

Hawaii Area Wide Fruit Fly Integrated Pest Management Program A Model System

Hawaii has very rich, fertile soil and a climate that can produce four or five crops a year. Yet Hawaiian growers have only been able to produce 32 percent of fruits and 35 percent of vegetables consumed in Hawaii.

One of the major obstacles has been fruit flies.

For decades, four species of exotic fruit flies have driven Hawaiian farmers either to almost weekly sprayings of organophosphate and carbamate insecticides or to simply abandoning crop production altogether. These exotic fruit flies have been costing Hawaii more than \$300 million each year in lost markets for locally grown produce. And that doesn't include potentially high-value export markets.

Fruit fly problems in Hawaii are not new. The Mediterranean fruit fly arrived in 1910 and the melon fly in 1895; the oriental fruit fly came in 1945; and the Malaysian fruit fly is the newcomer, first being found in Hawaii in 1983.

This quartet of tiny pests lay eggs in and ruin more than 400 different fruits and vegetables, including citrus, coffee, eggplant, guava, loquat, mango, melon, papaya, passion fruit, peach, pepper, persimmon, plum, star fruit, tomato, and zucchini. And with the recent decline of sugar and pineapple plantations, it is just these fruit fly-susceptible, high-value crops that are now the backbone of Hawaiian agriculture.

Eradication programs have been proposed or attempted in Hawaii in the past, especially for medfly. While none of them succeeded, these eradication attempts, especially during the last 25 years, clearly illustrated the major problems with the idea: heavy economic costs, quarantine issues within the Hawaiian island chain, limits on resources, and lack of information on the effects on nontarget insects.

The Agricultural Research Service (ARS), the U.S. Department of Agriculture's in house research agency, has been a major developer of fruit fly control techniques for use in the continental United States and around the world. Over the years, much of this work has been done at the agency's Pacific Basin Agricultural Research Center (PBARC) in Hilo, Hawaii. But until this program, no one had packaged the techniques and adapted them for use in Hawaii.

Creating an Areawide Pest Management Program

Rather than eradication, the project was planned as an areawide integrated pest management program (IPM). One of the principal differences between IPM and eradication is that IPM sets the goal of keeping pest damage below an economically significant threshold rather than trying to eliminate every last fly

Right from the beginning, the Hawaii Area Wide Fruit Fly Integrated Pest Management (HAW-FLYPM) program has been a working partnership.

ARS-PBARC provided the research to develop the package of techniques needed and to adapt them to individual situations. They also tracked success rates and helped

provide data for registration of biorational agents and environmentally-sensitive chemicals, including data on the impact of the program on native Hawaiian fruit flies and other nontarget insects.

The University of Hawaii Cooperative Extension (UH-CES) created the communications program to explain HAW-FLYPM to farmers and gardeners and sell the idea of the program. Extension leaders created simple, logical educational materials that would result to users who were empowered to adopt or adapt the IPM program. Educators used standard field demonstration and hands-on teaching methods.

The Hawaii Department of Agriculture (HDOA) was essential to the establishing the program, especially given that baits and lures used in the program were not registered when it began. HDOA will sustain the areawide program cooperatively with the University of Hawaii Extension Program and growers employing the technologies developed by the areawide.

Long-term sustainability of the program was a key goal from the start and was kept in mind at each step. This went as far as arranging for smaller, quart sizes of GF-120 to be produced by a manufacturer to help ensure growers can continue the program by themselves.

A large measure of the success of the program rests with the initial groups of cooperators. Not only did they prove the viability of the areawide concept, but these cooperators acted as secondary information distributors, generating a chain reaction of interest and enrollment.

Growers were provided with all IPM materials, supplies and advice that were needed to manage the fruit fly pests during the initial phases of the program. Eventually, they graduated to obtaining their own supplies. But the program is continuing.

Program steps

HAW-FLYPM's package of control techniques are focused around a combination of monitoring and population control methods. Traps with species specific lures are used for monitoring and population elimination. Field sanitation—removing and sequestering or destroying all fruit left in the field is critical to the success of the HAW-FLYPM program. In addition, roosting crops and releases of sterile male flies and parasitoid wasps can be used to enhance the program, if needed.

