several mating disruption products including Isomate C+ hand-applied twist tie dispensers and the newly registered, sprayable pheromone product CM Flowable available from Suterra.

At a PMA field day in Chico on November 8, 2001, University of California IPM Advisor Carolyn Pickel said, "Assessing the codling moth population pressure prior to implementation is the key to success with either mating disruption product. In orchards with low population pressure, all pheromones are effective without supplemental control methods."

She advised growers with high codling moth population pressure to use caution during the first year of implementing a mating disruption program, and to supplement with an insecticide application to knock down the population during the first flight. "In the second year, or in orchards with medium population pressure, growers can supplement with a softer insecticide such as Confirm or four applications of the parasitic wasp, *Trichogramma platneri*, aerially applied at the rate of 200,000/acre in August," Pickel said.

It is also recommend that growers using mating disruption continually monitor using pheromone traps, nut drop assessment, canopy counts and a harvest sample. Growers should use pheromone

Appendix 20

PHEROMONES ARE IN THE AIR

Walnut growers hope synthetic fog throws off moths' mating

By Stuart Leavenworth
BEE STAFF WRITER

MARYSVILLE – Every spring, Mike Bennett's walnut groves become ripe with the smell of love.

Tiny moths emerge from their cocoons, then use the scent of other moths to locate mates. Within weeks, millions of these codling moths are flying through Bennett's orchards, ready to bore through his walnuts and destroy a year's crop.

Now, in their ongoing battle against bugs, Central Valley farmers are using the sexual habits of insects as a weapon against them. More and more, they spray pheromones – chemicals emitted by all creatures to attract mates – to fog orchards with a confusing cloud of sexual scents and make it more difficult for pests to reproduce.

It's an experimental technique but one that holds great promise. That's good news for California's orchard industry, which faces increasing restrictions on its favored pesticides, say agricultural advisers.

"This is not a fix-all, but it should dramatically reduce the chemicals we spray," said Patrick Weddle, a Davis agricultural adviser who is working with Bennett and other farmers.

In particular, the use of pheromones could cut down on applications of three toxic pesticides – azinphos methyl, chlorpyrifos, and diazinon – that regularly are sprayed on walnuts.

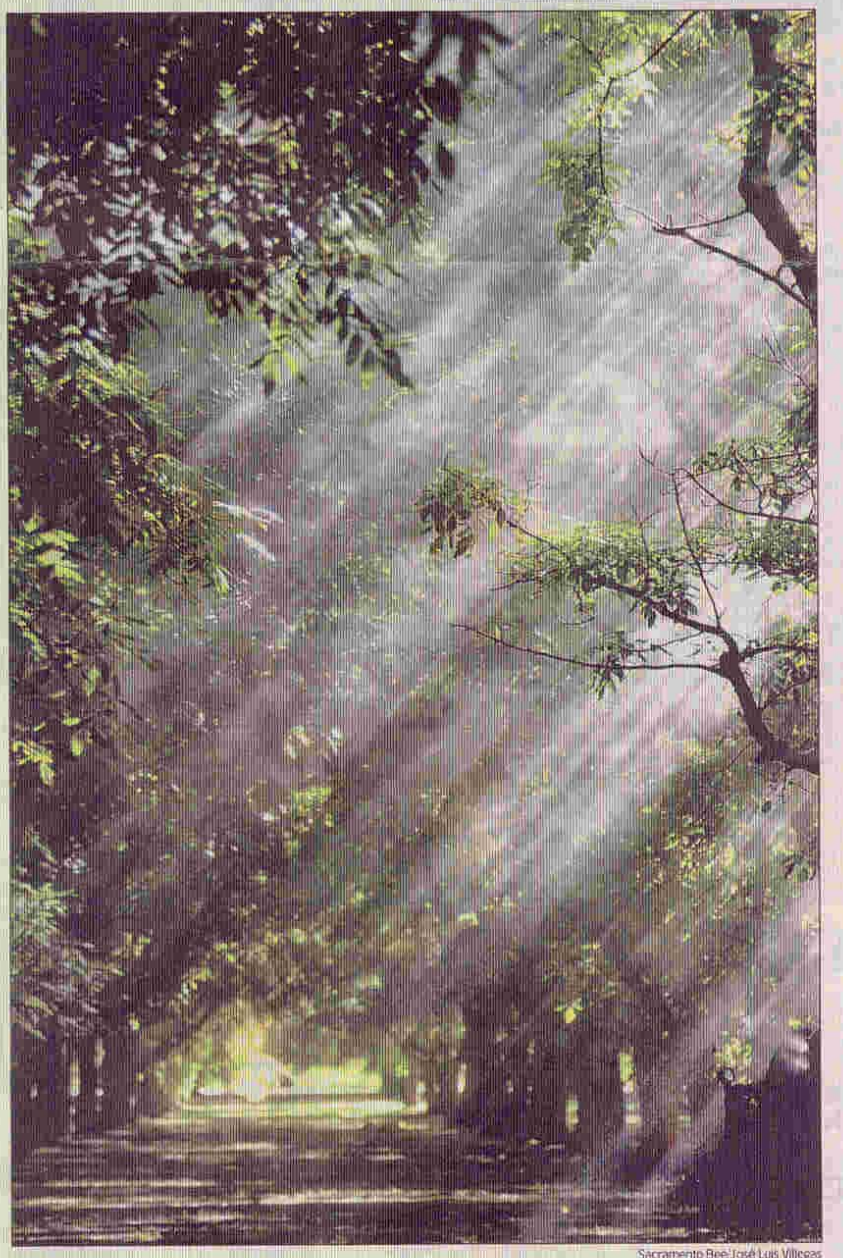
All three chemicals have been known to wash into local waterways, including the Sacramento River, which provides drinking water for Sacramento and many other cities. The compounds also pose risks to farm workers and children who regularly consume fruit, according to the U.S. Environmental Protection Agency.

