PMA 97-0277 FINAL REPORT

POULTRY MEAT BIRD INTEGRATED PEST MANAGEMENT SYSTEM: EVALUATION, DEMONSTRATION AND IMPLEMENTATION

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I. Abstract

The Pest Management Alliance for Poultry Meat Birds identified 4 areas of pesticide use which were affected by regulatory issues: FQPA insecticides and antimicrobials, ground water contamination and surface water runoff, worker health and safety and protection of endangered species. Our work plan was designed to work with the two largest poultry production companies in California to develop and demonstrate that there are available cost-effective alternatives to the pesticides they are currently using. Specifically, in 1998 over a million pounds of formulated formaldehyde (class B2 carcinogen) were used annually for poultry house disinfection; we demonstrated cost effective alternatives which resulted in an estimated reduction of >70% in formaldehyde use last year. Demonstration of monitoring, alternative control strategies and manure/litter management techniques significantly reduced the use of methomyl based fly baits on our fryer breeder farm and the number of fly sprays used on the fryer and turkey demonstration farms. Demonstrating the use of ground preparation, tillage, mowing, optimum sprayer configuration, and alternative herbicides to control weeds eliminated the need for diuron on these farms. The integrated use of farm sanitation, preflock placement rodent baiting, and continued rodent monitoring and baiting of the breeder flock reduced the incidence of rodents significantly and the amount of rodenticides used. Information from the projects was presented at CPF Quality Assurance meetings and further implementation has commenced on other types of poultry farms.

II. Executive Summary

The mission and goal of our Alliance project was to reduce pesticide risk on poultry fryer farms. We utilized Integrated Pest Management (IPM) as the strategy and selected various tactics to demonstrate and implement. These tactics included demonstration and development of 1) fly, rodent and microbial monitoring techniques, 2) manure and litter management techniques to reduce breeding sites, 3) alternatives for formaldehyde, insecticides and herbicides that are routinely used in pest control on poultry farms, and 4) outreach and educational pest management information through the California Poultry Federation. Since all pests interact on the farms, integration of IPM could result in a highly reliable cost effective proactive approach for the poultry industry.

The poultry industry routinely uses pesticides in a variety of situations to protect their birds and farms from pests. The most important pests are pathogens, flies, rodents and weeds. Disinfectants are routinely used in a prophylactic manner to mitigate pathogens causing disease in birds, the greatest economic cost in production (excluding husbandry and feed). Diseases may have both avian and human impact and, with the onset of food quality programs, the issues with *Salmonella*, *E. coli, Listeria* and *Camplylobacter* are increasingly important. Between the three cool season flocks, formaldehyde is the disinfectant of choice; however, efficacy of this B2 carcinogen has not been demonstrated under farm conditions and treatment may be unnecessary or there may be cost effective and less toxic alternatives. Worker exposure to this compound also increases application expenditures and is estimated to cost this industry between M$1.3-1.5 annually. Our demonstration program was conducted on two complexes of fryer farms and provided strong data supporting alternatives to formaldehyde. The antimicrobial data and growout information indicated that both a new product, Dyne-O-Might, and a new application technique in combination with a sanitizer (Foam + ALAS 478) provided as effective, and in most cases better, antimicrobial control without sacrificing growout numbers.

Flies are treated on schedule with fly baits or sprays put out at regular intervals. Our pest management survey indicated that performance was questionable with the fly baits, which are all based on the carbamate insecticide, methomyl. The effectiveness of permethrin and other pyrethroid fly sprays was also perceived as less than adequate. Our demonstration projects on fryer and turkey farms highlighted monitoring tools to detect fly population buildup and the use of litter management to minimize breeding sites. Parasites were released and drinkers were adjusted to alleviate water spillage. The fly program was successful in eliminating the need for fly bait and fly sprays on the breeder farm and reducing the number of fly sprays on the turkey farm. Additionally, the use of fly bottles may have contributed to effective fly control on the breeder farms. Both the turkey and fryer breeder farms had been cited for public nuisance in the previous year but made it through the fly demonstration project with such low populations that no complaints were made.

Rodents are traditionally managed by keeping bait out in bait stations on an as needed basis. Unfortunately, this method allows buildup of tremendous numbers of mice and rats on breeder farms where the birds are housed undisturbed for a year. Leaving bait out also became illegal in certain areas where endangered species live. Alternatives to bait stations were demonstrated using visual monitoring to determine sites of activity and baiting holes. Intensive pretreatment of empty houses between flocks also significantly reduced populations and subsequent buildup during the production cycle. Reducing external harborage by eliminating

weeds and rotating rodenticide chemistries were also included in the demonstration project.

Weed control on the breeder farm depended heavily on glyphosate. Other poultry facilities used diuron or oxyfluorfen, which were included in our demonstration project along with Oust®, a low rate sulfonylurea registered for this pattern of use. Oust + RoundUp outperformed all other treatments, negating the need for diuron.

The reduced pesticide risk program centered on industry needs highlighted in the survey. The projects on commercial fryer breeder, fryer growout and turkey growout farms addressed needs the industry reported in their survey. The estimated use and benefits to the industry are presented in the following table.

Description of Project	Lbs used in 1997 (formulated product)	Cost of Current Use	Estimated $ Benefit of changing to alternative	ai on FQPA lists	Benefit for Reduction in Worker Risk (safety & exposure)	Benefit for Reduction in Environmental Risk
Formaldehyde Alternative	1,159,920	$1,178,496	>M$1	yes	significant	significant
Fly bait (methomyl) alternative	18,000	$75,000	decreased bait use	yes	significant	na
Diuron alternative	>5764	>$25,400	$12K-0	no-ground water & surface runoff issue	na	significant
Rodent Management	48,960	>$120,000	increase effectiveness of rodent baiting and decrease amount of bait used	no	no	will reduce impact on endangered species and prevent resistance development

The funding and allocation of funds during the course of these projects are summarized in the following table: Poultry Pest Management Alliance Program Costs

Project	Total*	DPR funds	Industry Matching
Fryer Formaldehyde	$352,385	$55,383	$297,002
Fryer Flies	$57,693	$8,710	$48,983
Turkey Flies	$432,355	$5,300	$427,055
Fryer Breeder flies, rodents, weeds	$130,551	$30,204	$100,347
Total	$972,984	$99,597	$873,387

Direct and Indirect Costs. Note: Does not include the value of the birds or feed. If these are included, then the total value of this program is >M$7.

The combination IPM program on a fryer breeder farm which demonstrated fly, rodent and weed management resulted in eliminating all fly bait and sprays, reducing the amount and labor involved in rodent baiting, and eliminating the need for diuron. The program saved an estimated $7000 compared to prior year's efforts and produced more effective pest management.

This program demonstrated reduced risk pesticide alternatives to several classes of pesticides. Cost savings as well as environmental and health benefits were realized by the producers during the projects. Adoption of several IPM strategies has been undertaken by poultry companies on a farm customization basis and outreach and education programs sponsored by CPF have been favorably received by the poultry community.

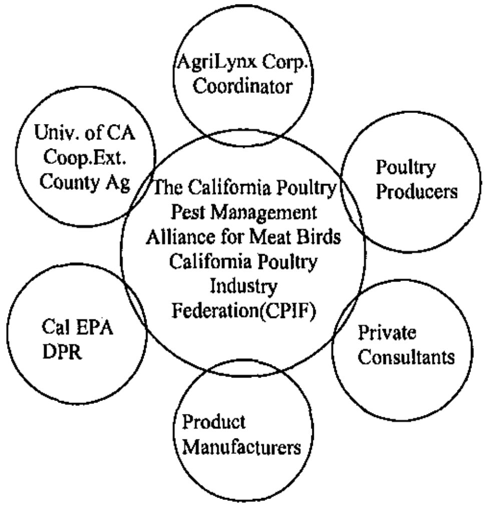
III. Introduction: Scope of the Program

The poultry industry is a highly integrated industry with most chickens and turkeys produced by three large companies. While the number of farms and farm acreage are large, most of these farms are in the central valley of California, which makes a statewide IPM program for these birds less of a geographical challenge. These producers are represented by CPF and are striving for farm-to-fork programs that not only seek reduced pesticide usage (and risk) but more efficient pathogen control. The two are related in that many of the pathogen vectors such as flies, rodents and darkling beetles are known hosts for microbes such as *Salmonella* and *E. coli*. CPF sponsors annual meat quality assurance training programs that include pest management strategies. Farm personnel are required to attend and pass a test to satisfy the requirements of their companies that participate in the Meat Quality Assurance Program. This industry is interested in developing, implementing, and promoting IPM programs on farms. At the time this proposal was submitted, California's chickens and turkeys had generated $679 million dollars in cash receipts (CDFA, 1996, based on value of quantity harvested) and together would rank as #10 in commodity ranking.

The California Poultry Pest Management Alliance for Meat Birds (PPMAMB) was formed in 1997 and has membership consisting of poultry producers, private consultants, product manufacturers, product distributors, the University of California Cooperative Extension, California Department of Pesticide Regulation (DPR, a division of the California EPA) and a central nonprofit professional organization representing >90% of all poultry produced and processed in the state, The California Poultry Federation (CPF). We came together in response to a funding opportunity proposed by Cal EPA, which sought a participatory solution to challenges facing industries in the state:

1) Developing alternatives to organophosphate and other pesticides which may be lost due to re-registration requirements triggered by the Food Quality Protection Act (FQPA)
2) Reducing/eliminating surface water contamination by pesticides
3) Reducing/eliminating groundwater contamination by pesticides
4) Reducing/eliminating human exposure to pesticides due to off-site movement
5) Managing pesticide resistance
6) Managing new major pest infestations
7) Reducing risks associated with post-harvest treatment of produce
8) Reducing field worker exposure to pesticides in labor intensive crops
9) Developing reduced-risk pest management systems in the urban environment
10) Developing reduced-risk antimicrobial systems

Our central group is CPF, which is a focal point for coordinating, developing, demonstrating, and implementing reduced risk techniques and information. Most of the other members of the alliance are CPF members; however, that is not a requirement for participation. This is an informal alliance. There are no dues or organization structure.



A pest management survey was conducted in 1997 to assess the current status and detect areas that were of concern to our producers. We put together a one page survey form that asked producers to respond to questions on how they managed pathogens, insects, weeds, rodents, and other vertebrates. We asked what monitoring techniques they used as well as types of treatments, including mechanical control, pesticides, and biological control. The results indicated that our producers depended very heavily on certain pesticides (which were likely to be lost to FQPA), worker health and safety, resistance, antimicrobial risk, and groundwater issues.

We put together a proposal that outlined an 18-month series of 4 projects to demonstrate various methods to monitor, evaluate, and control flies, rodents, and weeds. An additional 5th project looked at alternatives to formaldehyde. This multifaceted project was funded by DPR by a $99,597 contract. Matching funds (in equipment, labor, farms, and products) by the cooperators totaled >$873,387 which made the value of this contract >$972,984.