Table 1. Program components for controlling fruit flies by species

Species	Treatments
Medfly	<ul style="list-style-type: none">• Population monitoring• Sanitation by removing damaged fruit from field and orchards.• GF-120 Fruit Fly Bait applied as spot applications
Melon fly	<ul style="list-style-type: none">• Population monitoring• Sanitation by plowing and destroying crops within 7-10 days

	<p>after the last commercial harvest</p> <ul style="list-style-type: none"> • GF-120 Fruit Fly Bait applied as spot applications every 3-5 meters on established borders or “roosting” plants adjacent to crops at weekly intervals from flowering to final harvest • Cue-lure used for mass trapping at a rate of 10 traps per acre and thereby reduce successful reproduction by adults
Oriental fruit fly	<ul style="list-style-type: none"> • Population monitoring • Sanitation by plowing and destroying crops within 7-10 days after the last commercial harvest • GF-120 Fruit Fly Bait spot applications to host fruit trees weekly during the periods between initial fruit set and maturity • Methyl eugenol used for mass trapping at a rate of 5 traps per acre
Malaysian fruit fly	<ul style="list-style-type: none"> • Sanitation by removing damaged fruit from field and orchards • GF-120 Fruit Fly Bait spot applications to host plants weekly

State and Federal EPA Registration

Prior to this program, no chemicals were registered in the United States specifically for the suppression of fruit flies. Lures were available for monitoring only (e.g. methyl eugenol, cuelure, trimedlure, and latilure+cade oil), and baits were allowed in combination with pesticides already registered for use on crops (e.g. Nulure and malathion).

The HAW-FLYPM program was instrumental in obtaining first research registrations and then assisted in the registration process with state and federal authorities.

Table 2: Registration of Agricultural Chemicals through Hawaii AWPM Fruit Fly Program for Use against Tephritid Fruit Flies in Hawaii*

Date of Reg.	EPA Reg. No.	Hawaii Licensing No.	Product	Source
Aug. 1, 2002	8730-50	9628.6	Vaportape II™	Hercon Environmental Inc.
Aug. 9, 2005	2719-498	24C HI-000003	GF-120 Naturalyte Fruit Fly Bait	Dow AgroScience Inc.
Aug. 9, 2005	2719-498	9786.234	GF-120 Naturalyte Fruit Fly Bait supplemental label	Dow AgroScience Inc.
June 5, 2006	2719-498	9786.234	GF120 Naturalyte Fruit Fly Bait all crops supplemental label	Dow AgroScience Inc
Sep. 20, 2007	7969-253	9131.131	Amulet™ C-L w/fipronil stations	BASF Corp.
Oct. 3, 2007	36638-42	9721.4	Cue-lure in plastic matrix w/o toxicant	Scentry Biologicals Inc.
Dec. 11, 2007	36638-40	9721.3	Methyl eugenol in plastic matrix w/o toxicant	Scentry Biologicals Inc.
Oct. 26, 2007	81325-3	8637.1	Methyl eugenol in plastic matrix	Farma Tech
June 2008	Final label approval projected by Dow in Q2 '09	NA	Sprayable SPLAT-MAT with methyl eugenol and spinosad	Dow Agro-Science/ISCA Technology

*This does not imply endorsement of specific commercial products.

More benefits than costs

HAW-FLYPM has made major economic contributions to agriculture in Hawaii and instigated the growing of a greater diversity of crops. In addition, by allowing farmers to make significant cuts in pesticide use, the program is helping improve Hawaii's environment and sustaining open space, which contributes to maintaining the islands' tourism.

The HAW-FLYPM program has led to a significant increase in the number of commercial farms. In addition, existing farms added crops or revived some previously phased out due to fruit fly problems.

Box A

Program adoption by 2007

Hawaiian Island:	More than 888 users; 7,546 acres under suppression
Maui:	More than 1,074 users; 2,646 acres under suppression
Oahu:	More than 528 users; 5,637 acres under suppression
Kauai:	More than 200 users; 588 acres under suppression
Molokai:	More than 57 users; 348 acres under suppression

Statewide total: More than 2,747 users; 682 farms; 16,765 acres under suppression

End Box

Aloun Farms, one of the largest and most diversified growers on Oahu, began producing an additional 130,000 pounds of zucchini a year and had no problem marketing all of it. This production gain translates into a financial benefit to the farmer of around \$75,000 at current farmgate prices.