With pheromones, on the other hand, the only real risk is dousing yourself in the spray and becoming a magnet for amorous insects.

"You don't want to go to the butterfly exhibit for a while," joked Bennett as he walked through one of his groves the other day.

On Wednesday, crews sprayed a

► SPRAY, page A4



Sacramento Bee/José Luis Villegas

A mist of laboratory-produced pheromone of the codling moth wafts through a walnut orchard last week near Marysville. At top, what growers are up against: a codling moth caterpillar that has bored inside a nut.

Sacramento Bee/José Luis Villegas

A sprayer sends pheromone toward codling moths, which lab tests show are thrown off the mating trail by the nontoxic compound.

Spray: Project officials aim for 25,000 acres in 2 years

▶ CONTINUED FROM A3

cloud of codling-moth pheromone through more than 150 acres of walnut groves north of Marysville. The groves are owned by Deseret Farms, a major walnut grower that employs Bennett and is participating in a project to perfect use of "mating disruption techniques."

The project, organized by the nonprofit Center for Agricultural Partnerships, involves 1,000 acres of commercial walnut groves in the Central Valley. Over the next two years, officials with the group hope to expand that to 25,000 acres, or an eighth of all walnut acreage in the state.

California farmers, who produce 99 percent of the nation's walnuts, are watching closely. When left uncontrolled, codling moths can destroy about 40 percent of a crop, mainly by boring into the nuts and leaving them susceptible to rot.

"Codling moths are the proverbial worm in the apple," said Larry Elworth, executive director of the center and a former apple grower. "They pose problems for all kinds of fruit growers, all over the country."

Elworth said pheromone disruption holds lots of potential. The trick, he said, is getting farmers involved and figuring out techniques that work in the field, not just the lab.

Three years ago, for instance, walnut growers and various state agencies experimented with a parasitic wasp to kill moths. Unfortunately, said Weddle, "The amount of parasite necessary to do the job made the costs prohibitive."

By contrast, tests have proven pheromones to be effective and reasonably priced, said Weddle. The pheromone technique costs about a third more than using pesticides, but costs are expected to drop as the spray becomes more available, he said.

As Weddle notes, spraying pheromones isn't as simple as wafting a cloud through an orchard. The spraying, he said, has to coincide with the peak mating period of the moths.

To get the timing right, Weddle and another crop consultant, John Post, are using two types of baited traps. One contains moth pheromone, which provides an indication of the males that are mating. The other includes a type of pear scent, which attracts moths of both sexes.

Once a sufficient number of moths show up in the traps, farmers can crank up their spray trucks and pump the pheromone into the orchards, just like they would a pesticide.

"We are not sure if the males get lost or just get desensitized," said Weddle. But it works, he added, reducing reproduction by 60 percent to 70 percent.

Over the next year, the agricultural partnerships group and various walnut growers hope to fine-tune the methodology so it can be used across the Valley. Funding for the $200,000 program comes from the partnerships group, the federal EPA, 3M Canada (which makes the synthetic pheromone spray), and the Great Valley Center, another nonprofit group.

Bennett said it makes sense for growers to try alternatives, and that he's tired of headlines about farmers polluting water.

"We are sensitive to that," said Bennett. "We want to help the industry in any way we can."

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Appendix 21

Center for Agricultural Partnerships, Walnut IPM Expansion Project Case Study for CARAT

February 2003

Prepared by: P.W. Weddle, Project Manager

Pest Management Problem

- **Describe the pest management problem (regulatory, resistance, new pest, secondary pest, needs of the IPM system, IPM system not being used). What are/were the consequences of not resolving the problem.**

California produces 99% of U.S. walnuts and 38% of the world production. In 2001, California growers produced over 300,000 tons of walnuts valued at over $346 million. Codling moth, Cydia pomonella, (CM) is the key statewide pest of walnuts, infesting 60% of the more than 200,000 planted acres in California. Uncontrolled codling moth can cause economic damage on up to 40 % of the crop. Organophosphates (OPs) are the primary insecticides used to control codling moth but pending regulatory action under FQPA is likely to further restrict or eliminate one or more of the existing uses. In addition, the pressures from insecticide resistance and the problems associated with secondary pest outbreaks as a result of OP applications have created additional problems and increased pesticide use. Furthermore in its "1998 California 303(d) List and TMDL Priority Schedule", the Central Valley Regional Water Quality Control Board identified the insecticide chlorpyrifos as a high priority for development of a Total Maximum Daily Load on 190 miles of the Merced and San Joaquin Rivers and 480,000 acres in the Delta waterways among the watersheds targeted. Chlorpyrifos has been widely used on walnuts in the Sacramento and San Joaquin valleys.

Use of OP's in walnut pest management is relatively inexpensive. Cooperator surveys show that costs and efficacy concerns are a major barrier to adoption of CMMD.

