TERMINAL REPORT

(MAY 1997 – DECEMBER 2000)

FAO/AusAID/UNDP/SPC
Project RAS/97/331 on:

REGIONAL MANAGEMENT OF FRUIT FLIES IN THE PACIFIC

Part 1: TECHNICAL REPORT

Introduction

The FAO/AusAID/UNDP/SPC Project on Regional Management of Fruit Flies in the Pacific (RMFFP) originated in 1990, when the first phase of the Regional Fruit Fly Project commenced in September 1990, and ceased in December 1993. It was funded by the combined support of the FAO, AusAID (then known as AIDAB), UNDP, and SPC. The amount of funding was USD858,000 (including two Technical Cooperation Projects worth USD304,000, funded by FAO). It initially operated in Fiji Islands, Cook Islands, Tonga and Western Samoa. The second phase, funded by AusAID, UNDP and the New Zealand Government (USD 1,146,396) operated from January 1994 to April 1997 and included the four countries above plus Federated States of Micronesia, Solomon Islands and Vanuatu. The third phase (RMFFP) is funded by AusAID, UNDP (USD 1,770,700) and the New Zealand Government (NZD 100,000 per year), and started in May 1997. It includes all 22 Pacific Island countries and territories (PICTs).

The development objective of the RMFFP is to strengthen the technical capacity of the Governments and Administrations and the private sectors in PICTs to manage fruit flies regionally in order to protect fresh fruit and vegetable production and export and to enhance farmers' incomes, food security and rural employment.

The six immediate objectives of the RMFFP are:

1. To overcome constraints to production and export of fresh fruits and vegetables in FSM, Solomon Islands and Vanuatu caused by the presence of damaging fruit fly species.

2. To improve substantially the quarantine preparedness of PICTs to cope with inevitable outbreaks of exotic fruit flies regionally.

3. To enhance production and export of fresh fruits and vegetables regionally in order to increase farmers' incomes and to assist in providing food security, particularly in those countries not included in the previous fruit fly project.

4. In cooperation with ACIAR, to develop a separate multi-disciplinary fruit fly programme to address the enormous risk of fruit fly spread through and from PNG into the rest of the region.

5. To ensure sustainable technical capacity for coordination of future activities on fruit flies in the Region.

6. To promote private sector involvement in sustaining quarantine surveillance and research into fruit fly control and quarantine treatments for commodities destined for export.

From its beginning in 1990 until 30 April 2000, The RMFFP was coordinated by Allan Allwood, Chief Technical Advisor employed by FAO. In May 2000, FAO implementation of the Project officially ceased and the Project became fully embedded into SPC. The RMFFP will end on December 31st 2000. Starting in January 2001, fruit fly activities will become Component 2, "Fruit Fly Management", of the newly established Project on "Pest Management in the Pacific", executed by SPC. The fruit fly component of the PMP Project Document is included separately in Annex.

A. Protection of Horticulture

Quarantine surveillance

Quarantine surveillance encompasses activities that assist in the early detection of unwanted exotic fruit flies and other pests and diseases. It is designed as an early warning system so that authorities are able to mobilize resources quickly to deal with an incursion or establishment of an unwanted pest species, before the introduced species becomes widely distributed. Having an effective quarantine surveillance system in place gives importing countries confidence in data on the presence (or absence) and economic importance of fruit fly species that already exist in each country. It is a prerequisite for developing quarantine protocols for overseas trade in fresh fruits and vegetables.

Trapping provides information that is an essential starting point for understanding and managing fruit fly populations. The type of information generated includes: geographic distributions of species on a regional and national basis, seasonal abundance, population density differences in different habitats (e.g. rainforest vs. village), abundance of fruit flies during fruiting periods, impact of control or eradication measures on fruit fly populations and, most critically, early detection of incursions and establishment of exotic species.

Modified Steiner traps baited with Cue-lure (CL) and methyl eugenol (ME) are commonly used in the Pacific region. Two traps (one baited with CL and one with ME) are usually set at each trapping site. Sites cover high-risk areas such as international ports and airports, urban and suburban areas, tourist resorts, refuse dumps, near diplomatic missions, and education institutes that cater for overseas students, to detect rapidly foreign species that may be introduced through contaminated exotic fruits brought in by travellers. Some countries (Fiji Islands, Tonga, New Caledonia) also use traps baited with trimedlure, to detect Mediterranean fruit fly (*Ceratitis capitata*). Traps are emptied weekly to monthly, and collected flies are placed inside small cardboard boxes for later examination.

Initially, permanent quarantine surveillance in the PICTs was assured by trapping and host fruit surveying carried out primarily for research in Fiji Islands, Tonga, Samoa and Cook Islands, as a component of the RFFP (phase 1). During the same period, surveillance was also established by governments in such countries as New Caledonia and CNMI. During phase 2 of the RFFP, quarantine surveillance networks were established in FSM, Vanuatu and Solomon Islands. During the training course conducted in Cairns on Asian papaya fruit fly recognition, quarantine surveillance and ERP development (June 1996), trapping equipment kits were distributed to participants, who came from 16 of the 22 PICTs. As participants set up traps in their countries, Oriental fruit fly was discovered on Tahiti.

The regional quarantine surveillance network was consolidated during phase 3 of the RMFFP. In 1998, surveillance kits composed of trapping and host fruit surveying equipment and a guideline booklet were distributed to PICTs, to encourage them to maintain a good surveillance network. In countries that had been running traps for 3 years or more years already (Fiji Is, Tonga, Samoa, Cook Is, Vanuatu, Solomon Is, FSM), the trapping system was revised and modified to serve quarantine surveillance purposes instead of research.

There are presently permanent trapping stations for quarantine surveillance in all PICTs, except Pitcairn Island. Overall there are 799 sites with a Cue-lure trap and 1175 sites with a ME trap. Most sites have one CL and one ME trap. The following table summarizes the surveillance status in each PICT. Details are provided in a complete table in Section 3.

	Last update	Number Dacinae species	No. trapping sites	No. Islands / Atolls covered	No. sites with trimedlure traps	Host surveys done
AMERICAN SAMOA	Nov 2000	4	9	1	0	Yes
COOK ISLANDS	Nov 2000	2	31	5	0	No
FSM	Oct 2000	1	33	5	0	Yes
FIJI	Nov 2000	7	123	16	75, on all islands	Yes
FRENCH POLYNESIA	Nov 2000	7	464 (ME), 190 (Cue)	8	20 on Tahiti	Yes
GUAM	Nov 2000	2	20	1	20	No
KIRIBATI	Oct 2000	1 or 2 ?	11	3	0	Yes
MARSHALL ISLANDS	Nov 1999	1	4	1	0	No
NAURU	Nov 2000	1	33	1	0	Yes
NEW CALEDONIA	Nov 2000	12	49	4	49	Yes
NIUE	Nov 2000	4	25	1	0	No
NORTHERN MARIANAS	Nov 2000	2	10	1	0	Yes
PALAU	Oct 2000	3	112 (ME), 10 (Cue)	6	0	No
PNG, ISLANDS	Nov 2000	> 180	20	5	0	Yes
PNG, SOUTHERN	Nov 2000		24	1	0	Yes
PNG, NORTH / HIGHLANDS	Nov 2000		23	1	0	Yes
PITCAIRN		2	0	0	0	No
SOLOMON ISLANDS	Nov 2000	48	35	8	0	No
TOKELAU	Sep 1998	1	5	1	0	No
TONGA	Dec 1999	6	25	6	25	No
TUVALU	Jan 2000	1	14	5	0	Yes
SAMOA	Nov 2000	7	36	2	0	Yes
VANUATU	Oct 2000	13	63		0	Yes
WALLIS AND FUTUNA	April 2000	5	6	1	0	No

Table 1: Status of quarantine surveillance in all PICTs, based on questionnaire handed to each PICT.