The Alliance Mission and Goal

Like many groups seeking to define a project centering around Integrated Pest Management, we struggled with defining the mission and goals for the alliance. Historically the definitions can be very complicated and may result in alienation of a participant. It may also lead to misunderstanding by others outside of the immediate project; e.g., to reduce pesticide use may not be a result that a pesticide manufacturer would support. Also, if a producer were faced with a complex set of items in a mission statement, he may be overwhelmed with all the items he would be faced to comply with and may be less than enthusiastic in his support. There are also instances where the mission statement and goal statements are written in such a manner where success would be difficult to measure, especially if there were social and political issues involved.

Since the alliance was focused on reducing pesticide risk we decided that that would be both our mission and goal: Reduce Pesticide Risk. No one could argue with those three straightforward and very clear words, nor would they be threatened by their use since everyone's best interest would be served. The poultry industry wanted to reduce risk, DPR wanted to reduce risk, the pesticide manufacturers wanted to reduce risk, the beneficial insectaries would want to reduce pesticide risk to their biological agents, etc.

The Alliance Strategy

We decided to use Integrated Pest Management as our strategy to follow our mission and reach our goal. IPM has had various definitions over the last few decades and, whatever one is subscribed to, the end result is to reduce pesticide risk. IPM is really a strategy encompassing a whole box of tools, from which appropriate tactics can be selected. It is not necessary to use all of them, just the ones needed for a particular project. It is a flexible, evergreen philosophy that can be customized for each situation. Sustainable agriculture is very much like IPM. It is a strategy that should be customized for each situation.

The Alliance Tactics

We selected IPM tactics requiring intense cooperator participation. This type of technology demonstration is the most likely to be adapted by the producer and disseminated by peer group discussion and presentation. We selected various types of monitoring tools for flies (cards, bottles, visual assessment), rodents (live traps, visual inspection, baits), disinfectant efficacy (biological swabs, growout data), and weeds (visual estimation). We also selected various treatments to compare in all projects with the producer evaluating effectiveness. We do not have any economic thresholds for any of the pests we identified in our project plan. We needed to establish some type of monitoring for our quality assurance programs and the monitoring procedures we do have can be optimized over time. In fact, from data collected during the alliance programs, we were able to enhance this knowledge base for future projects.

CALIFORNIA PEST MANAGEMENT ALLIANCE FOR MEAT BIRDS

MISSION: REDUCE PESTICIDE RISK

GOAL: REDUCE PESTICIDE RISK

STRATEGY: USE INTEGRATED PEST MANAGEMENT TECHNIQUES

TACTICS: DEMONSTRATE/OPTIMIZE MONITORING, DEMONSTRATE ALTERNATIVE TREATMENTS, EDUCATE CONSTITUENCY THROUGH PUBLICATIONS, WEB PAGE, PRESENTATIONS AND IMPLEMENTATION IN THE CPIF QUALITY ASSURANCE PROGRAM

The results presented in the following sections indicate substantial tangible and intangible benefits to the poultry producer in California. The tangible benefits include real dollar savings in managing flies, rodents and weeds as well as demonstrated alternatives to certain disinfectants. The intangible benefits include the formation of a pest management group within a major company, an increased awareness of reduced risk pest management programs, and a new level of credibility for these types of programs within the industry.

The progress in developing and implementing reduced risk pesticide programs for managing pests has exceeded the expectations of the alliance. The development of these alliances also has implications for sustainable agriculture.

We believe that we have enhanced the development and implementation of reduced risk pesticide programs in California poultry because we have kept the program very focused, very simple, and have encouraged industry and producer participation. The projects centered on demonstrating known techniques and products, not research. The alliance template is a good one for addressing a multitude of challenges for the agricultural industry and it makes sense.

The entity that is most likely to benefit from any advances in IPM or sustainable agriculture is the industry itself. By having a group focused on pest management for its members, the industry becomes less dependent on regulators, pesticide manufacturers, or other outside advisors, and is able to proactively address issues of concern internally.

The workplan for the commercial poultry meat birds was multifaceted and included projects with the two largest California meat bird companies. These 5 projects were based on areas of concern highlighted in the poultry survey conducted in 1997: 1) use of formaldehyde disinfectant (Total formaldehyde use reported by our survey respondents was 1,159,920 pounds of 37% formaldehyde or 429,170 pounds of active ingredient), 2) dependence on methomyl-based fly baits (an active ingredient related to organophosphates which is also under FQPA review), 3) use of diuron herbicide for maintaining weed control (a herbicide which may contribute to water quality issues), and 4) the continuing problems with rodent infestations on farms even with the high poundage of rodent bait placed (the pattern of use may impact endangered species).

The individual projects covered evaluation and demonstration of alternatives to 1) formaldehyde disinfectant, 2) methomyl fly baits, permethrin (classified C carcinogen), and organophosphate fly sprays, 3) diuron herbicide, and 4) rodent management. Embedded in each project were techniques that include training in monitoring, use of mechanical systems, biological controls and pesticide selection and application. The commercial fryer project centered around California's largest company's fryer and turkey operations with participation by experts in disinfection/sanitation, poultry production and logistics, entomology, and vertebrate pest management, and outreach of the developments by CPF and Cooperative Extension. The breeder farm trial centered around the need to provide better methods to monitor and manage rodents, flies and weeds in the valuable breeder production system which is unlike commercial meat operations. This project aided in the creation of an IPM group within the poultry company that began meeting regularly to share and develop IPM program information. The CPF Board was updated and information on the results of the alliance was presented at two Quality Assurance meetings. Educational materials on existing IPM systems for poultry were produced and reprinted for CPF and Cooperative Extension. They were also shared with other poultry and dairy alliances.

To develop, demonstrate and implement some of the alternative methods of treating these pests on commercial growout farms, we designed a multidisciplinary program with the largest poultry company in California. The fryer formaldehyde alternative project included experts in disinfection, poultry health, worker safety, pesticide chemistry and application, and flock production. There is no peer reviewed published information regarding the efficacy of disinfectants used during poultry production. Most data published by the disinfectant manufacturers are generated within controlled laboratory conditions. This project's year long trial on two large complexes utilized a total of 120 houses to evaluate alternatives to formaldehyde. The original workplan specified using only three flocks during the cooler seasons, which traditionally received formaldehyde treatments. Because of the results from the three flocks, the company continued the project for two additional summer flocks. An interesting facet of this project included demonstrating the effectiveness of a new application technique (foam) which was used in combination with a sanitizer. Other products demonstrated were a relatively new iodine product as well as two traditionally used disinfectants. The fryer farm fly project utilized two complexes consisting of four farms with 14-16 houses/farm for one flock cycle during the heaviest fly population of the year. The farms received treatments for alternatives to fly bait: fly bottles, mechanical litter mixing, and a combination of the two. Similar fly management techniques were demonstrated on a large turkey growout farm project that ran for one flock production cycle during peak fly season.

The multidimensional breeder project included 1) demonstrating the fly monitoring techniques 2) demonstrating and evaluating fly bait alternatives which included fly bottles, parasites, and fly sprays, 3) demonstrating optimum manure management techniques that minimize fly breeding sites and 4) demonstrating alternatives to diuron, which included selection of nozzles, sprayer calibration, optimum timing of applications, and efficacy comparison of reduced risk herbicide products. The breeder farm had never received a pre-emergent herbicide application and the vegetation was contributing to significant rodent populations on the farm.

The goal of these projects was to demonstrate and implement technologies and products that reduced pesticide risk on these farms. Results of these demonstration programs provided a new basis for reduced risk pesticide information and methods which the industry is adopting to manage their pests. Each facet was designed to meet both industry needs and regulatory concerns.

IV. Formaldehyde Alternative Demonstration Project

A. Abstract

Demonstration treatments utilizing reduced risk disinfectants on two fryer complexes through five flocks provided data supporting alternatives to formaldehyde. The PocketSwab® ATP in-field monitoring technique performed reliably and substantiated reduced microbial loads post treatment with several disinfectants. Correlation with designated flock production numbers indicated that both Dyne-O-Might and Foamed ALAS 478 provide disinfectant efficacy as good as or better than formaldehyde. Subsequent treatments of formaldehyde by one company have reduced the use of formaldehyde by an estimated 70%. Data also indicated that two commonly used disinfectants may give only slightly better antimicrobial control than a good soap + water washdown.

B. Introduction

Disinfectants are used between flocks to manage pathogens of concern to the producer. The most effective and expensive (based on total costs involved) disinfectant used is formaldehyde. Formaldehyde is a B2 carcinogen and has worker health and safety issues, mandating "remote" application in California. It is routinely used by fryer companies 1-3 times per year and used on other turkey and egg farms when disease has become an issue. The product is applied with special equipment that minimizes applicator exposure but increases treatment cost. Even with the large cost disadvantage, the use of this product ensures a profitable flock and it is unlikely that these companies will change unless cost effective alternatives are available. In fact, three companies indicated that they were looking at increasing their use of this material for their own production. Other less expensive disinfectants are utilized extensively instead of formaldehyde; however, field demonstrations of their effectiveness are lacking in the literature. Our project focused on finding alternatives to formaldehyde or reducing formaldehyde usage such as:

a. Alternative application techniques such as foaming a disinfectant sanitizer, which is very effectively used in the food processing industry and has demonstrated equivalence to formaldehyde in limited field studies last year. The key to this development was designing and constructing equipment that could apply adequate foam in a 16,000 square foot house. The current high cost of this application also reflects the increased labor and time required for a high quality application.
b. Demonstrating reduced risk alternative compounds such as iodine that are similar in cost on a product basis to formaldehyde application but do not generate the issues associated with formaldehyde application.

Typical disinfection expenses according to our pest management survey indicated the following:

Disinfection Expense	Cost/ House	Cost to the producers responding to the survey	Estimated cost savings per house compared to using formaldehyde
Formaldehyde	$12	$55,596	
Delivery to farm	$12	$55,596	
Product cost	$98	$455,887	
Application cost	$110	$509,630	

Security (@ $9/hr x 24 hrs)/2 ranches	$8	$35,720	
Hotel for employees, 2 nights @ $150	$11	$49,619	
Per diem/employee ($20/day x 4 people x 2 days)	$11	$52,955	
Clear ranch for release (4 hr/ranch)	$4	$19,088	
Subtotal	$254	$1,178,496	
Alternatives			
Typical quaternary ammonium or phenolic disinfectant	$17	$79,585	
Application cost	$14	$64,862	
Subtotal	$31	$144,447	$223
Dyne-O-Might (Iodine disinfectant)	$208		
Application cost	$14		
Subtotal	$222		$32
Foam + Alas 478	$28		
Application cost*	$175		
Subtotal	$203		$51

*Application cost would decline significantly once foaming equipment is more widely available

C. Materials and Methods

Two fryer complexes consisting of four farms with 14 or 16 houses/farm for a total of 120 houses were treated for 5 flocks (two more than the original contract specified). These complexes were located in Merced and Stanislaus counties and differed structurally in that one was an open span style building and the other a center brooded layout. The farms in a complex are located adjacent to each other but handled logistically separately. All cleanout, washdowns, disinfection, litter and flock placements are done in a sequential manner and completed within a two-week period. There was greater than a 10 day down time between all flocks. All houses were completely cleaned out of old litter between each flock.