Solution

- **Describe the solution and how it is/was intended to solve the problem**
- **What is/was the time frame for solving the problem**

The most promising option for resolving the critical regulatory and biological problems in walnut pest management is pheromone mediated mating disruption. This project was a cooperative effort of the Center for Agricultural Partnerships (CAP) with growers and their organizations, crop consultants, researchers and farm advisors to implement a systematic process to further adoption of a sprayable mating disruption system on a wide scale in commercial walnut production and; 2) Document and communicate economic, biological and decision-making changes in the adoption of sprayable mating disruption at the farm and project levels on a wide scale in commercial walnut production.
In conjunction with the implementation of the sprayable pheromone, the project also implemented and validated the effectiveness of kairomone-based lure as a key component in the

use of sprayable mating disruption on a wide scale in commercial walnut production. Since codling moth is a key pest on other crops, which also rely on organophosphates being regulated under FQPA, successful use of this technology in walnuts could also have a dramatic effect on pest management on those key crops.

The most promising option for resolving the problems of cost and uncertainty of transition to new pest management technologies and practices is to provide growers and their pest control advisors a systematic program designed to "failsafe" their on-site adoption experience. The CAP walnut project was designed to provide individual and collective coordination and support for early adopters of the target technologies. In addition, the project has developed a commercial network to enhance the capacity of growers to more efficiently incorporate new technologies into their daily pest management activities.

Implementation of the technologies was to be accomplished during the growing season by cooperating growers with the support of their pest management advisors (PCAs). The foundation of the implementation effort is the involvement of growers and their pest management advisors throughout the project. The involvement of PCAs ensures that results are documented and provides a means for growers to receive the information necessary to make better decisions. By allowing growers and PCAs the opportunity to see this system work in their own orchards, they have the opportunity for direct observation that is essential to the adoption of innovation. PCA involvement also provides the mechanism for sustaining implementation efforts commercially after the project ends.

The project was initially designed to implement sprayables on 25% of the walnut acreage susceptible to codling moth infestation, approximately 25,000 acres by the end of the third year.

Project Development

- **Characterize the nature of the project: basic research, applied research, registration, education, demonstration, and implementation**
- **What is/was the budget and time frame for the project**
- **What are/were the sources of funds for the project**
- **Who led the development of the project**
- **Who are/were the key supporters, participants**
- **Who is/was responsible for securing the funding, writing the proposal**
- **What problems are/were encountered in securing funding**

The CAP walnut project was focused primarily on farm based, site-specific implementation of new technologies and practices.

The budget for the feasibility study and design o f the project were was approximately $125,000, about 70% of that dedicated to assessment of the project's feasibility. Actual field implementation efforts were projected to cover three years at about $150K per year.
CAP has provided the bulk of the funds. US-EPA Region 9, The Great Valley Foundation and 3M Canada provided approximately 47% of the funds.

Diamond of California provided significant communications support through its newsletter and publications and provided the services of its field staff for the project. The outreach within the industry was conducted through the Diamond of California newsletter, which recognized and reinforced the work of project participants and informed the cooperative's members of the project. The project was publicized to the entire walnut industry through the Walnut Marketing Board's quarterly newsletter. Press relations were also conducted to the general public about the industry's efforts use environmentally sound farming practices.

Patrick Weddle, Senior Consultant to CAP, conducted the feasibility assessment and was the project manager.

Key supporters were Diamond of California, the Walnut Marketing Board, 3M-Canada Corporation, Trece, Inc., Suterra, and Certis. Steve Wulfert, fieldman, Diamond of California; Joe Grant, Extension Pomologist, U.C. Cooperative Extension, San Joaquin, Co.; and Steve Sibbett, Extension Pomologist Emeritis, U.C. Cooperative Extension, Tulare Co. served as coordinators for the project. Steven Welter, U.C Berkeley, Walt Bentley and Carolyn Pickel UC-IPM served as technical advisors and participants. Once the project was started, The Nature Conservancy and Crain Orchards became involved in sharing data and comparing field results.

The key to project success was the intensive involvement of private crop consultants in the project. Since implementation at the field level is a private sector activity their participation along with that of their grower-clients made the field implementation effort possible.

Larry Elworth, Executive Director of the Center for Agricultural Partnerships, led the development of the project and was responsible for securing project funding and writing proposals. There are virtually no funding sources for commercial implementation projects that are farm based and site-specific. Though a number of funding sources propose to include implementation as one of the purposes that are supported, they regularly confuse research and demonstration with commercial implementation. In addition, due to severe budget deficits, California state funding sources, such as the Department of Pesticide Regulations, have drastically reduced or eliminated implementation project funding programs (e.g. Pest Management Alliance Program). Commodity research boards, such as the Walnut Research Commission traditionally fund research and not implementation. Environmental funders have reduced or eliminated their funding for IPM projects and for site-specific efforts to reduce pesticide risks in conventional agricultural. To the extent that they do have funds for this purpose, the recent drastic decline in the stock market has had a severe impact on non-profit funders reducing their ability to fully fund programs and initiate funding of new projects.