An economic assessment found that HAW-FLYPM program is easy to use and initial economic benefits were estimated at \$2.6 million per year and projected to increase to \$6 million by 2011.

A full cost-benefit analysis found the HAW-FLYPM program will create as much as a 32-percent return on an investment of \$14 million over 15 years—and that doesn't count the substantial indirect benefits, such as increased agricultural employment, nor environmental benefits that don't have a direct dollar return.

The benefits were measured in three categories: (1) already-achieved increases plus forecasts of their continuing, (2) benefits based on likely outputs over the next 5 years, and (3) benefits based on possible outputs over the next 10 years.

Even the most conservative economic analysis without including the 'possible benefits' category, the rate of return still came to 27 percent, according to the cost-benefit study.

Economic return came from a variety of revenue streams. For example, field sanitation and trapping are less expensive than pesticides and spraying. The annual direct cost of spraying organophosphate pesticide to control melon fly in commercial cucurbit production in the Kamuela area comes to \$1,680 per acre, including health and safety costs.

A 5-million-pound expansion in Hawaii's production of cucurbits could occur over the five years following the original five-year program, but only if adopting the HAW-FLYPM program is financially attractive to growers and if the bait sprays and lures are available.

Suppression of fruit flies in Hawaii also has benefits in other parts of the United States. California alone has spent more than \$500 million eradicating the same exotic fruit flies over the last 40 years. If any of them became established there, it could cost California over \$1.4 billion a year in lost markets, export sanctions, treatment costs, and reduced crop yields, plus the loss of 14,000 jobs. Suppressing exotic fruit flies in Hawaii lessens the chances that they could become the source for outbreaks in the continental United States.

Home gardeners have also gained from the program, making it possible to raise many crops in their yards without resorting to pesticides. There is a tradition in the Hawaiian culture of bringing fruit and vegetables when visiting friends and neighbors, and gardeners are pleased to have fruit-fly-free gifts to share.

But backyard gardens can act as reservoirs in which a few fruit flies can survive and produce another generation—in effect creating a never-ending cycle for growers, large and small, even when farmers in an area do a good job of controlling fruit flies. Successfully enlisting gardeners to use the HAW-FLYPM program also enhanced the success of program for commercial growers.

Papaya was the last crop targeted by the AWPM, and is largest sector of the agricultural economy that is impacted by fruit flies. In recent years, Hawaiian papaya production declined due to papaya ring spot disease. When genetically engineered cultivars were developed with resistance to papaya ring spot, the industry began to recover, but production continued to decline, partly because Hawaii’s share of the U.S. papaya market declined. The quality of Hawaii papaya and competition from foreign producers were important factors in that decline. The AWPM allowed Hawaiian growers to improve their quality by allowing a papaya that is one quarter to half-riper to be picked without fruit fly damage. The result is to allow marketing of a riper, sweeter product, that commands a higher local price.

Table 3. Reduction in fruit fly infestation with program use

Area	Species	Crop	Reduction in infestation (%)
Kamuela, Hawaii	Melon fly	Fruiting vegetables	83.2
	Mediterranean fruit fly	Sub- and Tropical fruits	90.7
	Oriental fruit fly	Tropical fruits	60.7
Puna, Hawaii	Oriental fruit fly	papaya	94.6
Kula, Maui	Melon fly	Fruiting vegetables	87.5
	Mediterranean fruit fly	Persimmons and sub-tropical fruits	90%
Ewa, Oahu	Melon fly	Fruiting vegetables	80.0

International impact

The success of the HAW-FLYPM program has had international impact on fruit fly management as many other countries are also facing similar problems. Researchers and officials from Australia, People's Republic of China, the Commonwealth of the Northern Mariana Islands, Fiji, French Polynesia, Guam, South Africa, Bangladesh, Kenya, Tanzania, Madagascar, Sudan, Taiwan, Vanuatu, Argentina, Canada and Mexico, among others, have expressed interest in or adopted the program as a model for fruit fly suppression.