Six disinfectant/cleaning treatments were applied after cleanout and washdown. Washdown and Quick Klean (soap and water traditionally used to clean buildings and reduce organic matter prior to disinfectant application) were applied by poultry company crews. Disinfectants were applied post cleaning at labeled rates. Formalin (33-37 gallons of 37% formaldehyde/house) was applied by Clark Pest Control and Advanced Specialty Chemicals. The foam + sanitizer (ALAS® 478, 1 gallon/house) was applied by Advanced Specialty Chemicals. Dyne-O-Might was applied at a rate of 32 gallons product/16,000 sq. ft. house. Synergize (26% ammonium chloride + 7% gluteraldehyde) was applied at a rate of 1 gallon/house. Quick Klean, Synergize, and Advantage treatments were applied by the poultry company. A total of 30 houses per treatment application with five treatment times = 150 house treatments per product through 5 flocks on each farm. Formaldehyde and a control (Quick Klean only) were applied to both complexes. The treatments were:

Complex	Farm	Treatment No.	Treatment
1	1	1	Quick Klean
	2	2	Foam + ALAS[1] 478
	3	3	Dyne-O-Might®[2]
	4	4	Formaldehyde[3]
2	1	1	Quick Klean
	2	5	Synergize[4]
	3	6	Advantage[5]
	4	4	Formaldehyde

1 ALAS 478 is an acid-anionic cleaner sanitizer
2 Dyne-O-Might is a propionic acid/iodine mixture in a polyoxyethylene-polypropylene block polymer complex
3 Formalin is a 37% solution of formaldehyde
4 Synergize is a quaternary ammonium-gluteraldehyde cleaner-disinfectant-deodorant
5 Advantage 256 is a quaternary ammonium disinfectant

Antimicrobial load and recolonization were determined through ATP-based tests at pretreatment and two times post treatment. Swabs were taken by the same poultry company person. The Pocket Swab® Plus is a self-contained single service ATP rapid hygiene test which is used in the food and beverage industry. This is a bioluminescence test for the detection of adenosine triphosphate (ATP) on materials and provides a measure of immunoeffectiveness. It can be used in the field with data downloaded in the laboratory. Swab locations were outlined (2 x 2 inch squares) on side posts facing the interior of the house above the sidewalls at the base of the screen. There were 10 locations/house with 4 houses per farm. Swab samples were taken three times during each flock: 24 hours post flock pick-up, 24 hours post cleaning and 24-48 hours pre-chick placement. Growout data were also correlated with individual houses on each farm. The original PocketSwab was the most sensitive single use test based on preset PASS/FAIL readout (Food Quality April '97) and this version is now 40 times more sensitive. The cost for the swabs for this trial was $12,000.

D. Results

The results are attached in three reports from Haag Consulting. Overall both ALAS 478 and Dyne-O-Might consistently performed as well or slightly better than formaldehyde. The first report analyzes swab data (=microbial load) only from the first three flocks. The second report correlates swab data (biological load) with production numbers from the first two flocks and the third report summarizes all growout data comparison from five flocks. Full reports are included in the Appendix section.

A summary of the first report dated 7/10/99 on the comparisons of the biological load is summarized below.

1) The "No Treatment" category contains all of the pre-treatment data together and averaged across all three growouts. This gives an indication of the range of variability between farms and seasons.
2) Treatments ranked in order of performance are : 2>3>4>1>6>7>0 (treatment 5 = treatment 1; treatment 8 = treatment 4)

Treatment 1 = Quick Klean; Treatment 2 = Foam ALAS; Treatment 3 = Dyne-O-Mite

Treatment 4 = Formaldehyde; Treatment 6 = Synergize; Treatment 7 = Advantage

3) Treatments 2 and 3 are superior in the following way:
   a) We cannot distinguish them from each other
   b) We cannot distinguish 3 from 4, but 4 is worse than 2
   c) We cannot distinguish 4, 1, 6, 7, but 1, 6, 7 are inferior to 3
   d) No Treatment cannot be distinguished from treatments 1, 6, and 7

4) Treatment 2 outperformed treatment 4 during all three tests at post treatment. The average post-treatment count (log units) of Trt 2 ranged from 10-100 while Trt #4 ranged from 1000-4000
5) Within farm variation is very small; between farm variation is very large

Report 2 summarizes the relationship between the production measures and various factors including the disinfectants. The data analyzed were for each swab sampled house (not for the entire flock from the treated farm). The third flock data came in post analysis and may be used to test the hypothesis and results from the first two flock analyses. We did not attempt to analyze the effect of the different breed sources. Dr. Haag's table on the first page of his report shows the significance and interaction of these responses. He includes a discussion of the analysis on subsequent pages. The results are presented in a Summary Table entitled Performance Data vs. Treatment below. The analysis indicates the following:

1) The location of the test directly influenced the results and, since four of the treatments were present only on one site, differentiating true differences between treatments was confounded by lack of replication at a different location.
2) Weight gain was related to the date and location of the trial.
3) Condemnation was dependent on the treatment, the complex and the treatment by complex interaction.
4) Disease is dependent upon the treatment, complex and the treatment by complex interaction.
5) Cellulitis is related to the treatment.
6) Feed conversion is dependent upon the treatment, complex and the treatment by complex interaction.
7) Livability is dependent upon the treatment, complex and treatment by complex interaction.
8) Mortality at one week is dependent upon the treatment, complex and treatment by complex interaction.
9) Mortality at two weeks is dependent upon the treatment, complex and treatment by complex interaction.

The summary table of Dr. Haag's Report 2 is attached here.

SUMMARY TABLE: Performance Data vs Treatment for the October and December Growouts at Two Fryer Farm Complexes, October - December 1998

Note: Production data were taken from only those houses that were swabbed; analysis by breed source was not conducted. Dec refers to the Fall flock's
production data; February refers to the winter flock's production data

TREATMENTS: Trt 1=Quick Klean Trt 2= Foam ALAS Trt 3=Dyne-O-Might Trt 4=Formaldehyde Trt 6=Synergize Trt 7=Advantage

	Weight Gain	Condem	Condem	Disease	Disease	Cellulitis	Feed Conv	Feed Conv	Livability	Livability	1 wk mortality	1 wk mortality	2 wk mortality	2 wk mortality
Factors		*Treatment*	*Treatment by Complex*	*Treatment*	*Treatment by Complex*	*Treatment*	*Treatment*	*Treatment by Complex*	*Treatment*	*Treatment by Complex*	*Treatment*	*Treatment by Complex*	*Treatment*	*Treatment by Complex*
Best		2/a	4/La/a	4/a	4/Feb/a	4/a	3/a	3/El/a	7/a	4/El/b	6/a	6/La/a	6/a	6/La/a
		3/a	2/El/a	3/ab	4/Dec/ab	3/ab	2/a	2/El/a	6/a	1/El/b	4/a	4/La/ab	7/ab	1/La/a
		4/a	3/El/ab	2/ab	3/Dec/ab	2/ab	4/b	4/El/b	1/a	3/El/b	1/a	1/La/b	1/bb	4/El/a
		7/a	7/La/ab	7/ab	6/Dec/ab	6/ab	1/c	4/La/c	4/a	7/La/b	7/ab	7/La/c	4/c	7/La/ab
		1/a	1/El/ab	1/b	7/Dec/ab	1/b	6/c	1/El/c	3/a	1/La/b	2/ab	4/El/d	3/cd	1/El/ab
		6/a	4/El/ab	6/b	3/Feb/ab	7/b	7/c	6/La/d	2/a	2/El/b	3/ab	1/El/e	2/d	3/El/ab
			6/La/b		2/Dec/ab			7/La/d		6/La/b		2/El/e		2/El/b
			1/La/b		2/Feb/ab			1/La/d		4/La/a		3/El/f		4/La/c
					7/Feb/ab									
					1/Dec/b									
					1/Feb/b									
Worst					6/Feb/c									

Comm-ent	Weight gain was related to the date of the trial and the location (complex).	Percent condemned is dependent on treatment, complex and treatment by complex interaction	Data suggests that Trt 2 is better; caution necessary since site differences are important; trt 2 only applied to one site	Percent diseased is dependent upon the treatment, complex and interaction	Treatments 4,3,2 & 7 cannot be statistically separated; Trt 4 appears better than 1 or 6	Treatment is the major factor. Trt 4 is better than 1 or 7; trt 4 cannot be statistically separated from 3,2,or 6	FC is dependent upon the trt, cplx and trt by cplx interaction. Trts. 2 & 3 are significantly better than the rest.	EN appears to have better FC than LA	Livability is dependent upon the trt, cplx, and the trt by cplx interaction	Trt 4 Lake is worse than all others; however trt 4 alone is not significantly worse than any other trt	1 wk mortality is dependent upon the trt, cplx, and trt by cplx. Trts 6,4,and 1 are all better than trt 3	Trt by complex analysis indicates mortality is significantly higher at EN than LA	2 wk mortality is dependent upon the trt, cplx, and trt by cplx. Trts 6 and 7 are significantly better than trts 4,3 and 2	A similar trend between complexes is evident with mortality higher at EN than at LA

A Summary of Dr. Haag's final report is summarized below:

Results derived from a general linear model analysis using PROC GLM from SAS. Treatment effects were calculated within each complex for the four treatments, correcting for flock to flock variation, which may include seasonal factors. Comparisons made within complex are straightforward.

Treatments with the same letter cannot be distinguished. If two treatments do not have the same letter in common, they are different (with a 5% risk of false conclusion)

	Complex 1 Trt		Complex 2 Trt	
Feed Conversion	3	a	4	a
	4	a	6	a
	2	a	7	a
	1	a	1	a
Condemn	3	a	4	a
	4	ab	6	ab
	2	ab	7	b
	1	b	1	b
Disease	4	a	4	a
	3	a	7	ab
	1	b	1	b
	2	b	6	b
Cellulitis	3	a	4	a
	4	a	7	a
	1	ab	1	b
	2	b	6	b
Livability	4	a	6	a
	1	a	7	ab
	2	a	1	b
	3	b	4	b
Mortality, wk 1	4	a	1	a
	1	a	6	a
	2	a	4	a
	3	b	7	a
Mortality, wk 2	1	a	1	a
	4	a	6	a
	2	a	7	ab
	3	a	4	b
Weight Gain	no difference	no difference		

Comparison of the Control and Formaldehyde between the two complexes shows that only % condemnation and disease are significantly different. No other metrics were different between treatments.