Project Management

- **Describe how the project was initiated; what were its objectives**
- **How was planning done**
- **How was success defined at the beginning**
- **How is/was the project staffed. Who is/was responsible for handling money, coordinating, managing the project.**

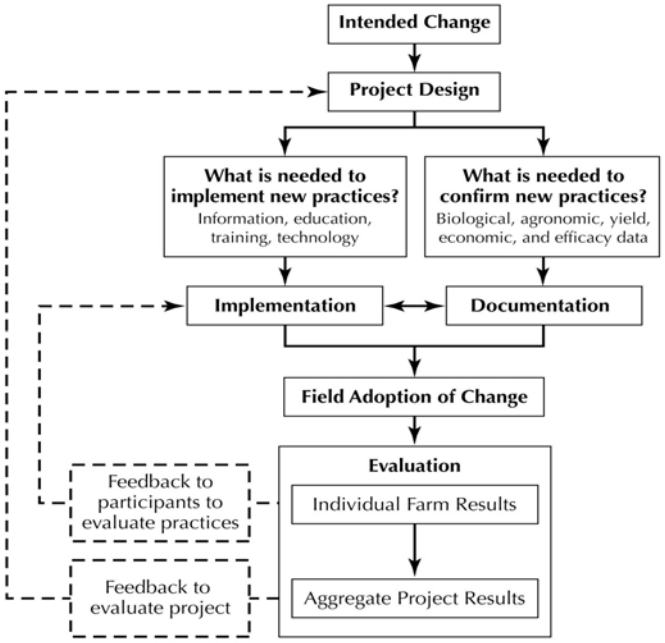
The "CAP Process" for project development

Implementation of new technologies and practices in agriculture, especially technologies that are farm-site specific, information intensive and unconventional relative to those being replaced, can be slow to implement commercially on any large scale. For growers to learn of new innovative technologies and practices they initially benefit from access to collective experience, i.e., credible research, extension and regional field demonstration of the innovation. This collective experience is currently provided by traditional research and education sources such as the land grant system and cooperative extension. For growers to ultimately adopt new technologies and practices they need to take the collective experience and incorporate the knowledge to individually experience and observe the relative advantage of the innovation, its trialability in the field, its compatibility with other cultural practices and its complexity relative to older practices (Rogers). In many cases, this individual experience takes place in a context that is dominated by many forces and interests beyond the innovation yet influencing grower decisions to use the target innovation nonetheless. In 2001, CAP initiated a study to determine the feasibility of conducting a large-scale commercial implementation project in California walnuts. Through a systematic decision tree process it was determined that the potential existed within the California walnut industry to have large scale environmental and economic impact by commercially expanding upon successful ongoing efforts of the walnut industry to research, educate and demonstrate new biologically based systems of crop protection (The Walnut Pest Management Alliance Program). As a result, CAP initiated funding of the Walnut IPM Expansion Project (WIPMEP) in 2001. In 2002, the pilot field project component was initiated statewide.

Project Objectives

The project has the following objectives:
1) To implement a systematic process for further adoption of a sprayable pheromone-mediated mating disruption system on 1000 acres of commercial walnut production.
2) To measure, document, evaluate and communicate economic, biological, and decision-making changes in the adoption of sprayable mating disruption at the farm, project, and industry levels.

Project Design and Planning
The diagram below shows the integrated process used by CAP in this project:



A planning meeting with the project's core participants including the Walnut Research Commission research coordinator, the three regional coordinators and the four cooperating consultants was held in February to develop a work plan for the 2002 field season. In the meeting, which was conducted by a facilitator, the participants were prompted to provide their views of what needed to be done to accomplish project objectives. These results were then transcribed into a work plan format. The work plan was used throughout the season as the road map for project activities. Thus, project core participants designed and took immediate ownership of their work plans for the project year

Success was defined in keeping with the integrated process. First of all, success was defined as the efficacious use of sprayable pheromones and kairomones in the field and the ability to assess that efficacy at the grower and aggregate project level. In addition success was defined in terms of the project's ability to effectively provide the information and support necessary for the implementation and evaluation.

Pat Weddle was project manager. Larry Elworth, Executive Director of the Center for Agricultural Partnerships and CAP staff handled all of the administration, oversight and press relations.

Project Work

- **What are/were the main activities - what are people doing**
- **What are/were the milestones and chief accomplishments of the project**

Project management in collaboration with CAP and project cooperators conducted the following work in 2002:

Project Organization & Planning

- Developed project field budgets, January
- Designed survey and interview instruments, February
- Conducted project planning meeting and focus group with core technical cooperators, March 14

Education & Outreach

- Formal Presentation introducing the project to the Western Orchard Pest and Disease Management Conference, Portland, OR (Jan 10)
- Formal Presentation introducing the project to the Walnut Research Committee Annual Conference, Bodega Bay, CA (Jan 24)
- Co-sponsored mating disruption technical seminar, AAIE Annual Conference, Berkeley, CA (Feb 5)
- Formal presentation on the project to Cal-EPA, Dept. of Pesticide Regulations, Pest Management Alliance Annual Workshop, Sacramento, CA (March 12)
- Formal presentation introducing project to Tulare Co. growers at UCCE grower meeting, Hanford, CA (April 2)
- Formal presentation on mating disruption in walnuts and the CAP project to Diamond Walnut Technical Staff Meeting, Stockton, CA (May 30)
- Two meetings with UC-IPM Area IPM specialists, one in Yuba City and one in Parlier to review project and statewide UC-IPM pheromone data (June)
- Conducted industry education meeting for project stakeholders to report project results (November)