Host fruit surveying is the second key component of quarantine surveillance, which complements trapping. It involves collecting samples of commercial / edible and wild fruits and incubating them in the laboratory over moist sawdust in containers for two to three weeks to determine whether they are infested with fruit flies. For quarantine surveillance purposes, it specifically targets high-risk commodities, which should include, among others, guava, breadfruit, mango, papaya, avocado, banana, carambola, tropical almond, Tahitian chestnut, citrus, Malay apple and other Syzygium species, capsicum and chilli, tomato, eggplant and cucurbits. Host fruit surveys are regularly carried out in American Samoa, Fiji Islands, French Polynesia, Federated States of Micronesia, Kiribati, Nauru, New Caledonia, Papua New Guinea, Samoa, Tonga, Tuvalu and Vanuatu.

General host fruit surveying has yielded over the years a considerable amount of information on the host range of each fruit fly species, the economic importance of each species on different hosts, the host stage of maturity when infestation occurs, comparative level of susceptibility to fly attacks for different host species and different varieties within a host species and diversity and impact of natural parasitoids. Host survey data have been incorporated into a comprehensive database of host records in each country and species distribution, hosted at SPC. The database is discussed later in the report.

KEY ACHIEVEMENTS

- Stable quarantine surveillance system by trapping in place in all PICTs, except Pitcairn Island, where short term trapping was done in 1998. Intent is to have a national and regional early warning system for exotic fruit flies to protect fruit and vegetable production.
- Large scale trapping network in PNG, with up to 140 actively serviced sites covering 16 provinces, but considerably reduced in early 2000 from a research to a surveillance network.
- Regular host fruit surveying of high-risk commodities for quarantine surveillance in 13 PICTs: American Samoa, Cook Islands, FSM, Fiji Islands, French Polynesia, Kiribati, Nauru, New Caledonia, Niue, Palau, Papua New Guinea, Samoa, Tonga and Vanuatu.
- Quarantine surveillance entirely maintained by governments in New Caledonia, French Polynesia, Guam, CNMI, Fiji Is, Tonga, Kiribati and Cook Is, Tuvalu, Tokelau and Wallis and Futuna, and with partial support from RMFFP in American Samoa, Samoa, FSM, Vanuatu, Solomon Is, Niue, Palau, PNG and Nauru.
- Quarantine surveillance kits comprising trapping materials, host survey supplies and instruction booklet distributed to American Samoa, Tuvalu, Tokelau, Wallis and Futuna, Palau, Kiribati, Marshall Islands and to FSM for Chuuk, Yap, Kosrae.
- National staff capable to identify most species in their countries and to detect unusual, potentially exotic, species in samples.
- Trapping and host surveying data recorded in Microsoft Excel databases by national staff.
- For complete chronological list of achievements, see progress report in annex under outputs 1.2, 2.1, 4.1.

Emergency Response Planning

The increase in fruit fly outbreaks in the region has warranted the improvement and strengthening of the quarantine preparedness of PICTs to face outbreaks of exotic fruit flies. Developing Emergency Response Plans (ERPs) is one way of improving and strengthening quarantine preparedness to cope with outbreaks of exotic fruit flies. The Papaya fruit fly eradication workshop in Cairns, Australia in 1996 was the start of the development of ERPs in PICTs. As part of their training in the Nauru Fruit Fly Eradication Programme, trainees from 19 PICTs started developing ERPs for fruit flies. 13 PICTs have ERPs in draft and have submitted to RMFFP for comments. Simulation emergency exercises (dummy runs) using draft ERPs have been carried out in Fiji and Samoa. As part of its role to improve quarantine preparedness for pests in the region, SPC Plant Protection Service has developed generalized ERPs for plant pests.

KEY ACHIEVEMENTS

- In total, 41 plant protection and quarantine officers from all PICTs (except French Polynesia, CNMI and Pitcairn) and from New Zealand and SPC trained in emergency response planning and eradication procedures in the Nauru Fruit Fly Eradication Programme.
- Emergency Response Plan (ERP) completed for Fiji Islands, ready to be submitted to the government for endorsement.
- ERP in advanced draft form for Vanuatu, Samoa, and Solomon Islands. Good ERP drafts developed for Niue, FSM, New Caledonia and Kiribati. Drafts also produced by Tonga, Guam, French Polynesia, Tuvalu, Nauru and Cook Islands.
- Generalized ERP for pests and animal diseases being developed by SPC with significant input from fruit fly ERP. Training courses for 2001 using fruit fly ERP as case study planned.
- ERP and dummy run covered during refresher training course in Samoa. Dummy ERP run also conducted in Fiji Islands.
- Stockpile purchased and being shipped to Fiji Islands. It will be stored at Koronivia Research Station. In total, 200 litres of Methyl Eugenol, 65 litres of Cue-lure, 1000 traps, 20 single-action sprayers, 100 Kg of protein bait and thousands of plastic containers purchased.
- For complete chronological list of achievements, see progress report in annex under outputs 1.2, 2.2, 2.3, 2.5.

Eradication Programmes

NAURU

The RMFFP has been actively involved in setting up and running successfully an ambitious fruit fly eradication programme in the Republic of Nauru, targeting four exotic species. The Republic of Nauru was home for four species of fruit flies – Oriental fruit fly (*B. dorsalis*), Pacific fruit fly (*B. xanthodes*), melon fly (*B. cucurbitae*), and mango fly (*B. frauenfeldi*). All four species were introduced, with melon fly and Oriental fruit fly being introduced in about 1985 and the other two species probably being present at or just after World War 2. As Nauru did not have a quarantine service and had a national airline that flew to Fiji, FSM, Guam and Australia, there was a risk that these fruit fly species may be carried in fruit by passengers and be inadvertently introduced to other countries in the Pacific. For these reasons, the RMFFP combined resources with the Crawford Fund for International Agricultural Research, the private sector in Australia (Bronson and Jacobs and Rhône Poulenc Rural (Australia), now known as Aventis CropScience, and the Governments of Nauru, Australia and New Zealand, to eradicate all four species. The programme commenced in October 1998.

The techniques used to eradicate fruit flies consisted of a combination of male annihilation and protein bait spraying. The principle of male annihilation is to reduce the male population to such a low level that no mating occurs and, as a result, the fruit fly population crashes. Male annihilation was achieved by distributing fibreboard blocks (50mm x 50mm x 12.7mm) soaked in male lures and an insecticide, called Fipronil, at intervals of 50 metres over all areas of Nauru accessible to ground teams. The male lures were methyl eugenol, which attracted male Oriental fruit flies and Pacific fruit flies, and Cue-lure, which attracted male melon flies and mango flies. Blocking was repeated every eight weeks, resulting in fourteen campaigns up to December 2000. Ground teams supplied by the Nauru Government, National Phosphate Corporation and Buada Lagoon Council, and later by Nauru Secondary School, were responsible for nailing the treated blocks to trees. Each campaign resulted in about 7,000-10,000 blocks being distributed.