The fryer farm formaldehyde alternative program costs are summarized in the table below:

Project	Cost/ project	Direct Matching	PMA Cost	Matching Source
Fryer Farm Formaldehyde Alternative	$135,031	$79,648	$55,383	Foster Farms, Advanced Specialty Chemicals, AgriLynx, Preserve International, Great Western Chemicals, Haag Consulting
Total Direct Cost	$135,031	$79,648	$55,383	
Total Indirect Costs : Foster Farms fryer facilities + personnel	$243,254			
Total Fryer Formaldehyde Program Costs	$352,385			Does not include birds or feed

E. Discussion

There appear to be alternatives to formaldehyde based on both flock performance and antimicrobial efficacy. Both the foam+ALAS and Dyne-O-Might treatments performed consistently better than Synergize and Advantage and comparably to formaldehyde. The ALAS 478 + foam application also requires less water than all other treatments (50 gallons/house vs 300 gallons/house) and dries quickly. Dyne-O-Might also contains organic acids that are recognized by FDA as GRAS (Generally Regarded As Safe). The sampling method performed well and appeared to represent the microbial load in the farms consistently and variation between houses on each farm was minimal, indicating uniform application and sampling methods. Formaldehyde is commonly used during cooler season production cycles where flocks are more at risk to respiratory diseases. The use during warmer weather is minimal. While these results indicate that formaldehyde use may be contraindicated for these particular production conditions, it may still be necessary to use this product in times of severe disease outbreak, when there is less than 10 days between flocks, or under conditions of rare disease occurrence/eradication. The fryer company running these evaluations discontinued using formaldehyde, reducing estimated use in California by 70% (>800,000 pounds formulated 37% formalin) in the subsequent year. Depending on the disinfectant method substituted, this may have saved the company >$1,000,000.

This evaluation should be repeated to validate the results, which were all collected during a single year. Poultry litter is not always removed between cycles and many organisms survive well on the surface and deeper layers of old litter. Most disinfectants do not perform well on litter because of the high organic load. Cleaning houses prior to disinfection removes this residue, allowing maximum disinfection activity. Formaldehyde may be able to penetrate more deeply than surface disinfection with the alternatives presented here. The sampling method is non specific and was not able to differentiate between microbes of concern and others naturally present in the environment. Diseases tend to be cyclical, and although growout numbers correlated with antimicrobial activity, in the future, some diseases may not be as sensitive to alternative disinfectant treatments.

V. Fly, Rodent and Weed Management Demonstration on a Fryer Breeder Farm

A. Abstract

A commercial fryer breeder farm with a history of fly complaints, high rodent populations, and heavy weed pressure served as the site to test an integrated pest management program which showcased techniques reducing pesticide risk. Effective fly breeding site management and the use of fly bottles appeared to eliminate the need for fly baits or sprays. Intense rodent preflock placement baiting and monitoring with concurrent baiting of perimeter burrows reduced labor and bait use significantly. Alternatives to diuron herbicide provided excellent long term weed control around buildings and fallow fields. The reduction in all targeted pest species was the result of a highly focused effort that saved an estimated $7,000 over prior year's efforts. Work is continuing by the company on optimizing their IPM program in all poultry production operations.

B. Introduction

Pest control is often done as a piece meal exercise on poultry farms. The opportunity to demonstrate a fully integrated program, which also elucidates the interaction of several pests, was offered to the Alliance on a commercial fryer breeder farm. Since breeders are housed for much longer periods of time than fryers, pest management is more challenging and the damages from ineffective management can be more costly. Breeder hens and roosters are valuable birds and are the source for the company's needs on the growout business. Breeder farms can be fast adopters for new technologies that reduce time, labor, and cost as well as provide economic benefits. The three projects on this breeder farm were:

1. Alternatives to methomyl fly baits or reducing the amount of fly bait
    a. The use of mechanical devices can solve two problems: they literally remove flies from the environment and they can be used as monitoring tools. The use of these has not been fully investigated on fryer and turkey farms although limited studies last year indicate high probability of success by using fly bottles on these farms.
    b. Parasites have shown to be very effective in layer farms; however, they have not been investigated as tools for meat bird farms. The recent gregarious species combined with a solitary species would make an ideal combination for investigation on these farms.

2. Alternatives to diuron herbicide or reducing diuron usage project
    a. Alternative herbicides such as oxyfluorfen, sulfometuron-methyl, and others are available and were demonstrated to the growers.
    b. Reduction of weeds and other vegetation around poultry farms has a direct influence on the population of rodents and flies; minimizing this habitat reduces the attractiveness of the area for these potential disease vectors.
    c. Optimum nozzle selection and placement and sprayer calibration maximize application effectiveness.

3. Reducing the potential for rodenticide resistance and exposure of endangered species
    a. A system to monitor rodents provides a tool whereby growers would not need to leave bait out continuously. This record-keeping would alert producers as to the effectiveness of their current management program and the need to rotate bait chemistries. Rodent monitoring tools such as live and snap traps serve dual purpose by eliminating the pest

as well as documenting rodent activities. These techniques had not been developed in this industry.

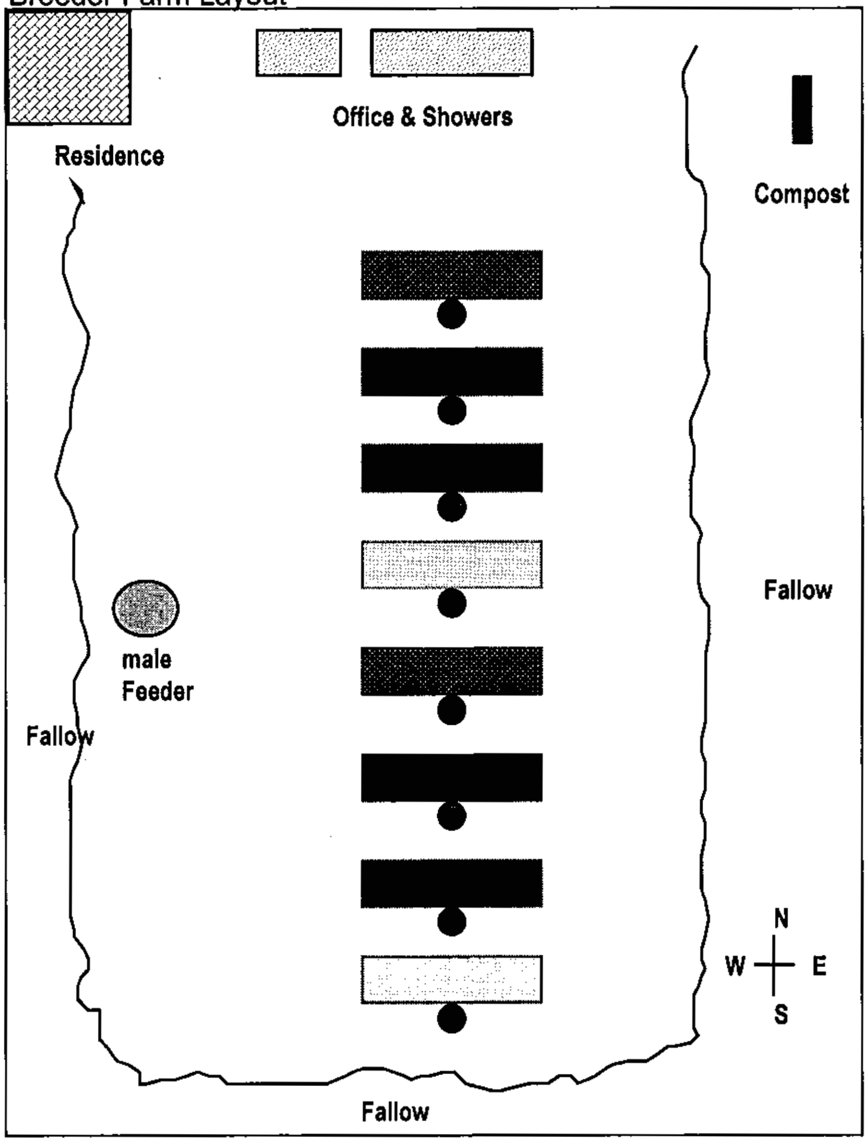
b. Published literature states unequivocally that it is impossible to eliminate rodents by just baiting. Demonstrating the concurrent use of multiple rodent management tools incorporating weed control, live/snap traps, tracking powder, and bait pellets and blocks would increase rodent control on the farms and reduce bait use and dependence.

C. Materials and Methods

An eight house fryer Breeder Farm located in Fresno County was the site of this project. This farm is located on 40 acres of which ~15 have houses/buildings and 25 are fallow. After flock removal in June, the buildings were completely cleaned out, washed down and sprayed with disinfectant and Tempo 20 WP (for darkling beetle control). Baiting and dusting for rodents commenced one week prior to flock placement. All houses were identical in construction. Two houses each were utilized per fly and rodent treatment. The farm layout, treatment sites and weed plots are diagrammed in charts below. Breeder flocks are in production for almost one year; this project ran for the entire flock cycle. This farm had also been the site of several fly nuisance complaints from adjacent neighbors in the prior year.

House fly monitoring: One fly bottle and two spot cards were placed in each house to evaluate fly populations and treatment efficacy with the objective to reduce the use of fly bait and fly sprays. Additional bottles were placed in the patio area next to the management office and adjacent to the compost bins. Data were collected weekly.
Fly Treatments: Two houses per farm per treatment: 1) Standard fly bait and fly spray; 2) 4 parasite releases 5 weeks post flock introduction at 5 colonies of 50:50 mixed *M. zorapter* and *M. raptorellus* per house; 3) 2 fly bottles/house + two fly bottles on the outside near intake and exhaust vents; 4) no treatment.
Rodent Monitoring: Rodents were monitored weekly by using visual counts of active rodent holes on the perimeter all the way around outside of each house, tin cats placed in each feed room, and snap traps placed on sidewall beams.
Treatments: Two houses per farm per treatment: 1) Clout (bromethalin, a metabolic rodenticide) + Havoc (brodifacoum, a single feeding anticoagulant rodenticide); 2) bromethalin + anticoagulant, 3) chlorophacinone (a multiple feeding anticoagulant) tracking powder + bromethalin + anticoagulant; 4) tracking powder, bromethalin, anticoagulant, live and snap traps.

Chart 1: Fryer Breeder Farm Layout



Weed Monitoring: The fallow ground was scraped and leveled prior to treatment. A Round Up treatment was made 2-3 months prior to plot layout. Treatments were laid out in a complete randomized block design between buildings and surrounding area of farm (see Chart). Weed counts were taken by using 1 foot x 1 foot square aluminum rectangles from UC Cooperative Extension (K. Hembree, Fresno County) and tossing them 10 times in each treatment block. Identification and counts were made on broadleaf and grass weeds.