Establishment of Cooperators

- Established three Regional Coordinators (January)
- Established three Regional Consultants (January)
- Established 8 grower cooperators with 9 orchards representing 900 acres (February, March)
- Secured sprayable pheromone donations from 3M Canada and Suterra LTD
- Secured trap and lure donations from Trece, Inc. (April)
- Field trapping by cooperators was initiated (March-April)

Project Evaluation

- Collaborated with UC-SAREP on walnut industry survey to be conducted in 2002
- Conducted interviews and surveys of Regional Consultants (April)
- Conducted interviews and surveys of grower cooperators (May-June)
- Conducted interim project field evaluation to determine effectiveness of new trapping technologies, sprayable pheromones and project communications with Regional Coordinators and Consultants (June 5-6)
- Conducted monthly visits with cooperators to periodically assess cooperator perceptions of target technologies
- Conducted an end of season project wrap-up meeting with regional coordinators and consultants to document project outcomes (November)

Field Data Management

- Initiated on-line field data management system with UC-IPM (April)
- Established and verified field trapping methodology with Regional Coordinators and Regional Consultants (April-May)
- Established data management coordination with DJS Consulting (May)
- Provided updated summaries to Regional Coordinators, Consultants and other key project cooperators (June)
- Initiated economic analysis data collection (June)
- Supported Certis' design and execution of comprehensive harvest sample damage analysis (September)
- Summarized field data for industry presentations (October)

Industry and General Public Communications

- Published industry solicited article on project description, goals and objectives in Diamond Walnut Newsletter, January. This newsletter is sent to approximately 50% of California walnut growers
- Published industry solicited article on project history, design, goals and objectives in Walnut Marketing Board Newsletter, June. This newsletter is received by all California Walnut Growers
- Field meeting with Sacramento Bee to develop a newspaper article highlighting the CAP walnut project, Marysville, CA, May 21
- Sac Bee newspaper article "Pheromones are in the air" published June 9

Implementation of Sprayable Pheromone and other CM Treatments

Approximately 832 of the 900 project acres were treated with label rates of sprayable pheromones (the remaining acreage was used as comparison blocks). Approximately 663 project acres were treated with 3M MEC-CM® and 226 acres with Suterra's Checkmate® CM-F. In Tulare County only, sixty project acres were designated "conventional" and not treated with pheromones. These blocks were used as a comparison with nearby pheromone treated blocks. Pheromone treatments were initiated soon after materials were available and, in all but the Southern Region, prior to peak flight of overwintering moths. Due to the early flights in the Southern Region, Lorsban was applied in the spring prior to application of pheromones.

In the South Region, supplemental chemical sprays were applied to two blocks. Confirm (tebufenozide) was applied to 20 acres (Vina variety) where May-June dropped nut counts averaged more than 12 nuts per tree. Lorsban (chlorpyriphos) was applied to a second orchard where the grower feared another potential worm pest (redhumped caterpillar, Schizura cocinna).

There were no attempts to determine differences between the two sprayable pheromone products and none can be inferred from the results of this year's field experience.

Cooperating growers and consultants agreed that the incorporation of sprayable pheromones into their pest management program in 2002 was technically feasible though prohibitively expensive in terms of out of pocket costs relative to their conventional pesticide program. Based on their use of sprayables in 2002, all consultants and all but one grower stated willingness to examine sprayables in 2003. These cooperators stated that the expansion in use of sprayables would be a function of the

cost of the sprayable product in 2003 and the willingness of their clients to incur added costs of purchasing sprayables.

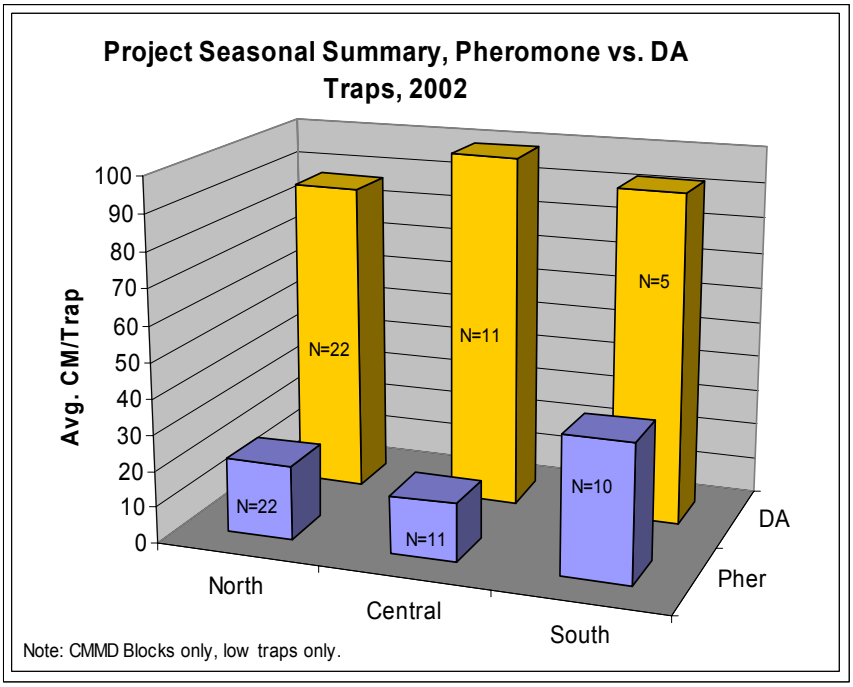
Codling moth trapping results

Field results represent the springtime period through the end of the codling moth flight in September.