Protein bait spraying was done by teams of youth, who applied about 180 litres of protein to most host fruit trees in Nauru once a week between October and December 1999. Weekly bait spraying resumed in February 2000, operated by teams from Nauru Phosphate Corporation and students from Nauru Secondary School (since October).

Within twelve months, it was possible to declare that Oriental fruit fly and melon fly were eradicated from Nauru. The President of Nauru, His Excellency Mr. Rene Harris, made this official declaration at a public meeting in Nauru on Monday, 6 December 1999. Pacific fruit fly has not been recorded since February 2000, and it has been officially declared eradicated from Nauru in November 2000, during the Committee of Regional Governments and Administrations (CRGA) meeting.

For the first time since 1985, people in Nauru are able to eat ripe mangoes. In October 1998, about 90% of mango fruits were infested with fruit fly maggots, mainly Oriental fruit fly. Now, mangoes are virtually free from fruit fly infestation. Improved fruiting of breadfruit is also obvious as a result of eradication of Oriental fruit fly and the near eradication of Pacific fruit fly.

The population of mango fly has been reduced to a very low level – less than two flies per trap per week now compared to 1,500 per trap per week in late 1998, but still subsists despite intense efforts for its eradication. A trip to review the eradication programme in Nauru was done by Allan Allwood in September 2000. The preliminary report produced includes recommendations on improvement of the eradication programme to target mango fly. A technical report on the eradication programme (1998-2000) has been compiled and released. The main recommendation is to continue eradication campaigns against mango fly and to re-assess the programme in late 2000, once the Nauru Quarantine Service is active.

Plans are underway to introduce in the 14th campaign the use of papier mâché blocks pre-treated with Cue-lure and Fipronil - a new technology developed by Aventis CropScience and known as BactroMAT C-L. These lightweight blocks contain a minimal amount of attractant and are tied, no longer nailed, to trees.

The Nauru Government should be congratulated for its support of the programme and also for enacting a new Agricultural Quarantine Act, which will allow the Government to control the entry of fruits and vegetables from overseas. SPC and the RMFFP will provide training for Quarantine Officers in Nauru through the Plant Protection in Micronesia Project.

Through the eradication programme in Nauru, it has been possible to provide hands-on training and experience on eradication methods and the development of emergency response plans to cope with outbreaks of exotic fruit flies to 41 plant protection and quarantine officers from 19 Pacific Island countries and territories, from New Zealand and from SPC.

PALAU

Oriental fruit fly (*Bactrocera dorsalis*) was recorded in the Republic of Palau in September, 1996. The Government of the Republic of Palau, in early 1999, formally requested assistance from the RMFFP to investigate and report on the feasibility and cost of eradication of the Oriental Fruit Fly.

In August 1999, a feasibility study on eradication of fruit flies attracted to methyl eugenol (*B. dorsalis* and *B. umbrosa*) in Palau by Allwood, *et. al* ., highlighted the options for eradication, the quarantine risks of the species in Palau, and the need for quarantine at all stages and levels of commitment by the Government of the Republic of Palau for human resources, facilities, and funds. Although this report did not state directly that it recommended that an eradication programme was possible, the issues presented in the report had clearly indicated that the authors recommend that the eradication of Oriental fruit fly and breadfruit fly (*B. umbrosa*) was feasible.

Over 100 trapping sites were established in 1999 on the islands of Babeldaob, Koror, Angaur and Peleliu, Kayangel and Rock Islands, mostly with ME lure, but also some traps charged with Cue-lure. Intensive host fruit collections of target host fruit species for both Oriental fruit flies and mango fly have been collected to initiate the establishment of laboratory colonies of mango flies and Oriental fruit flies, in a laboratory refurbished with financial support from the RMFFP. The colonies will be used for host status testing of betel nuts and for generation of data on heat tolerance of mango fly.

RMFFP funded a socioeconomic feasibility study of the eradication of Oriental fruit fly (*B. dorsalis*) and breadfruit fly (*B. umbrosa*) from the Republic of Palau, conducted by Dr. Andrew McGregor in March 2000. The study concluded that it is technically feasible to eradicate Oriental fruit fly and breadfruit fly in Palau and the cost of the eradication program were valued to be significantly less than the value of the benefits to the programme.

A trip to the Republic of Palau to assist the Plant Protection and Quarantine Service in establishing the fruit fly program and commence the initial work that is required prior to the Palau Oriental fruit fly and Breadfruit fly eradication program was carried out on 13 – 25 July, 2000. An implementation workshop for the eradication programme is planned for January 2001. A new technology developed by Aventis CropScience (Australia), blocks made of papier mâché treated with Fipronil, will be used in the eradication campaigns.

FRENCH POLYNESIA

The RMFFP has provided an advisory role in the eradication programme against Oriental fruit fly in French Polynesia. The pest fruit fly was discovered on Tahiti, following a training course on quarantine surveillance and emergency response planning conducted in May 1996 in Cairns, Australia. Following an assessment trip, Mr. Allan Allwood and Prof. Dick Drew produced in August 1996, a report describing in details a strategy for eradication of Oriental fruit fly as guidelines to conduct the programme.

Following the recommended guidelines, a large scale eradication program was conducted in 1997 by nailing to trees and dropping from helicopter coconut husk pieces soaked in a mixture of methyl eugenol and Malathion combined with protein bait spraying in areas of high fruit fly density. Six campaigns, two months apart, were done in 1997. The RMFFP and the French Polynesia government conducted, in November 1997, a Regional Symposium, to which representatives from 14 PICTs participated. The programme was stopped too early, though, with residual fruit fly populations breeding in isolated pockets, from which, they multiplied and spread all over Tahiti and Moorea. Efforts to eradicate the species resumed in January 1999 and are still in process.

By request from the French Polynesia Government, the RMFFP Chief Technical advisor (Allan Allwood) and Entomologist (Luc Leblanc) made two advisory visits to French Polynesia, in April and October 2000. On the second visit, Allan Allwood was sent as a consultant by Aventis CropScience. From the first visit a series of recommendations were emitted and implemented by the Government. One of the main recommendations was to introduce the use of a new technology developed by Aventis CropScience (Australia): blocks made of papier mâché treated with Fipronil instead of Malathion, to replace the coconut husk blocks. The methyl eugenol treated blocks are known as BactroMAT M-E. Negotiations with Aventis also resulted in a deal that

the company provides free of charge enough blocks for two campaigns, after which the Territory will purchase blocks for subsequent campaigns. The November 2000 trip served the purpose of introducing and demonstrating the new technology to French Polynesia, and to also demonstrate the Fipronil-based "Bactrogel", a superior alternative to Malathion for use in protein bait spraying.

GUAM AND CNMI

The RMFFP funded a consultant (Dr. Andrew McGregor) to review the economic feasibility study to eradicate melon fly from Guam and CNMI published by Kevin Boyle in 1993. The report from the consultation expectedly confirmed that the high cost of eradication, involving the release of sterile male flies, is above the economic profits from eradication, but identifies benefits in the form of import substitution, niche export markets, especially sales to Japanese tourists, increased self-sufficiency in fruit consumption, and quarantine security to the whole PICTs region.