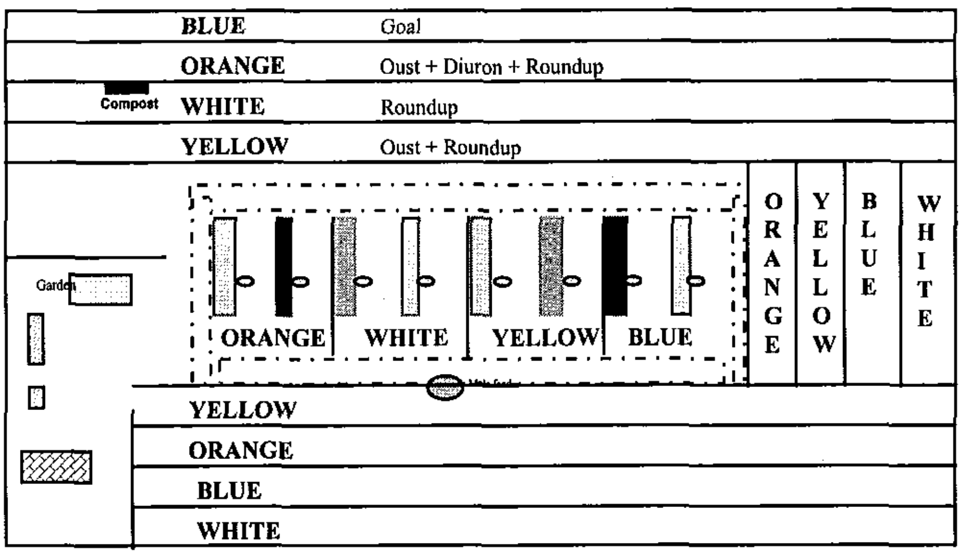
Herbicide Treatments: (10 total acres per treatment arranged in a RCB) on scraped, tilled and leveled/compacted soil 1) glyphosate; 2) Diuron 5 lb + Oust 3 oz + glyphosate; 3) Oust 3 oz + glyphosate ; 4) Goal 2 lb + glyphosate

a) Goal: oxyfluorfen, diphenylether selective herbicide for pre-emergence and/or post-emergence control of certain annual broadleaf and grassy weeds. Registered for use in many tree fruits, nuts, vegetables, cotton. Works with moisture at the soil surface to form a barrier. Formulations: EC and Granules, Toxicity Class: II, , Signal word : WARNING
b) Diuron: effective against emerging and young broadleaf and grass weeds as well as mosses;

suitable for both selective and total weed control. Wide use pattern. Formulations: F, G, WP, Toxicity Class: III (Tech), Signal Word: CAUTION (Tech)

c) Oust: sulfometuron-methyl, SU. Controls many annual, biennial, and perennial grasses and annual broadleaf weeds growing in noncropland, and reforestation areas including certain conifers and hardwoods. Effective for control of johnsongrass. Gives contact and residual control; used alone and in combination with other residuals for nonselective use. Also recommended for selective weed control in bermudagrass, bahiagrass, crested wheatgrass, and smooth brome on noncrop sites. Formulations: WDG, Rate: 3 oz/A, Toxicity Class: IV, Signal Word: CAUTION
d) RoundUp: glyphosate, Nonselective postemergence herbicide, Formulations: Aqueous, Water soluble liquid and concentrate. Rates: 1-2%, Toxicity Class (Roundup Pro or Ultra): III, Signal word (Roundup Pro or Ultra): CAUTION

The sprayer was retrofitted at a company cost of $1400. It was calibrated with nozzles selected for the most efficient application. Application was made using a tractor driven sprayer under near perfect conditions (almost no wind, clear, rain projected) using 11 TeeJet 8008 nozzles on the boom set 18" above ground running at 35psi. Originally TeeJet LP8003 nozzles were selected; back-pressure issues necessitated the change to the 8008s. Total gallons applied per acre averaged 38.4. Treatments were applied on February 18 and 19, 1999 and evaluated in June 1999. Calculations for treatment costs were based on a rate of $30/hour driver and equipment.



D. Results

House Fly Management

There was no significant difference between any of the treatments, including the untreated control. Both fly bottles and spot cards gave similar indications of trends in house fly populations that peaked ~8 weeks post flock introduction (see Appendix: Zacky Farms IPM Project, Green, Red, Blue and Yellow Fly Treatment charts provided by Mr. Palermo). Fly populations continued to decline until the flock was terminated. Care was taken to ensure that the drinkers were all adjusted to minimize water spillage and the ventilation system had been modified from the previous flock to maximize air flow through the slatted floors. Although externally placed fly bottles collected significant numbers of flies during some periods, total fly counts between treatments (colored houses represent different treatments) remained similar. We believe that those factors, placement of fly bottles in each house and the presence of numerous beneficial fly predators in the manure, contributed to excellent fly control in all houses. A fly bottle at the perimeter corner nearest a fly complaint location also caught few flies as did the bottle near the production office. The reduction in weeds during the course of this project may also have affected fly movement between buildings and properties. No fly sprays or baits were used on the farm. The management of the compost bins was modified to optimize composting and preservation of beneficial fly predators.

During the course of the fly project, the investigators met and worked with Ms. Sigrid Anderson from Fresno Environmental Health Services Agency. This agency is responsible for conducting public nuisance investigations

Rodent Management

The intensive rodent baiting program, which ran 5-7 days prior to flock introduction, reduced rodents significantly. While the two houses that were dusted with tracking powder appeared to have lower rodent numbers initially, these observations were not statistically supported. All treatments performed statistically the same. Tin cats in the male feeder area started catching mice late in the production cycle and were probably not a good early indicator of building populations. The snap traps placed along side-wall struts caught a few mice but were too few to give good information. They also fell off into the pit and were lost. The most telling signs of rodent activity were the external perimeter burrows, which were monitored and baited weekly. While new rodent-proof construction details footing depths and seals, these breeder houses were at least 20 years old with few physical barriers to entry. The holes are the first sign and are often reused. Baiting the holes provided very good rodent control and a measurement of activity, which built during the flock cycle. Please see Appendix: Zacky Farms IPM Project, Green, Red, Blue and Yellow Rodent Treatment. Rodent population measurements were confounded by having several people rate active/inactive burrows. Statistical analysis on hole counts showed no differences and variability increased along with actual burrow counts. However, rodent populations at flock termination were much less than the previous flock. More effective methods of evaluating rodent populations need to be developed for these farm production conditions and baiting externally may not be the optimum solution.

Weed Management:

The actual amount and cost of herbicides applied are listed below:

Products	PKG	Pkg cost	Formulation	Label Use Rate/A	Cost per Acre	Actual applied/ Acre	Actual Cost/Acre
Oust, DF	**3 lb**	**$569.79**	**75%**	**3 oz**	**$35.61**	**2.4 oz**	**$28.49**
Diuron FL	**2.5 gal**	**$37.11**	**40%**	**1.25 gal**	**$18.56**	**1 gal**	**$14.84**
Goal 2 XL	**2.5 gal**	**$217.00**	**22%**	**1 gal**	**$86.80**	**.8 gal**	**$69.44**
RoundUp Ultra	**2.5 gal**	**$91.88**	**41%**	**49 oz**	**$14.06**	**39 oz**	**$11.25**
Oust + RoundUp							**$39.74**
Oust+RoundUp+Diuron							**$54.58**

Mr. Rick Palermo and Martin de la Torre (Zacky's), Dr. Leslie Hickle (AgriLynx), Mr. Kurt Hembree (UC Coop Extension) and Mr. Fred Rinder from the Fresno County Agricultural

Commissioner's office rated the plots. Typical weeds encountered included purple nutsedge (*Cyperus rotundus*), yellow nutsedge (*Cyperus esculentus*), Johnsongrass, ripgut broom, purslane, puncture vine, knotweed, Russian thistle, spotted spurge, fiddleneck,, cheeseweed, annual blue grassand Bermuda grass.

ANOVA performed on the data indicated that both Oust treatments were statistically more effective than Goal or Round Up. There was no difference between Oust alone and Oust + Diuron. An interesting observation was that one section of the Goal plot had not been sprayed with Roundup prior to treatments and showed high grass populations.

The final ratings were:

Oust + RoundUp	a
Oust + Round Up + Diuron	a
Goal	b
Round Up	c

While Diuron is still the most inexpensive treatment at ~$15/acre, it must be used in conjunction with another herbicide such as bromacil or simazine. The Oust alone at $28.50/acre would still be more expensive than diuron combinations; however, it will have fewer water quality issues. There are other potential herbicides for consideration, which are mentioned in the discussion section.

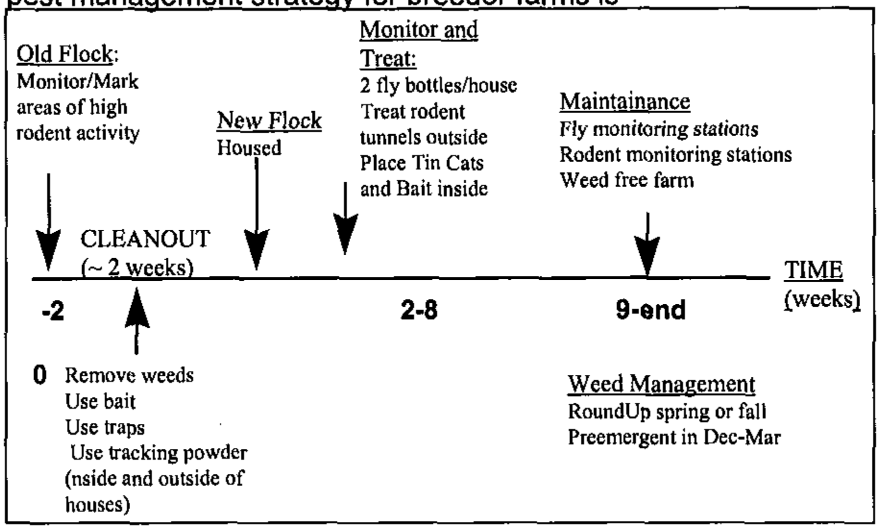
The total cost for this project was:

Project	Cost/ project	Direct Matching	PMA Cost	Matching Source
Fly IPM: Methomyl alternative	$32,401	$16,488	$15,913	Zacky's, AgriLynx, Walco
Rodent IPM	$22,896	$14,221	$8,675	Zacky's, AgriLynx, Loveland, Walco, Bayer
Diuron Alternative	$12,854	$7238	$5,616	Zacky's, AgriLynx
Total Direct Cost	$68,151	$37,947	$30,204	
Total Indirect Costs : Zacky's facilities + personnel	$62,400			
Total Fryer Breeder Program Costs	$130,551			Does not include birds or feed

E. Discussion

The results on the breeder farm exceeded expectations. Modification of vent systems prior to flock placement and subsequent drinker management perhaps in combination with the fly bottles appeared to ameliorate any fly problems and no fly bait or fly sprays were applied during the year this project ran. Vegetation management also affected both fly and rodent harborage, resulting in zero fly nuisance complaints from an adjacent neighbor. The rodent management program demonstrated clearly reduced rodents significantly in the flock houses. However, this effort requires optimization. Baiting programs should be run more intensively for a longer period of time than we had (2 weeks minimum instead of 1 one week) and pressure from the fallow fields requires reduction. Perhaps the installation of owl boxes on the perimeter of this farm would aid this effort. The weed management trial emphasized the need for optimum sprayer calibration, nozzle selection, land preparation and application timing for effective weed control. Pre-emergent herbicides require at least 1 inch of rainfall. The products selected were economically superior to RoundUp alone for long-term control and showed efficacy equivalent or better than diuron. Other potential herbicides to evaluate as potential replacements for diuron on poultry farms include: Milestone®, Prowl®, Telar®, and Liberty®. By reducing weeds near the buildings and in adjacent fallow fields, the pressure from rodents and flies was also reduced and undoubtedly contributed to results in those two projects.