Project orchards were all trapped with both 1X pheromone baited and kairomone baited traps donated by Trece, Inc. Most blocks received pheromone applications aimed to disrupt mating of the overwintering adults that emerged this spring and/or their offspring.

By the end of September, project cooperators had completed trapping of the codling moth populations, dropped nut evaluations and canopy nut count evaluations for codling moth damage. Certis sponsored harvest "wind row" nut samples of those project orchards that utilized 3M's CM-MEC sprayable pheromone.

Each cooperating orchard (with the exception of the "comparison blocks in the south region) received one or more sprayable pheromone applications and was trapped with both pheromone baited and kairomone (a.k.a. DA lure) baited traps. The purpose of this lure comparison was to evaluate the potential of the DA lure as a potential tool for monitoring codling moth adults in pheromone disrupted environments where pheromone traps are "masked" by the mating disruption treatment. Results of the trap counts are summarized in Fig. 1.



Pheromone vs. DA

Seasonal Flight	Pher	Avg/trap DA
North	20.77	87
Central	16.09	98.81
South	38.3	92.4

Figure 1. CAP walnut project statewide seasonal summary of codling moth trap count averages in DA baited traps compared to pheromone-baited traps.

In most project orchards, once sprayable pheromones were applied, pheromone baited trap counts declined relative to DA traps. Through the end of the overwintering flight, DA trap captures, on average, exceeded pheromone traps by a ration of at least 4:1, 6:1 and 2.4:1 in the North, Central and South regions, respectively. Cooperating consultants expressed strong interest in the ability of DA traps to capture moths when pheromone traps were effectively shut down.

Dropped nut damage evaluations

Dropped nut counts were taken in six participating orchards as the overwintering flight neared its end in late May and early June. Results generally demonstrated acceptable suppression of the overwintering CM flight. Average dropped nut counts ranged from 0 to 5 nuts per tree. The higher averages generally occurred in later samples.

Consultants were uncertain as to the ultimate benefit of dropped nut assessments. Because dropped nuts represent damage after the fact, they are valuable as an indication of past control failure and as an indication of the potential for increased damage risk in subsequent CM generations.

Canopy count damage evaluations

Systematic canopy count evaluations were conducted in the South and Central Regions. Results showed no substantial differences in CM damage levels between pheromone blocks and comparison blocks. CM infestations remaining on the trees at the end of the overwintering flight were generally less than 1%, well within acceptable damage levels. One Central Region orchard exhibited 4% infested nuts in a small area within a 25-acre block. Consequently, the crop consultant treated this area with chlorpyriphos in early July. Consultants agreed that, even though no direct correlation with harvest damage exists, canopy counts are, nonetheless, important in the assessment of harvest damage potential.

Harvest damage evaluations

Commercial harvest grading methodologies typically do not discriminate species-specific insect damage. In order to better determine the effectiveness of the 3M sprayable pheromone, Certis, in cooperation with project participants, conducted a series of windrow samples at commercial harvest to determine the species of Lepidoptera insects infesting harvested nuts.

In each of the 5 orchards where 3M pheromone was used, a series of four samples were collected, one sample each in the north, south, east, and west directions from the second tree away from DA baited codling moth traps. For each sample, two opposite swaths at 45º angles to the tree row were raked and a minimum of 100 nuts per sample were collected, hulled and immediately delivered to the Dried Fruit Association in Fresno, CA. From these collections, 100 nuts per sample evaluated for the number of "blows" (i.e. dried and/or shriveled nut meats), codling moth damaged nuts,

codling moth larvae present, Navel Orange Worm (NOW) Amylois transitella damaged nuts and NOW larvae present. A total of 130 samples were taken from the 5 cooperating orchards.

The results of this survey demonstrated low infestation levels of CM and NOW in all harvest samples. Most insect damage resulted from NOW. There was no apparent correlation of harvest damage to earlier canopy or dropped nut damage assessments.

Economics

- Input Costs

3M-Canada and Suterra have made significant contributions of their sprayable pheromone products to grower cooperators in 2002. Trece, Inc. has contributed all the DA trapping supplies. These contributions reduced the participation costs to growers and were favorable incentives for cooperators to be involved in the CAP project.

At the March planning meeting, the core participants determined that, during this initial project field year, they were primarily interested in tracking costs of materials and applications. Consequently, these costs to the grower have been calculated from their pesticide use in cooperating orchards. Input costs are calculated from the commercial price for products and applications reported by PCA cooperators. To compensate for the value of contributed pheromone product, the list cost (including estimated cost of sprayable pheromone) and the actual costs (excluding the value of contributed pheromone) are compared.

Where data allowed comparisons of the CMMD blocks with non-pheromone treated blocks (South Region only), list vs. actual costs of the pheromone program were substantially higher than the comparison blocks (Figures 3 & 4). On average, these cooperating growers actually spent $116 per acre more than their comparison blocks. Were it not for donated product, they would have spent $193 per acre more.