KEY ACHIEVEMENTS

Nauru:

- Fourteen blocking campaigns conducted against fruit flies in Nauru between October 1998 and December 2000.
- Nauru officially declared free on Oriental fruit fly and melon fly on 6 December 1999, and from Pacific fruit fly in November 2000.
- Mango fly (*B. frauenfeldi*) populations and damage suppressed by the action of the eradication campaign, but eradication not yet achieved. Decision will be taken in late 2000 about whether of not to continue eradication campaigns.
- 41 plant protection and quarantine staff from all PICTs (except CNMI, French Polynesia and Pitcairn) and from New Zealand and SPC have received hands-on training on fruit fly identification, the quarantine importance of fruit flies, control and eradication techniques while in Nauru during the Fruit Fly Eradication Campaigns.
- Groups of youth workers, Nauru Phosphate Corporation workers and Nauru Secondary School students trained in protein bait spray application technology under the FFERAD and are responsible for the treatment of 'hot spots' in Nauru.
- Fourteen Newsletters on the Nauru Fruit Fly Eradication Programme produced and circulated to make the travelling public of the dangers of moving fruit around the Pacific and to keep the public and Government informed of progress.
- The Nauru Government has drafted an Agricultural Quarantine Bill, which has been accepted by Parliament and in process of establishing of a small Plant Protection and Agricultural Quarantine Service to police the legislation.
- Trip for assessment of eradication programme in Nauru by Allan Allwood in September (consultancy). Report produced with recommendation and technical report on eradication programme (1998-2000) compiled and released. Main recommendation is to continue eradication campaigns against mango fly and to re-assess the programme in late 2000, once the Quarantine Service is active.
- For complete chronological list of achievements, see progress report in annex under outputs 2.2 and 2.5.

Palau, French Polynesia, Guam-CNMI:

- Completed a Feasibility Study on the Prospects of Eradication of Oriental Fruit Fly and Breadfruit Fly in Palau for the Government of Palau between June-September 1999. Estimated costs about USD1.2 million.
- Consultant Andrew McGregor completed and published a socio-economic feasibility study of the eradication of Oriental fruit fly and breadfruit fly from the Republic of Palau, and a review of the economic feasibility of eradicating melon fly from Guam and CNMI, based on an assessment trip in April.
- Palau Government has approved the allocation of USD 1 Million to initiate Oriental fruit fly eradication.
- Conducted Regional Symposium on Eradication of Oriental Fruit Fly in Tahiti and Moorea in Papeete on 24-27 November 1997 – 14 countries involved.
- Difficulties in obtaining fly reduction in eradication campaigns against Oriental fruit fly in French Polynesia in 1999-2000. Trip by CTA and Entomologist (Fruit Flies) to Tahiti in March 2000 for technical assessment of the programme. Report and recommendations produced.
- Negotiated with Aventis CropScience (Rhône-Poulenc) to provide free of charge enough papier mâché blocks pre-treated with methyl eugenol and Fipronil (new technology) to carry out two full campaigns in Tahiti and Moorea. New technology introduced to French Polynesia in October 2000.

- For complete chronological list of achievements, see progress report in annex under output 2.5.

B. Increased Production

Losses caused by fruit flies in the field

The economic impact of pest fruit flies has been assessed on selected crops by collecting and setting up large series of fruits in separate containers to determine the proportion of individual fruits that are infested. The extensive data from damage assessments is summarized in the following table:

HOST	COUNTRY	% INFESTED	FRUIT FLY SPECIES
Acerola	FSM	3.7%	*B. frauenfeldi*
Avocado	FSM	57%	*B. frauenfeldi*
Banana	PNG: East New Britain	0.5 %	*B. frauenfeldi*
Banana	PNG: Oro Province	10-40 %	*B. musae*
Banana (Cavendish)	PNG: Central Province	30-51 %	*B. musae*
Bittergourd	PNG: East New Britain	> 90 %	*B. cucurbitae*
Breadfruit (ripe)	American Samoa	62%	*B. xanthodes*
Breadfruit (ripe)	PNG: East New Britain	75 %	*B. umbrosa, B. frauenfeldi*
Breadfruit (ripe)	FSM	37%	*B. frauenfeldi*
Breadfruit (ripe)	Nauru (1)	12%	*B. xanthodes*
Breadfruit	Vanuatu	30%	*B. trilineola*
Capsicum	Tonga	97-100%	*B. facialis*
Carambola	PNG: East New Britain	0.8-13.7 %	*B. frauenfeldi*
Carambola (Malaysian)	PNG: Central Province	98-100 %	*B. frauenfeldi*
Carambola (Local)	PNG: Central Province	36 %	*B. frauenfeldi*
Carambola	FSM	18%	*B. frauenfeldi*
Carambola	Palau	80-90%	*B. dorsalis*
Cashew	PNG: East New Britain	6-66 %	*B. frauenfeldi*
Chilli	Tonga	89-97%	*B. facialis*
Guava (Vietnam white)	PNG: Morobe	48-88 %	*B. frauenfeldi, B. trivialis*
Guava (Vietnam white)	PNG: East New Britain	28.3-88 %	*B. frauenfeldi, B. obliqua*
Guava (Vietnam white)	PNG: Central Province	49-80 %	*B. frauenfeldi, B. trivialis*
Guava	Fiji	40-90%	*B. passiflorae*
Guava	FSM	31-91%	*B. frauenfeldi*
Guava	Nauru (1)	90%	*B. dorsalis, B. frauenfeldi*
Guava	Samoa	45-99%	*B. kirki*
Guava	Palau	90%	*B. dorsalis*
Guava (large, pink)	PNG: East New Britain	74.1 %	*B. frauenfeldi, B. obliqua*
Guava	Tonga	89-97%	*B. facialis, B. kirki*
Guava	Solomon Is	30%	*B. frauenfeldi*
Guava	Vanuatu	95%	*B. trilineola*
Kumquat	Fiji	60%	*B. passiflorae*
Malay apple	Fiji	62%	*B. passiflorae*
Mango (from market)	PNG: East New Britain	4.5 %	*B. frauenfeldi*
Mango (fallen)	PNG: East New Britain	53 %	*B. frauenfeldi*
Mango (ripe)	FSM	8%	*B. frauenfeldi*
Mango (ripe)	Fiji	20-25%	*B. passiflorae*
Mango (ripe)	Nauru (1)	95%	*B. dorsalis, B. frauenfeldi*
Mountain apple	Palau	80-90%	*B. dorsalis*
Mountain apple	Vanuatu	64%	*B. trilineola*
Orange	FSM	4%	*B. frauenfeldi*
Papaya (Summer)	Cook Is	12%	*B. melanotus, B. xanthodes*
Papaya (Winter)	Cook Is	1%	*B. melanotus, B. xanthodes*
Papaya (ripe)	PNG: Central Province	15 %	*B. frauenfeldi*
Papaya (ripe)	PNG: Morobe	25 %	*B. frauenfeldi*
Papaya (local)	Samoa	19-37%	*B. xanthodes*
Papaya (Sunset)	Samoa	4-41%	*B. xanthodes*
Polynesian chestnut	PNG: Central Province	60 %	*B. frauenfeldi, B. moluccensis*
Pond apple	FSM	26%	*B. frauenfeldi*
Pumpkin	PNG: Central Province	57%	*B. cucurbitae*
Pumpkin	Solomon Is	60-87%	*B. cucurbitae, D. solomonensis*
Snake gourd	Solomon Is	>90%	*B. cucurbitae, D. solomonensis*
Soursop	FSM	28%	*B. frauenfeldi*
Soursop	Nauru (1)	10%	*B. dorsalis, B. frauenfeldi*
Surinam cherry	FSM	61%	*B. frauenfeldi*
Syzygium spp	FSM	38-51%	*B. frauenfeldi*
Tahitian chestnut	FSM	56%	*B. frauenfeldi*
Tangerine	FSM	20%	*B. frauenfeldi*
Tropical almond	FSM	69%	*B. frauenfeldi*