The proposed pest management strategy for breeder farms is



We estimated that each fly bottle would last three years. At a cost of ~$13.00/bottle, and 1 bottle/house, this cost would be less than pesticide baits or sprays. It took an average of 4 hours per week to monitor flies (and change fly bottles) and rodents (and bait); time was equally divided between flies and rodents. At $10/hour, this equates to $40/week/8 house farm; however, the company would probably be baiting the rodents as part of a normal QC program so additional cost would be only the fly monitoring. Since flies are not an issue during cooler weather, it is anticipated that this cost will be reduced further since monitoring during late fall, winter and early spring will not be required or as intense. A six month fly program on an eight house farm is estimated to cost ~$810 [$40 (bottles) + $250 (replacement attractant) + $520 (labor @ 26 weeks x 2 hours/week x $10/hr)]. While we used spot cards to monitor house fly populations, the fly bottles were equally indicative. Also, in areas that attract *Fannia*, fly tape could be substituted or used instead of spot cards. Fly tapes average ~$0.35 each. This would add $80 in direct costs. Additional monitoring of perimeters or office areas could be maintained at incremental costs.

A comparison of the economic benefits shows that this farm spent $13,275 for weed, fly and rodent control in the prior year. The annual projected cost for this integrated program is estimated to be $6200. This estimate includes monitoring costs, herbicides, fly attractant, bottles, fly tape, and rodenticides. This is >$7000/year savings on each breeder farm.

VI. Fly Management Demonstration on a Fryer Growout Farm

A. Abstract

Fryer growout farms on two complexes in the Central Valley were utilized for demonstrating the use of monitoring tools and alternative treatment methods. No treatment was significantly better than the standard fly bait/fly spray treatment, nor were they any less expensive. Population monitoring with fly cards, fly bottles and drop wire counts were weakly correlated. Challenges continue on these styles of farms to optimize fly monitoring and management.

B. Introduction

During the hottest parts of the year, flies seek shelter from the heat and flee to the cool interiors of fryer houses. They can be most problematic when the houses are empty or when the chicks are small. Generally, fryer farms have litter which is too dry for breeding; however, small populations can develop from dead bird disposal bins, water leaks outside buildings, and areas around disinfectant foot washes. Farms adjacent to other livestock such as dairies and pastured cattle may also attract those flies seeking shelter. Some work has been conducted on fly monitoring techniques, but none on fryer farms. Reducing pesticide risk through reduction in fly baits/sprays was demonstrated by using fly bottles and composting litter between flocks.

C. Materials and Methods

Fryer growout farms are attractive to flies during the hot summer and fall months. Two complexes (4 farms each with a total of 120 houses) in Stanislaus and Merced counties were utilized for this demonstration project. Each farm received one treatment. All farms were monitored with fly bottles, large spot cards, or drop wire counts. Data were taken weekly from mid July to mid November.

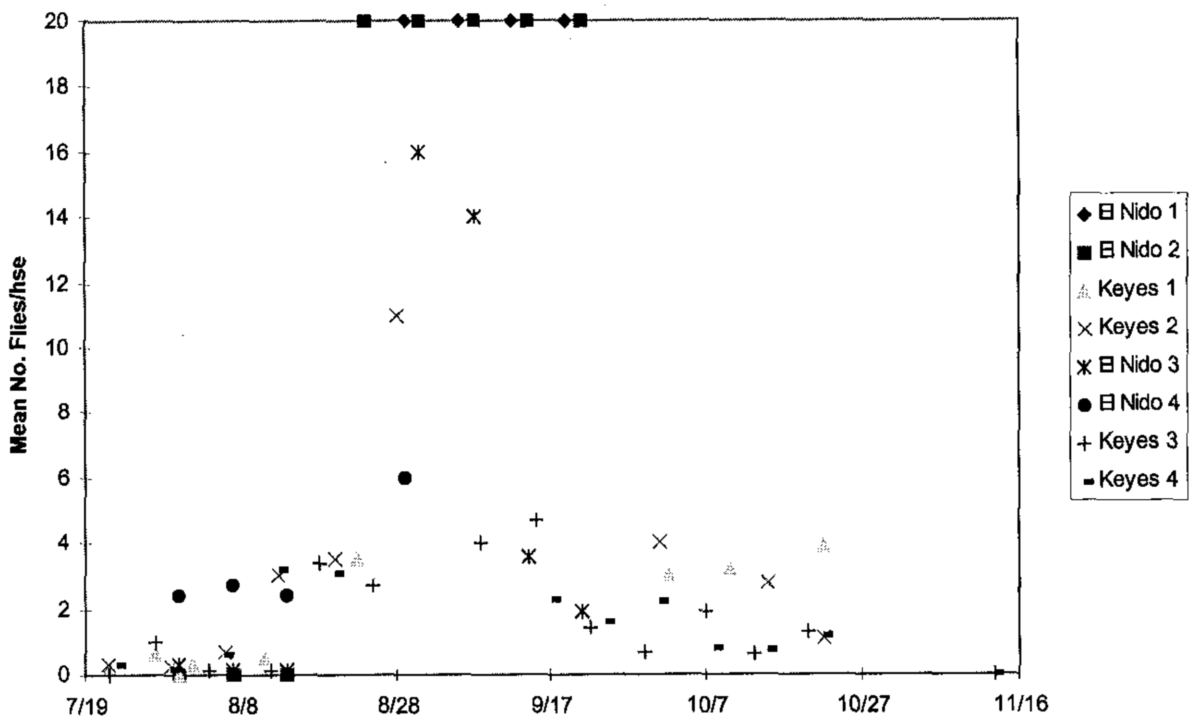
Treatments were as follows:
#1 Conventional insecticide bait and spray treatment; monitor drop wires EN 1 and KE 1
#2 One fly bottle per house; monitor bottles and drop wires: EN 4 and KE 4
#3 Two fly bottles per house; monitor bottles and drop wires: EN 3 and KE 3
#4 Compost litter between flocks; monitor drop wires: EN 2 and KE 2. We monitored moisture in the litter and added water as necessary.
We also compared the attractiveness of new pheromone vs old flies left in the jar replenished with new water by splitting some farms in half.

D. Results:

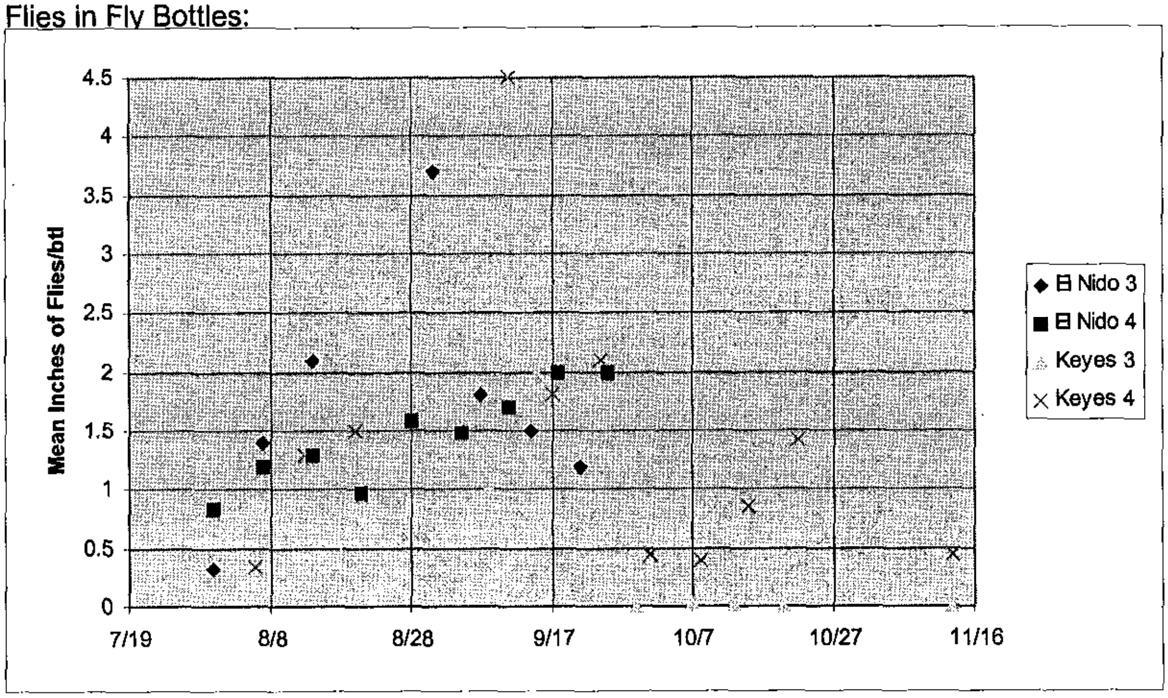
Charts from the drop wire and fly bottles are presented below. The flies did not rest on the large cards that were set up. It may be that the locations of the cards were in areas with too much wind; flies prefer dead air space, which is rare in well-ventilated fryer houses.

The drop wire near the corner of the feeder trough and entry door appeared to consistently have flies. We compared fly populations on all farms using drop wire counts. These are presented in the chart below:

Flies on drop wires:



Flies in Fly Bottles:



Costs of Treatments were estimated:

#1 Insecticides 55 lbs @ $ $4.00/lb = $220/year

Manpower (min/hse): Estimate 5 min/hse

Manpower/farm/yr

KE had 7 applications x 14 hse x 5 min/hse = 8.2 hr/farm/yr x $10/hr = $82/yr

#2 1 Fly bottle/house

KE $12.95/btl x 14 = $195 Manpower @ 10 min/bottle = 2.3 hr/farm/wk
EN $12.95 x 16 = $223 Manpower = 2.7 hr/farm/wk
Cost/hse/yr: 3 year life span of bottle: $4.64
Manpower/hse/yr: 4 months (17 weeks) w/1 bottle/hse: 170 min (2.83 hr)
Manpower/farm/yr: 14 hse farm: 39.7 hr/yr x $10/hr = $397/yr
16 hse farm: 45.3 hr/yr x $10/hr = $453

#3 2 fly bottles/house: double costs of treatment #2

#4 Composting: Labor to make windrow compost piles

Analysis using ANOVA indicates:

1> While data sets are normally distributed, there is only a weak correlation between drop wire counts and fly bottle counts (r=0.63). This may be due to incomplete data, effect of fly bottles on monitoring or sampling/sampler error.