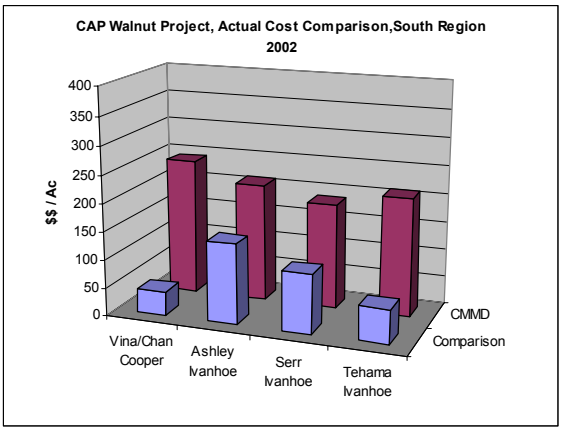


Figure 3. Comparison of *list* costs in the pheromone treated blocks vs. the comparison blocks in Tulare Co.

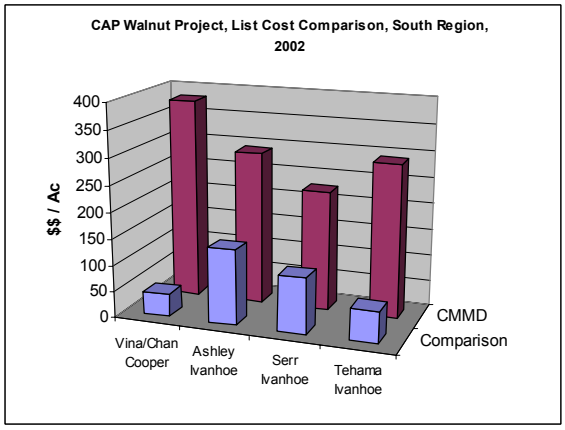


Figure 4. Comparison of *actual* costs in the pheromone treated blocks vs. the comparison blocks in Tulare Co.

Overall, CMMD potential (i.e. list) costs to growers averaged $ 283, $170 and $118 per acre in the south, central and north regions respectively. Because of product contributions, cooperators actually spent $207, $61 and $52 per acre, respectively (Fig.5).

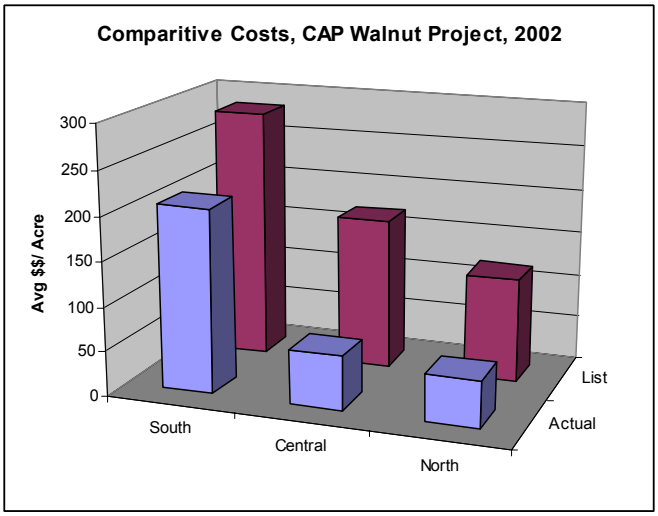


Figure 5. Regional comparison of average list costs vs. actual costs for sprayable pheromone treatments

As a result of the actual or potential costs to growers realized with sprayable pheromone this season, cooperators have determined that, for sprayable pheromones to be adopted, a more targeted approach to pheromone use will be required to minimize costs.

Core participants gathered for a facilitated evaluation session after the field season. The project was evaluated for its effectiveness in providing the information and support necessary for conducting field efforts. Participants indicated that the network created between and among PCAs and industry suppliers was a particularly valuable outcome. In evaluating the process, participants commented that the amount of work and clarity of direction achieved during the year far exceeded their previous experience in similar project efforts.

Accomplishments
Project Evaluation

- **Is/did the project succeed(ing) in solving the problem**
- **How can you tell**
- **What are/were the critical factors in its success/failure**
- **What are/were the key problems that were encountered**
- **What unforeseen events shaped the project**
- **If you were to start the project over again, what would you do differently**
- **What has happened since the project ended**

Evaluation of the project was conducted through an analysis of field data at the grower level and then aggregated to determine the overall project impacts.

Key factors in the success of the project were the time and effort spent in determining the feasibility of the project, its design and in the creation of an implementation network. A network of stakeholders including growers, crop consultants, Diamond of California field staff, a large independent processor, industry consultants, product manufacturers, product distributors, commodity group personnel and university and cooperative extension personnel were brought together to focus on project objectives. Project coordinators and consultants designed field evaluation methodologies and protocols and conducted the agreed upon tasks. These cooperators began building an experience base relative to project objectives and CAP methodologies. Biological, economic and decision-making data collection occurred in a planned and timely manner. Cooperators individually and collectively developed a sense what was and was not working with the project. Systematic efforts were made to expand the number of acres and cooperators for the 2003 growing season.

The key problems encountered were the expense of the pheromones and the availability of three inexpensive OP alternatives for codling moth control in walnut production. The newness of the kairomones and the lack of historical data to assess the results from the DA lures were anticipated. This first year was considered a beginning step in using the kairomone-baited traps. However the ambiguity of results from the use of sprayables was not anticipated and tempered the desires of cooperators to greatly expand 2003 implementation of sprayable pheromones.