Tropical almond	PNG: Central Province	23 %	*B. frauenfeldi*
Watermelon	PNG: Central Province	31 %	*B. cucurbitae*

Table 2: Percentage of fruits (ripe, unless otherwise indicated) infested by fruit fly larvae based on host fruit surveying. 1= Data from Nauru covers assessments before the eradication programme started.

Besides formal assessments involving setting up fruits individually, Solomon Islands Development Trust assisted with assessments of damage caused by fruit flies in Guadalcanal and Western Province. In a workshop held in Honiara and involving Village Demonstration Workers (VDWs), overall estimates of damage from fruit flies in all Solomon Islands resulted in losses of 90-100% to guava, 100% to snake gourd, 90% to kavika (*Syzygium malaccense*), 50% to papaya, 18-50% to cucumber, 20-50% to rock melon, and 5-10% to mango. In Western Province, fruit flies caused losses (estimates) to carambola (60%), breadfruit (62%), snake gourd (56%), papaya (48%), kavika (38%), banana (33%), orange (29%), and guava (26%). The loss figures in Guadalcanal are based on asking individual VDWs to estimate losses from their common knowledge, while estimates in Western Province are based on actual examination of fruits from VDWs. Most of these data have not been verified by confirmatory host fruit surveys and should be treated as tentative estimates.

Damage assessments on North Ambrym (Vanuatu) by the Farm Support Association (FSA) showed that breadfruit suffered 80-100% damage at the ripe-overripe stage and kavika (*Syzygium malaccense*) 100% damage at all stages from colour break to fully ripe.

Protein bait spraying

Protein bait spraying is an economically and environmentally sound alternative to cover sprays for fruit fly control. It consists of spraying a solution of a protein and an insecticide diluted in water. The protein, which attracts mostly immature females in need of a protein meal for egg maturation, is derived from yeast, heated and treated with an enzyme. One source of protein commonly used is Mauri's Pinnacle Protein Insect Lure (MPPIL), manufactured in Toowoomba, Australia. The commonly used insecticide is Malathion 50% emulsifiable concentrate.

The bait solution is applied as a coarse spray at relatively low pressure at a rate of 50-100 ml per spot on the undersurface of one square metre of tree leaves. Every trees in an orchard of highly susceptible fruits are sprayed. For less susceptible host trees, every second tree may be treated. Protein bait spraying is also used to control fruit flies pests of vegetable crops. For chilli, capsicum, eggplant and tomato, 20-25 litres of bait solution per hectare are applied weekly as a band of coarse spray to foliage of plants in every third row. For cucurbits crops, as well as spraying the crop, vegetation around the crop is sprayed with spots of 50-100ml.

Protein bait spraying has been widely used to protect citrus orchards in Queensland for over 20 years. It has become very popular in South East Asia, especially in Malaysia. Positive results from tests in the PICTs have convinced farmers to adopt protein bait spraying. It has even become a part of the quarantine pathway for export of mangoes, papayas and eggplants from Fiji, Tonga and Cook Islands to New Zealand. Results from some tests carried out with support from RFFP-RMFFP are very convincing:

Commodity	Country	% damage untreated	% damage treated
Capsicum	Tonga, using MPPIL	97-100%	< 7%
Capsicum	Tonga, using Royal Tongalure	97-100%	< 10%
Carambola	Papua New Guinea	70-100%	< 7%
Chilli	Tonga	93%	2%
Guava	Fiji	40-45%	< 4%
Guava	Vanuatu	90%	< 7%
Mango	Fiji	25%	1-2%

Table 3: Results from successful use of protein bait spraying to control fruit flies.

In very rainy areas, heavy rain can wash off a significant amount of bait, sometimes resulting in higher infestations one to two weeks after a spray immediately followed by a downpour. To overcome this limitation, an improved bait formulation was developed in 1998 by Aventis CropScience. The formulation is known as "Bactrogel" and is a Fipronil-based powder that forms a gel when mixed with a protein source used for protein bait spray. The gel formulation has the advantage of adhering to foliage better than other protein bait spray formulations and therefore is more resistant to being washed from leaves by rain. Also, the

amount of Fipronil used in the bait spray is vastly smaller than the amount of other chemicals (usually Malathion) currently used in protein bait sprays. A much smaller amount of bait solution is required to control fruit flies: spots of 10-15 ml of bait solution are sufficient to achieve control, instead of spots of 50-100ml. Fipronil is highly toxic to fruit flies and has virtually no odour. However, it is degraded by direct sunlight and, therefore, must be applied to the undersides of leaves, preferably in the crown of the tree.

Bactrogel has been extensively used during the Nauru eradication campaign and was demonstrated to and used by all participants from PICTs who were involved in each eradication campaign. It was also demonstrated in French Polynesia in October 2000. It will be used as part of the forthcoming Palau eradication programme.

Bactrogel has been extensively tested for fruit fly control in Australia, but is not yet commercially available. Results show that as little as 5ml of bait solution in each sprayed spot is sufficient to achieve control. The product will soon be registered for commercial use in Australia, and will then become available to PICTs. The use of Fipronil in bait sprays has already been registered by governments of Fiji Islands (for commercial use), Samoa and Tonga (for experimental use) in preparation for its future availability on the market. The governments of Vanuatu and PNG have also been approached for Fipronil registration in preparation for its introduction.