2> There is a significant difference between bottles with pheromone and with old flies (r=.74). Pheromone bottles caught more flies than bottles baited with old flies; however, both indicated fly trends.

3> There is no significant difference between houses with one or two fly bottles.

4> Data too variable to support composting for fly control; may be other benefits re nutrient, ammonia and beetle management; litter moisture inconsistent-may be too dry; composting time minimal.

Project	Cost/ project	Direct Matching	PMA Cost	Matching Source
Fryer Farm Fly Management Project	$20,846	$8,710	$12,136	Foster Farms, AgriLynx, Walco
Total Direct Cost	$20,846	$8,710	$12,136	
Total Indirect Costs : Foster Farms fryer facilities + personnel	$36,847			
Total Fryer Fly Program Costs	$57,693			Does not include the cost of birds or feed

E. Discussion

While flies may be a nuisance on fryer farms during summer flock growouts, they generally fly in while the buildings are empty or while the flock is young. Older birds appear to dine on flies and keep populations down. Since these operations have gone to nipple drinkers, the litter is extremely dry and fly breeding sites are rare. To effectively compost treatment between flocks, we had to add water to the litter, which tested at an average of ~14% moisture. The addition produced the elevated rise in temperature to 140F, which drove the darkling beetles to the surface of the windrows where they could be treated if necessary. The composting also released significant amounts of ammonia, which we did not measure. The fly bottles may aid in reducing flies, but fly counts were not significantly different from other treatments including the standard fly bait/spray. Work should continue on optimizing fly monitoring for fryer farms.

VII. Fly Management Demonstration on a Turkey Growout Farm

A. Abstract

A commercial turkey growout farm in central California was utilized to demonstrate reduced pesticide risk techniques such as litter management, litter amendments, parasites and fly monitoring. Early monitoring data revealed breeding sites under drinkers and foggers. The litter amendment and pesticide dust applications did not appear to reduce adult fly populations. Daily movement of drinkers, proper drinker height adjustment, tilling litter on a three day cycle (which destroyed house fly maggots and dried breeding sites) and utilizing non-drip fogging nozzles may have had the greatest impact on retarding the fly population development. Fly monitoring with sticky tape indicates that it may be a useful tool to monitor adult fly populations.

B. Introduction

This project was substituted at the poultry company's request in lieu of the budgeted weed management program. The budget was transferred as outlined and had no material affect on the PMA.

Turkey growout farms in California can be the source of fly breeding due to the wet conditions of the litter bedding. Elimination of fly egg and maggot predators such as the darkling beetle have aggravated fly problems and during the summer and fall heat, tremendous numbers of flies develop in these houses. Very little information is available on fly management on turkey farms.

This project was undertaken to demonstrate and develop fly monitoring and treatment programs to reduce dependence on fly baits and fly sprays.

A 12 house turkey farm in Fresno county with a history of fly complaints was used during peak fly season during the summer and fall of 1999 to demonstrate fly monitoring, litter management and fly control.

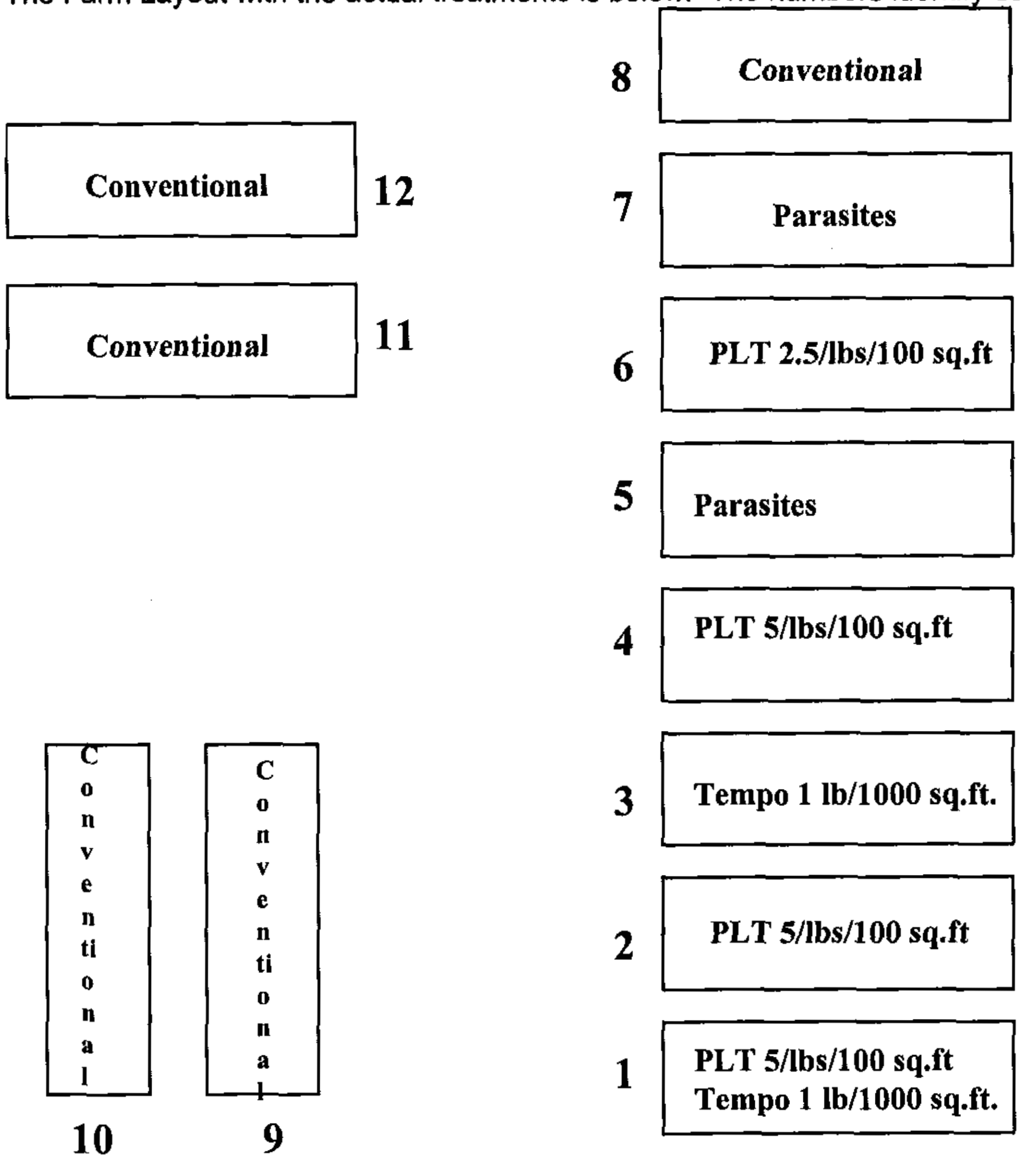
C. Materials and Methods

Eight houses of similar size and oriented in an east-west direction were selected for 4 treatments (2 houses/treatment). The litter was fourth run and in very good condition. The treatments were selected to provide alternatives to conventional sprays and fly baits. Poultry Litter Treatment is ammonium sulfate and is used to reduce litter pH, which aids in disease and ammonia control. It also lowers litter pH to highly acidic levels, which may increase pesticide residual and/or interfere with larval fly development. The treatments and their costs are presented in the following table:

Treatment	Product	Rate	pkgs/16,000 sqft house	pkg	cost per pkg	cost per house
1	Poultry Litter Treatment	5 lb/100 sqft	16	50# bag	$12	$192
2	Tempo 1% dust	1 lb/1000 sqft	2	10# sleeve	$31	$62
3	PLT +	5 lb/100 sqft	16			
	Tempo 1% dust	1 lb/1000 sqft	2			$254

4	Parasites (4 releases)	5 colonies/house	5	colony	$10	$199
	fly bottles	4 bottles/house	4	each	$13	$52

The Farm Layout with the actual treatments is below. The numbers identify each house.



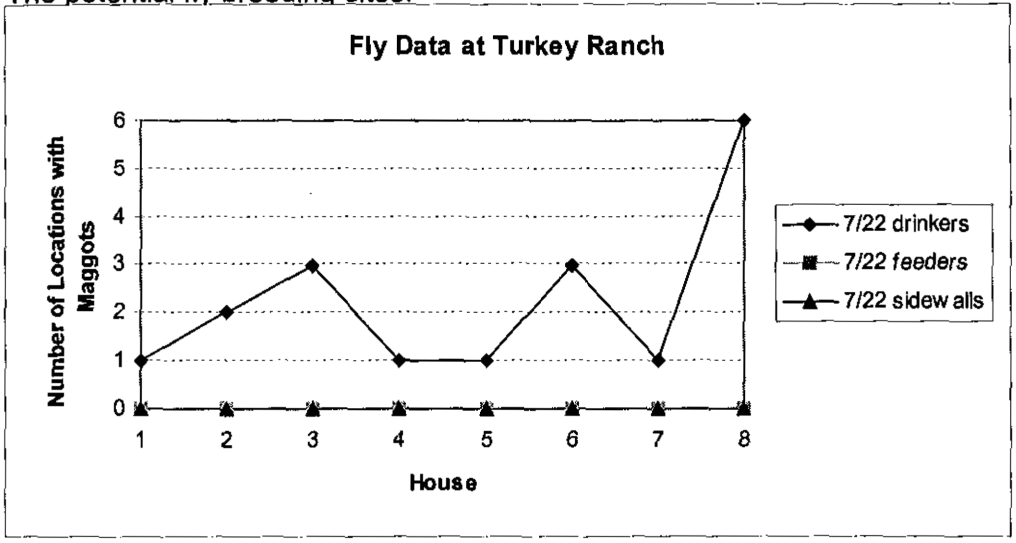
All litter treatments (PLT and Tempo) were applied prior to flock placement. 5-week-old poults were housed July 16. Potential breeding sites were monitored and adult populations were assessed using fly tape. Tapes were left up for 24 hours until populations increased to levels too high for consistent fly counts; they were then left up for 2 hours every week between 9-11 am. Two fly bottles were placed in each parasite treated house and changed on a weekly basis.

5 colonies of fly parasites (50:50 *M. zorapter* and *M. raptorellus*) were released 5 weeks post poult placement by hanging the bags from clips on the center posts.