The end-of-season project evaluation meeting provided the opportunity for participants to determine the next course for implementation. Participants indicated that they would use sprayables at roughly the same levels in the 2003 growing season. However, it also became clear that at this point on the implementation curve an alternative approach to implementation would be more effective. Instead of relying on sprayables as a wholesale substitute for OP's and thereby essentially using them prophylacticly, it was suggested that they be introduced into a system at low rates in combinations with OPs or other controls. Limited research has suggested that the addition of low rates of sprayable pheromone may reduce codling moth populations below levels achieved by an insecticide alone. That reduction in population and the resulting reduction in damage below 5% would qualify the crop for a series of premiums if delivered to Diamond. The price premiums could offset any additional expenses from the inclusion of pheromone. In this way, the use of the pheromones could be introduced and its value demonstrated more easily to the grower while additional experience was gained in the wider use of the materials.

Thus, while the problem of codling moth was not completely solved by the project, the problem of effective implementation of reduced risk technology was significantly advanced. The industry collectively gained the experience that can only be derived form commercial implementation by field practitioners on a wide scale. By having a systematic process and network for conducting that work, knowledge was gained that will serve as the foundation for subsequent efforts.

The unforeseen lack of funding terminated the CAP's involvement in the project. Because of the nature of farm-based implementation projects, substantial funding over a period of as many as 5 years is probably necessary to sustain project integrity leading to a significant, measurable and lasting project legacy. That sustained funding was not available for this project.

In retrospect, the in-season data collection and dissemination effort was not feasible or necessary. PCAs indicated that they did not have the time to submit data or the time to look at it during the season. Indeed, they said that "after the fact" data was of little use in real time, on the spot decision making. They suggested that a more informal network by which PCAs share their observations with each other in real time would have been a better means for communication and coordination.

Recommendations

What additional resources would be/have been particularly useful?

- **Are/were USDA resources used in this project - why or why not**
- **If USDA resources are/were available for this effort how could they be/have been more useful**
- **What outstanding needs would you look to USDA to fill? How should USDA programs be structured and managed to meet those needs.**
- **What EPA actions would/would have contributed to the success of the project**
- **How can successes and barrier reduction/elimination be applied to other transition efforts**

The availability of multi-year implementation funds is critical. It is hard to enough to find and keep skilled staff for a few years of soft funding. It is impossible to retain good staff when funding is from year to year. Having the funds to conduct a feasibility assessment and to effectively design the project was particularly important. Those funds are also largely non-existent. Funds directly available for wide-scale, commercial implementation efforts are virtually non-existent.

CAP applied to USDA – PMAP but was turned down in large part due to the term of the project and the amount of money requested. USDA staff indicated that CAP should, instead, apply for funding from CAR or RAMP – programs for which CAP was not eligible to apply since it is not a land grant university. While we could have applied to those programs under the auspices of a land grant, $50,000 to $80,000 of the money requested for work in the field would have been taken by a university for overhead. CAP declined to make application.

USDA funds were not directly used in this effort but the contribution of individuals who received USDA funds were important. The work of Dr. Steve Welter served as the basis for the protocols used in the project. His research was supported by an IFAFS grant – USDA no longer makes those grants available for pest management activities – and a RAMP grant. The development of the DA lure and the protocols for using it were supported by USDA ARS in California and Washington. In addition, UC-IPM extension specialists participated in the project and provided expert assistance.

As valuable as those research, education and demonstration programs are they do not

directly further implementation. The dividends from USDA's investment in research, demonstration and education accrue to farmers only to the extent that they can put the results to use in their own operations.

USDA needs to establish a program specifically dedicated to supporting the commercial field implementation of new practices. A systematic process for conducting implementation efforts should be adopted that all program participants use in creating field results. This sort of program would result in real benefits for farmers, advancing their production practices. It would also provide measurable benefits for human health and the environment. Finally, it would capitalize on the valuable investments in research, education and the registration of new pest management technologies.

IN order to ensure implementation results, the program should be targeted toward working with the private sector. Non-land grants should be eligible and land grants participating the in program should share funding with private sector entities. PMAP is the only program open to non-land grants. Originally intended to support implementation efforts with growers, it has now been designated as a research program by USDA.

Making the program open to non land grants is very important. CAP and other private sector organizations have encountered resistance, bordering on hostility, as the land grant system has apparently viewed the private sector as a competitor. Ignoring the irony of taxpayers being criticized by public employees as competing for their own money, the resistance of the land grant system is unfounded. Over the last six years, CAP has brought $1.2 million of new money directly to the universities with which it has worked. The reality is that implementation is a private sector effort that uses both private and public information. By definition the private sector must be at the center of the implementation process.

The conservation programs, EQIP and CSP, may provide the means for creating a dedicated implementation effort, even without changes in the other USDA programs. Given their objective of on the ground changes, they are well suited for use in implementation efforts. Additional work will need to be done with EQIP, its Conservation Innovation Grants program, and CSP, to ensure that they can effectively address the problems encountered in the adoption of reduced risk practices.

Delays in the registration of sprayable pheromones on walnuts by EPA almost prevented the project from taking place. This was due in part to the review of inert ingredients. That process needs to be improved so that pheromone registrants are able to refine their formulation and increase the longevity of the pheromones in the field without unduly restricting the commercial use of pheromones in the field. In addition EPA funds intended to aid reduced risk efforts need to focus on the tasks necessary to get newly registered alternatives used in the field.

CAP's experience can have application to a wide range of crop/pest/pesticide combinations. The overall process works and the engagement of the private sector makes field results possible.