KEY ACHIEVEMENTS

- Protein bait spraying continues being used by commercial farmers in Tonga, Fiji Islands, Samoa and Cook Islands for fruit fly control.
- Field demonstrations of protein bait spray technique in Fiji Islands (Sigatoka Valley).
- Protein bait sprays adopted by commercial guava and citrus producer (Des Park) on Efate, Vanuatu, resulting in damage reduction of over 90% to less than 7%, making guava production viable. Bait spray technology resulted in first harvest of marketable fruit from farmer's 800 guava trees.
- Consultancy arranged to establish pilot demonstrations of protein bait spraying and bagging at village level in Ambrym in Vanuatu (involving Farm Support Association NGO) and on protein bait spraying for cucurbits in Western Province of Solomon Islands (involvement of Solomon Island Development Trust network).
- Villagers on North Ambrym in Vanuatu have tested protein bait sprays and bagging of fruits as a means of controlling fruit flies and increasing food security. Bagging of fruits is appropriate technology.
- Two farmers from each of Aniwa, Anatom, Futuna, Tanna and northwest Santo islands in Vanuatu trained at Des Park orchard, by Des, and staff from the fruit fly project staff and the Department of Agriculture, on fruit fly control and citrus and guava orchard management. This constitutes objective 2 of a special project called "Promotion of Income Generation Opportunities from Fruit Production in Island Communities in Vanuatu". Objective 1 involves the purchase and installation of technology for conversion of brewery waste yeast into protein bait (sponsored by RMFFP and ACIAR) and objective 2 involves training of farmers from Aniwa, Anatom, Futuna, Tanna and northwest Santo on fruit fly control and orchard management (sponsored by UNDP-ICARE). As an outcome of the training, farmers will improve their orchards, apply fruit fly control methods and train other farmers on their islands.
- Extension activities with NGO groups in Vanuatu and Fiji result in adoption of protein bait spraying at the commercial level and bagging of fruits at the village level, respectively. Similar response to control techniques in Palau as a result of conducting two seminars on management of fruit flies for up to 25 people from a wide range of backgrounds.
- Protein bait spray demonstration and experiment trials carried out in Papua New Guinea at the Kerevat Prison on guava, in the Markham Valley on guava and mango and at Laloki on carambola. Control in carambola resulted in reductions of damage from 100% to less than 10%. Results in the trials at Kerevat and Markham Valley were less spectacular, but still showed marked reductions in damage levels. Heavy rainfall hampered achieving acceptable control. The new "Bactrogel" formulation of protein bait spray will overcome this problem.
- Combination of protein bait spraying and bagging of guavas at the Kerevat Prison allows the sale of guavas for 40-50 Toeas per fruit – a good income for the Prison.
- Demonstration of protein bait spraying to chilli growers to control *B. bryoniae* in Morobe.
- Demonstration of protein bait spraying using fipronil gel in French Polynesia in October 2000.
- Recommended bait spray trial at village level in Niue to test the effectiveness of destruction of fallen fruits and protein bait spraying – Planned for January 2001.
- Testing of a new formulation of Fipronil as an insecticide to replace Malathion for weekly protein bait spraying successfully carried out as part of the Nauru Fruit Fly Eradication Programme. This is being done with the Crawford Fund for International Agricultural Research and Rhône Poulenc (Rural) Australia. The formulation involves a thickener to improve the adherence of the bait to leaves particularly

during wet weather and also to improve the effectiveness of the bait. It will be commercialized under the trade name of "Bactrogel".
- Fipronil registered in Fiji Islands (for commercial use), Tonga and Samoa (for experimental use) for protein bait spraying.
- 41 staff from 19 PICTs received training in protein bait spray for fruit fly control during the Nauru Fruit Fly Eradication Programme, with the view of encouraging adoption of techniques on return to their respective countries. Training included the use of newly developed Bactrogel.
- For complete chronological list of achievements, see progress report in annex under outputs 1.3, 3.1, 3.2, 3.3 and 4.3.

Fruit bagging

Fruits are easily protected against fruit flies by bagging them in newspaper bags. The bag provides a physical protection to the fruit by preventing adult female flies from laying eggs. Bagging has been used for a very long time in Asia by commercial planters and smallholder farmers. The carambola export industry in Malaysia, worth 10 Million US$ in 1994, has been protecting entire orchards by bagging for over 70 years. It is also widely practiced to protect mangoes in Thailand and Philippines. Bagging is inexpensive and easy to apply and guarantees nearly complete protection from fruit flies. It is ideal for small-scale growers who cannot afford pesticides.

Bagging has been introduced and promoted in PICTs as an inexpensive alternative to the use of chemicals to protect fruits against fruit flies. It is ideally suited for small backyard fruit production. A Pest Advisory leaflet on fruit bagging has been published and distributed to all PICTs. Demonstrations of bagging to farmers and school children during field visits, school visits and agricultural shows are ongoing in PICTs.

KEY ACHIEVEMENTS

- Pilot demonstrations of protein bait spraying and bagging at village level in Ambrym in Vanuatu. Villagers have tested bagging of fruits with paper bags or bags made from leaves as a means of controlling fruit flies and increasing food security. Bagging of fruits is appropriate technology.
- Field pilot studies on bagging also carried out in Solomon Islands and Fiji Islands.
- Emphasis on recommending and actively encouraging, through demonstration, the bagging technique for fruit fly control, particularly at the subsistence level of production in all PICTs.
- 41 staff from 19 PICTs received training in bagging techniques for fruit fly control during the Nauru Fruit Fly Eradication Programme, with the view of encouraging adoption of techniques on return to their respective countries.
- Bagging techniques tested on guavas at the Kerevat Prison and in the Markham Valley (PNG). At the Prison, only 2 out of the 152 bagged fruits were infested with fruit flies. In the Markham Valley, the level of damage of bagged guava was 8.4% compared to that of unbagged fruits of 71% damage.
- Bagging trial in carried out in Central Province (PNG) to compare newspaper and plastic bags.
- Bagging of fruit and protein bait spraying on guavas adopted as orchard management practice at Kerevat prison (PNG). This has allowed the sale of high quality guavas for 40-50 Toeas per fruit – a good income for the Prison.
- Regular demonstrations of bagging and protein bait spraying to schools, farm visits and open days held at the research stations in PNG.
- Demonstration to farmers of whole bunch bagging of banana trees to East New Britain farmers as a means of controlling banana fly, a new pest of bananas for the Province (coming in December 2000).
- Bagging demonstration carried out in Rotuma and is currently a recommended field control method for fruit flies in Fiji. Recommendations are given to farmers and small scale or backyard gardeners in Fiji.
- Bagging demonstrations for orchard or backyard garden control carried out in Fiji in November-December, 2000.
- Publication and publication of a SPC Pest Advisory Leaflet on fruit bagging to control fruit flies. PAL illustrates, step by step, bag preparation and fruit bagging.
- For complete chronological list of achievements, see progress report in annex under outputs 1.3, 3.3, 4.3.

Brewery waste yeast modification

The Fruit Fly Project has been actively involved in the development of technologies to produce locally in PICTs a source of protein for fruit fly control as an inexpensive substitute to the import of Mauri's Pinnacle Protein Insect Lure from Australia. The initial step was the establishment of a plant to convert waste yeast from Royal Brewery in Tonga into protein bait. A special project (No 7500) executed by the Queensland DPI under ACIAR collaborated in the development of waste yeast conversion technology, in cooperation with the RFFP and USDA - Commercial Agricultural Development Project. The conversion process involves concentrating the waste yeast slurry by heating for several hours in an open stirred container to drive off the alcohol and excess water, treating the concentrated material with a proteolytic enzyme (papain) and holding the concentrate at 65º-70ºC for 24 hours and adding potassium sorbate as a preservative.

Extensive field trials were carried out in Tonga to compare effectiveness of locally produced protein bait with MPPIL at controlling fruit flies (*Bactrocera facialis*) on capsicum and chilli. Results have shown that the local bait is as effective as MPPIL.

The commercial product, known as Royal Tongalure, was launched in March 1998 and has been adopted by Tongan farmers. The excess protein is also available as protein additive for stock-feed, especially for pigs. Savings for farmers by using local source of protein are substantial – Tongalure costs TOP 2.00 per litre compared to TOP 30.00 for Mauri Pinnacle Protein Insect Lure imported from Australia.