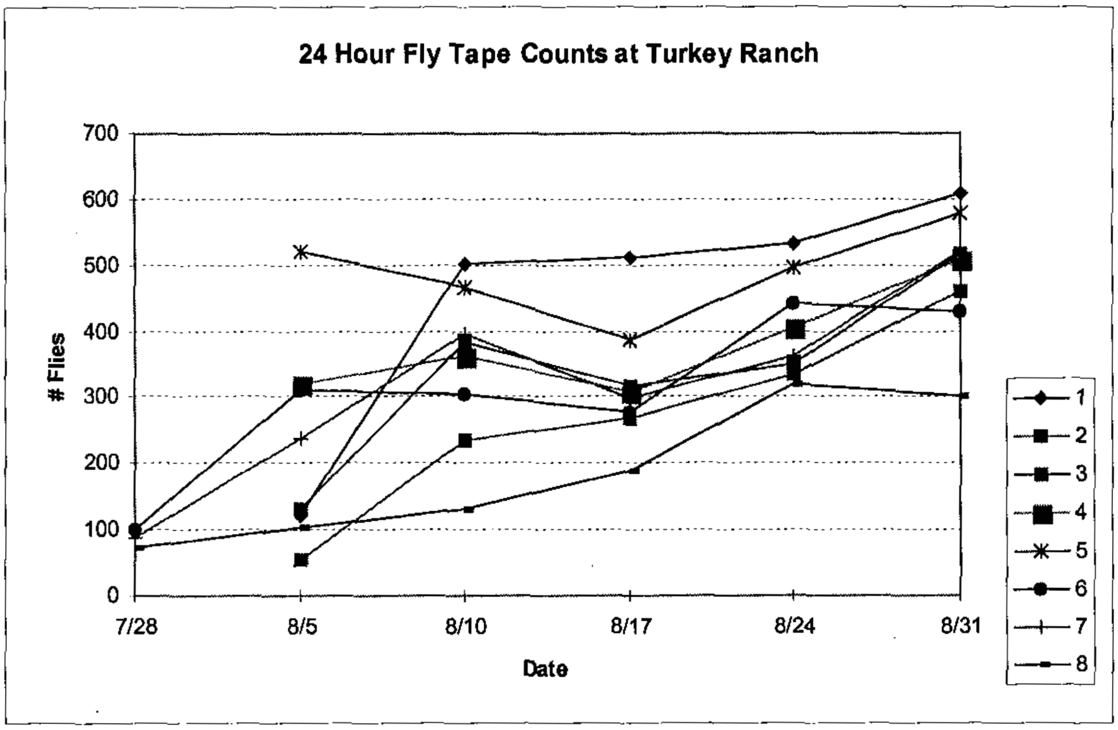
D. Results

Four days after poult placement, sites were sampled for potential fly breeding. All maggots were found under the plasson drinkers. Subsequent spot checks confirmed this as the major breeding site. Because maggots were found so soon after flock placement, tilling commenced in 4 houses within 5 days. Tilling each house on a three day cycle became the farm practice for all houses within two weeks. Tilling is normally delayed for as long as possible because it may trigger potential respiratory problems in the flock. As the weather increased in temperature, the foggers are activated and pockets of fly maggots were found under dripping nozzles. It was noted, but not quantified, that brass nozzles appeared to leak less than plastic nozzles.

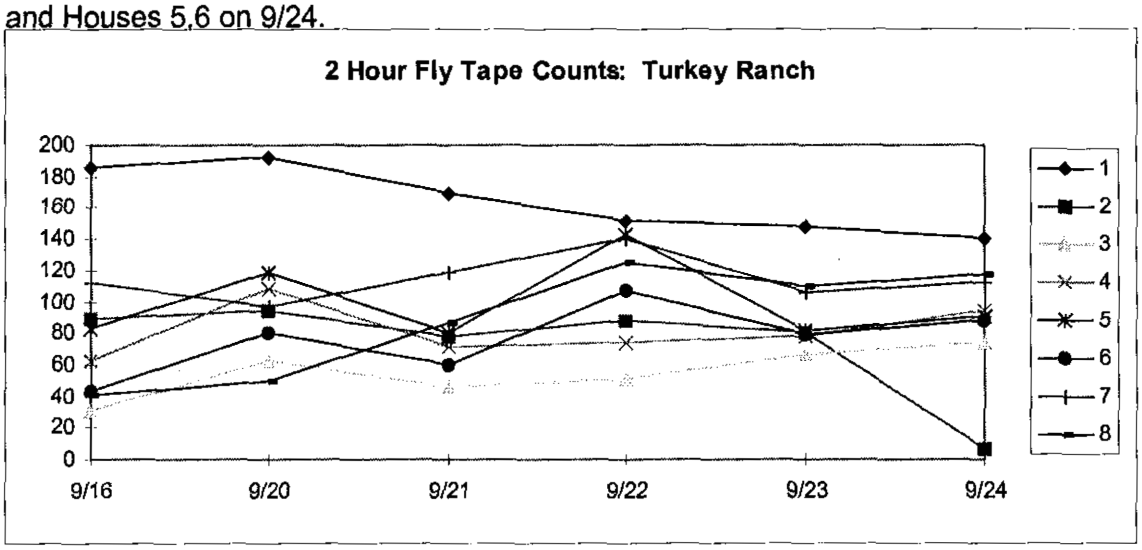
The potential fly breeding sites:



Early in the poult grow cycle, adult flies were at low levels. The fly tapes were left for 24 hours one day a week; the fly population trends are noted below.



Fly tape counts were changed to 2 hour exposures on September 16. Note that the following houses were sprayed with either Dimethoate on the litter or with Vapona on the walls and ceilings: Houses 1,2,3,4 w/dimethoate and 5,6,7,8 with Vapona on 9/20; Houses 5,6 on 9/22 and Houses 5,6 on 9/24.



The project was set up as a foundation to future projects and the number of reps was too few to provide significant statistical data. We did elucidate fly breeding sites, potential mitigating tools to use, and that fly tape may be a reliable monitoring tool. The houses with parasite releases did not differ from other treatments.

The cost of the project is summarized below.

Project	Cost/ project	Direct Matching	PMA Cost	Matching Source
Turkey Farm Fly Management Project	$22,355	$17,055	$5300	Foster Farms, Jones Hamilton, AgriLynx, Bayer
Total Direct Cost	$22,355	$17,055	$5300	
Total Indirect Costs* : Foster Farms turkey facilities + personnel	$410,000			
Total Turkey Fly Program Costs	$432,355	$427,055		

*Does not include the value of the birds or feed.

E. Discussion

The turkey farm reduced pesticide risk project provided valuable information on monitoring and identifying potential fly breeding sites. It also laid the foundation for evaluating the effect that tilling and different tiller configurations have on maggot mortality and litter clod breakup. This information will be used to further the use of manure management, litter amendments and biological control agents to manage flies on turkey growout farms. We also provided outreach and training for two individuals with the Fresno County Health Department who are responsible for responding to fly complaints.

VIII. Summary and Conclusions

Our pest management approach was multifaceted and multidisciplinary. We have stressed a program where monitoring, farm sanitation, use of biological organisms, use of mechanical devices, timed/targeted placement of pesticides, and better pesticide application methods were shown to provide more effective weed, rodent, and insect control. Since pests are attracted to similar cues, we found that if we cleared weeds away from the houses we would reduce rodent and fly harborage; similarly, if we reduced water leaks, we would reduce rat, fly, and wild bird visitations. This project advanced a total poultry farm IPM program in which growers initiate suppressive efforts prior to encountering pest populations. For instance, mice and rats move into farms every fall due to changing weather and crop practices; monitoring will detect these increased movement patterns, permitting interception before they can become established in the farm house. These projects have also aided in forming a basis of understanding and developing economic thresholds for pests on poultry farms. This IPM program will continue to develop the guidelines for reduced risk pesticide use for herbicides, insecticides, disinfectants, and rodenticides, while promoting implementation through education and outreach.

Specifically, accomplishments for alliance projects include

- Elimination of all formaldehyde treatments on poultry farms by one company, resulting in an estimated 70% reduction in formaldehyde use (by the industry) and an estimated benefit of >$1,000,000.
- Formation of a Pest Management Committee by one company to include all aspects of poultry production: breeder, fryer and turkey farms. This group meets regularly to share information and has customized monitoring sheets for each operation.
- Adoption of the successful facets of the breeder program on the rest of the breeder farms, resulting in eliminating diuron as a farm herbicide. Reduced fly bait and sprays, and reduction in rodenticide labor and baits.
- Grower education and outreach on the use of IPM tools has continued with strong support from CPF.

We believe that the alliance was a success because we had a history of credibility in this industry with team members who had previously worked together. The poultry industry was more accepting of a whole ecosystem IPM approach that matched their farm pest management and production program rather than a piecemeal approach. We shared in developing the projects together (from the survey through the workplan) and purposely included all parties in every aspect of the projects. The Alliance mission, goals and strategies were very straightforward and the industry's Quality Assurance program ensured grower outreach and long term accountability. In this cost conscious industry, the cost effectiveness of these projects also became quickly apparent. It is also a plus that 70% of poultry meat bird production is supervised by two major poultry companies who are both aggressive and innovative in their production approaches.

The challenges arising from work in this industry include the same cost effectiveness issues: if fly bottles work as well as fly bait but are more expensive, adoption will be poor. We are also at risk of losing IPM momentum when new chemistries are released since they will often demonstrate stellar effectiveness on pests that have developed resistance to older chemistries. However, historical adoption of these new chemistries without sufficient understanding of how they fit in a long-term IPM program has resulted in the same patterns of resistance development and loss of control. With an Alliance, we have opportunities to continue to demonstrate, develop, and define reduced risk pesticide use programs on poultry farms and other confined animal commodities. It is likely that public nuisance complaints will continue and that urban:agriculture interfaces will become increasingly sensitive. In this regard, it behooves our industries to work together in demonstrating a responsible approach to managing these pests concurrently with reducing pesticide risks.

IX. References

Baker, R.O., G.R. Bodman, and R.M.Timm. 1994. Rodent-proof construction and exclusion methods. Prevention and control of wildlife damage, Coop. Ext. Div, Institute of Ag and Nat Resources, Univ of Nebraska.

Lysyk, T.J. and R.C. Axtell. 1986. Field evaluation of three methods for monitoring populations of house flies (*Musca domestica*) (Diptera: Muscidae) and other filth flies in three types of poultry housing systems. J Econ Entomol 79(1):144-150.

Olsen, Alan R. 1998. Regulatory action criteria for filth and other extraneous materials. Reg Tox Pharm 28: 199-211.

X. List of Publications Produced

"Identification of Common Flies Associated with Livestock and Poultry." 2000. Nancy C. Hinkle, E. C. Loomis, J. R. Anderson, and A. S. Deal. University of California DANR Leaflet 2506.

Poultry Pest Management Web Page hosted by California Poultry Federation

XI. *Presentations Produced*

Presentations by Dr. Hickle:

3 California Poultry Federation Board Meetings

2 CPF sponsored Quality Assurance Training Meetings. One presentation was made by Zacky's field coordinator

Testimony at the Congressional Ag Subcommittee (Cardoza)

Invited speaker at the 2nd Asian Pacific Rim Conference on Sustainable Agriculture (AAAS sponsored)

Invited paper at the Entomological Society of America national meeting, section F symposium on "Life after FQPA", in Atlanta, 1999

2 presentations for Zacky Farms internal pest management group

Two Field day demonstrations of fly management included company farm personnel, Fresno County Health personnel, Fresno County Ag Commissioner personnel, DPR personnel, UC Cooperative Extension personnel