Call Outs

"I was losing about half of my watermelon, and now I have it under control. The techniques that the HAW-FLYPM staff taught me really work."

--Bill Pfei, Bills’s Organic Papaya Farm, Molokai.

"It used to be a battle against the fruit flies; we had to spray insecticides about once a week. With this program, we are growing more different crops than ever." Joseph Liu Man Hin, Aloun Farms, Oahu

"In the past I have had as much as 60 percent damage on my zucchini due to fruit flies. Now I have less than 2 percent."
--Sam Pangdan, farm name, Kauai.

"Your program is our first line of defense--mahalo."
--Peter Eising, Palila Growers, LLC, Kawaihae

"We have had 200 percent more crop production this year. After a year of GF-120, traps with the gel [lures], and keeping the ground cleared sooner of dropped fruits, we have had perhaps...6-8 percent cull."
--Pete and Marla Hunter, Eke Nui mango farm, Na`alehu

"With this program, I harvested well over 2,000 pounds of persimmons in one year and buyers grab it up as quickly as I harvest."
--Earl Yamamoto B.E.S.T. Farm, Kamuela

Box B

For more information about the HAW-FLYPM program including enrolling, see www.fruitfly.hawaii.edu

Big Island

Hilo – Komohana Extension Office
(808) 981-5199
komohana@ctahr.hawaii.edu

Kamuela Extension Office
(808) 887-6183
kamuela@ctahr.hawaii.edu

Maui County

Kahului Extension Office
(808) 244-3242 Ext.231
kahului@ctahr.hawaii.edu

Molokai Extension Office
P.O. Box 394
Hoolehua, HI 96729
molokai@ctahr.hawaii.edu

Oahu

Kaneohe Extension Office
(808) 247-0421
kaneohe@ctahr.hawaii.edu

Pearl City Urban Garden Center

(808) 453-6059

Wahiawa Extension Office
(808) 622-4185
wahiawa@ctahr.hawaii.edu

Kauai

Kauai Extension Office
(808) 274-3475
lihue@ctahr.hawaii.edu

End box

Box C

Fighting Fruit Flies Helps Save a Part of Hawaiian Culture

Ipu, Hawaiian for the hard-shell gourd, has always been an important part of the island culture. It's used as a drum in hula dance, and it's a traditional way to store food or water.

But the melon fly had made it almost impossible to grow the traditional ipu gourds in Hawaii.

"Most ipu growers have given up trying to grow them," explains Evie Morby, vice president of the Hawaii Gourd Society. "More than 3,000 gourds per year are bought from just one gourd farm in California for ipu heke, the two-piece gourd drum used with hula. That's really sad for something such a part of Hawaiian culture."

With the HAW-FLYPM program, Morby has been able to harvest ipu with little resort to pesticides.

Use photo **K11030-7** (see photo file)

End Box

References

Mau, R. F. L., E. B. Jang, and R. I. Vargas. 2007. The Hawaii fruit fly area-wide fruit fly pest management programme: influence of partnership and a good education programme. *In* Vreysen, M.J.B., A. S. Robinson, and J. Hendrichs (Eds.), *Area-Wide Control of Insect Pests: From Research to Field Implementation*. Springer, Dordrecht, Netherlands. 671-683.

Vargas, R.I., R.F.L. Mau, E.B. Jang, R. M. Faust and L Wong. 2008. The Hawaii fruit fly areawide pest management programme. *In: Areawide Pest Management: Theory and Implementation*. Eds. O Koul, G. Cuperus and N. Elliott. CAB International. 300-325.

For a larger list of journal references, please see URL to come

Core Team Members

(logos, see photo file)

Agricultural Research Service

University of Hawaii Cooperative Extension Service

Hawaii Department of Agriculture

Associate members

Animal and Plant Health Inspection Service

California Department of Food and Agriculture

IR-4 program

Dow AgroSciences LLC

ISCA Technologies

Scentry Biologicals, Inc.

FarmaTech International