Royal Brewery in Tonga is assisting with the transfer of technology on brewery waste yeast modification to Vanuatu Tusker Brewery, its sister brewery. The RMFFP has developed, in collaboration with UNDP-ICARE, a project called “Promotion of Income Generation Opportunities from Fruit Production in Island Communities in Vanuatu”. There are two objectives: 1. Development of cheap protein bait produced locally from waste yeast conversion by Tusker Brewery (sponsored by RMFFP and ACIAR). 2. Training of farmers from Aniwa, Anatom, Futuna, Tanna and northwest Santo on fruit fly control and orchard management (sponsored by UNDP-ICARE). An implementation workshop for the new project conducted on 22 May 2000. Farmers were trained between August and November. A waste yeast conversion system similar to that used in Tonga has been manufactured in New Zealand and has been shipped to Vanuatu in November 2000. An engineer from the Brewery will be sent to Tonga on attachment, in January 2001, to become familiar with the conversion process. The attachment is jointly sponsored by NZODA and Vanuatu Tusker Brewery. Waste yeast conversion is expected to start in early 2001.

Research is underway to convert waste from Carlton Brewery in Fiji Islands into protein bait. The conversion work and lab and field attractancy tests are conducted by the fruit fly team at Koronivia Station in Suva. Meanwhile, Royal Tonga Brewery has started exporting Royal Tongalure to Fiji as a cheaper alternative to importing MPPIL.

Breweries in Samoa, Solomon Islands and especially Papua New Guinea have shown interest in adopting the waste yeast conversion technology. Experience in Vanuatu and Fiji Islands will help in guiding these countries in developing the new technology.

KEY ACHIEVEMENTS

- Completed testing of Royal Tongalure on capsicums in 1997. Untreated plots 97-100% damage treated plots less than 10% damage. Final product commercially released in March, 1998.
- Tusker Brewery in Vanuatu agreed to modify waste yeast to protein bait for controlling fruit flies (similar to that in Tonga), as an protein additive to animal feed and so as to reduce environmental pollution by discharging about 800 litres of waste yeast into the ocean.
- RMFFP developed, in collaboration with UNDP-ICARE, a project called “Promotion of Income Generation Opportunities from Fruit Production in Island Communities in Vanuatu”. There are two objectives: 1. Development of cheap protein bait produced locally from waste yeast conversion by Tusker Brewery (sponsored by RMFFP and ACIAR). 2. Training of farmers from Aniwa, Anatom, Futuna, Tanna and northwest Santo on fruit fly control and orchard management (sponsored by UNDP-ICARE).
- Unit for brewery waste yeast conversion into protein bait purchased from New Zealand with funds from RMFFP and ACIAR and shipped to Vanuatu in November. Bait production will commence in early 2001.
- Fiji MAFFA conducted preliminary trials of conversion, based on Tongan procedure, and field testing of protein bait from waste yeast from Carlton Brewery.
- Royal Tongalure exported to and used by farmers in Fiji Islands as a cheaper alternative to MPPIL while research underway for waste yeast conversion in Fiji.

- For complete chronological list of achievements, see progress report in annex under outputs 1.3, 3.2 and 3.4.

Socioeconomic study

A consultant economist (Dr. Andrew McGregor) was hired in 1998-1999 to carry out a socioeconomic study to review the 1996 estimates of the benefits and impact from fruit fly project and to estimate the impact of fruit flies at the village level. The consultancy involved field visits and consultancies in Fiji Islands, Vanuatu and Solomon Islands. The complete report was presented in October 1999, and published as a book in August 2000. The executive summary of the report is included in annex. In summary, the main conclusions of the study are as following.

The 1996 Study, published in the Proceedings of the Regional Symposium (Allwood and Drew, 1997) covered the period 1993 to 2002. The benefits were measured entirely in terms of increased export earnings. It estimated the total consolidated benefits over the 10 year period to be USD24.5 million. When compared with Project costs, this benefit flow generated an internal rate of return (IRR) of 37%. The 1999 assessment saw a downward revision of benefits. Also, the actual donor contributions (cost) for the years 1997 to 1999 were substantially more than what was projected in 1996. Thus the internal IRR in the 1999 assessment declined by half to, albeit a still healthy, 19%.

Domestic losses due to fruit flies have been determined taking into consideration the damage to fruit caused fruit flies in the various PICTs, the nature and level of fruit production and consumption in the PICTs, the impact of fruit fly damage on fruit consumption at the subsistence or self-sufficiency level, and the impact of fruit fly damage on fruit consumption at the commercial level.

The overall conclusion is that fruit flies **at present** do not have a significant impact on fruit consumption and nutrition at the household self-sufficiency level. The reasons for this can be divided between staple (banana and breadfruit) and non-staple fruit. Bananas for many households in the region is the most important food staple. Breadfruit is also an important staple throughout the region, particularly for small islands and atolls. However, in most locations fruit flies do no, or little, damage to bananas. The experience in PNG and Palau are important exceptions and show the danger that fruit flies pose to this most important staple. In most situations fruit fly damaged breadfruit, even when considerable, is unlikely to have a major food and nutrition impact. This is due to the large surpluses of breadfruit are usually available and that fruit fly damaged breadfruit can still usually be utilised.

At **present,** generally the damage caused to non-staple fruit by fruit flies does not have a major impact on subsistence consumption and nutrition. This is due to a combination of factors: non-staple fruit is of relatively minor importance, a wide range of alternative non-staple fruit is usually available, and sufficient quantities of non-infested fruit can normally be found.

The incursion of an exotic species such as Asian papaya fruit fly or Oriental fruit fly could however have a devastating impact on domestic fruit sales [as it happened in Palau]. In cases like Samoa, where a fruit [banana] is the main traded staple, the commercial losses would be even greater if there was the incursion of a serious exotic fruit fly.

The study identified a lack of traditional control and mitigation measures. This can be explained by the fact that fruit flies were not perceived as a major problem by village communities. Bait spray technology has been identified as having potential in terms of expanded domestic consumption of fruit and vegetables. Fruit bagging was the other technology examined at the village level. Results from pilot studies of application of protein bait spraying in Vanuatu at village and commercial orchard level, and of bagging in Solomon Islands are discussed.

The benefits from the eradication programme in Nauru are reviewed by the study. They include the substantial reduction of the risk of spread of exotic fruit flies from Nauru to other PICTs, the emergency response capability of the PICTs enhanced, the improvement of nutrition and food security in Nauru, and that Nauru has for the first time an Agricultural Quarantine Act.

KEY ACHIEVEMENTS

- Consultancy (Dr. Andrew McGregor) to carry out study on the value of fresh fruit and vegetable production at the subsistence level and the impact of increases in fruit and vegetable production on poverty and the rural labour market, commenced in September, 1998.
- Consultancy arranged to establish pilot demonstrations of protein bait spraying and bagging at village level in Ambrym in Vanuatu.
- Workshops with Village Demonstration Workers (VDWs) from Solomon Islands Development Trust (SIDT) held in Honiara and Gizo to explain the importance of fruit flies, their control and assessment of damage levels. VDWs undertook damage assessments in villages to determine the impact of fruit flies on subsistence food security and production. It resulted in fruit fly control at the village level being included in the compulsory tasks to be performed by each VDW.
- Consultant has compiled report on data on levels of damage caused by fruit flies and benefits of fruit fly control technology to subsistence fruit and vegetable production, collected in Solomon Islands, Vanuatu, Fiji and Nauru.
- Hired professional editor to edit, publish and print one thousand copies of Andrew McGregor's "Socioeconomic evaluation of the Regional Fruit Fly Projects".
- For complete chronological list of achievements, see progress report in annex under outputs 1.3 and 3.1.

C. Enhanced Trade

Laboratory colonies

Before research on quarantine treatment development was carried out, fruit fly laboratory colonies have been established for economic fruit fly species in Fiji Islands, Cook Islands, Samoa, Tonga, Vanuatu, Solomon Islands, PNG, Palau, FSM and New Caledonia. This enabled a consistent supply of insects that were used in research on field control methods and quarantine treatments development. The techniques used for rearing of Tephritid Fruit Flies in the Pacific are documented in the ACIAR Proceedings No. 76 on Management of Fruit Flies in the Pacific. At present, 13-14 species are kept in cultures throughout the Pacific, as shown on the following table:

	Cook Is	Fiji Is	FSM	New Caledonia	Palau	PNG, Bubia	PNG, Kerevat	PNG, Laloki	Samoa	Solomon Is	Tonga	Vanuatu
Bactrocera cucurbitae						A				A		
Bactrocera curvipennis				A								
Bactrocera dorsalis					A							
Bactrocera facialis											A	
Bactrocera frauenfeldi			A		A		A			A		
Bactrocera kirki									A		A	
Bactrocera melanotus	A											
Bactrocera minuta												B
Bactrocera musae								A				
Bactrocera papayae						A						
Bactrocera passiflorae		A										
Bactrocera psidii				A								
Bactrocera quadrisetosa												B
Bactrocera samoae									B			
Bactrocera trilineola												A
Bactrocera tryoni				A								
Bactrocera umbrosa				B						B		B
Bactrocera xanthodes	A	A							A		A	
Dacus solomonensis										A		

Table 4: Fruit fly species kept in colonies in PICTs. A = colonies still maintained / B = colonies not maintained anymore

KEY ACHIEVEMENTS

- Colonies continuously maintained since 1991-92 in Fiji Islands, Tonga, Samoa, Cook Islands and New Caledonia.
- Fruit fly entomologist from Tonga (Tuipulotu Langi) sent to Samoa in April for attachment training on rearing techniques for *Bactrocera kirki.* He is now re-establishing colonies of *B. kirki* for heat tolerance testing.
- Handbook on fruit fly rearing produced by fruit fly staff in Samoa and used as reference guide during the August refresher training course.
- Maintained colonies of *Bactrocera cucurbitae* (melon fly), *B. frauenfeldi* (mango fruit fly), *Dacus solomonensis* in Solomon Islands.
- Maintained colonies of *B. trilineola* in Vanuatu, used for heat tolerance research and host status testing.
- Colonies of mango fruit fly in FSM died in 1997, but have been re-established in 1998 and are maintained on a small scale to breed parasitoids for biological control.
- Fernando Sengebau (plant protection officer in Palau) on attachment training in Fiji Islands on fruit fly rearing and confirmatory tests on HTFA in February 2000, and in USDA-ARS laboratories in Hilo, Hawaii, on fruit fly rearing, heat treatment research and biological control, in August, 2000.
- Colonies of *B.* dorsalis and *B. frauenfeldi* established in Palau for host status testing on betel nuts and for heat tolerance research.
- Laboratory colonies established in Papua New Guinea: *B. frauenfeldi* in Kerevat, *B. cucurbitae* and *B. papayae* at Bubia and *B. musae* at Laloki.
- For complete chronological list of achievements, see progress report in annex under outputs 1.4, 3.2, 4.4.

Heat tolerance studies and Forced hot air technology

As a prerequisite to the development of the Forced Hot Air, a quarantine treatment for fruit flies, studies on the heat tolerance of economic fruit fly species were carried out. Studies were executed under RFFP/RMFFP supervision in Fiji Islands, FSM, Solomon Is, Tonga and Vanuatu, and carried out in Cook Islands and Samoa by New Zealand Hort + Research, in New Caledonia by CIRAD and NZ Hort + Research, in Hawaii by USDA Pacific Basin Agricultural Centre (PBARC) and in Australia by Queensland Department of Primary Industries (QDPI). The species tested throughout the Pacific are listed in the following table:

	Cook Is	Fiji Is	FSM	New Caledonia	Palau	PNG, Bubia	PNG, Kerevat	PNG, Laloki	Samoa	Solomon Is	Tonga	Vanuatu	Hawaii	Australia
Bactrocera cucurbitae													A	
Bactrocera curvipennis				A										
Bactrocera dorsalis													A	
Bactrocera facialis											A			
Bactrocera frauenfeldi			B		C		C			B				
Bactrocera kirki									A		C			
Bactrocera melanotus	A													
Bactrocera musae								C						
Bactrocera papayae						C								A
Bactrocera passiflorae		A												
Bactrocera psidii				A										
Bactrocera trilineola												A		
Bactrocera tryoni				A										A
Bactrocera xanthodes	A	A							A		A			

Table 5: Heat tolerance research carried out in PICTs, Hawaii and Australia
A = study completed / B = partially studied / C = study scheduled to start in 2001

Forced Hot Air (FHA) units allow to treat fruits before overseas export to ensure that fruits are not bearing live eggs or larvae of fruit flies. Heat tolerance studies on pest species in countries have allowed developing treatment schedules that vary slightly in different countries. In the Cook Islands, the treatment parameter is

47°C and the fruits are held for 20 minutes at this prescribed temperature. In Fiji Islands, the treatment parameter is to raise the core temperature of the largest fruit placed in the coldest spot in the FHA chamber to 47.2°C and then holding it at that temperature for 20 minutes and then hydrocooling it. FHA units have been installed inFijiIs, Tonga, Cook Is and New Caledonia, but only Cook Is and Fiji Is have so far developed a sizeable export industry.

FHA units have allowed to make commodities that are fruit fly hosts exportable to New Zealand. Fiji Is started exporting fresh papaya (Hawaiian "Waimanalo" and "Sunrise" varieties) in 1996, and mango (assorted varieties) and eggplant since 1997. In late 1999, Fiji Is has obtained clearance to export FHA-treated breadfruits as well, though exports have not started yet. Amounts exported and value of exports are:

Commodities	1996 (kg)	1997 (kg)	1998 (kg)	1999 (Kg)	2000 (Kg) (until June)	Total (kg)	Estimated (FJD)
Pawpaw	33,037	90,010	85,965	152,000	21,938	382,950	1,705,738
Mango	-	23,072	120,209	28,000	1,813	173,096	549,095
Eggplant	-	69,615	185,155	190,000	77,140	521,910	1,559,545
Total	33,037	182,679	391,329	370,000	100,891	1,077,956	3,814,378

Table 6: Produce treated by the HTFA facility at Nadi, Fiji (1996-2000), source: Manager Natures Way Cooperative (Fiji) Ltd.

Cook Islands started exporting papaya to New Zealand in 1994, and has exported almost 2000 tonnes in five years. It also exports more modest amounts of mangoes (since 1997) and eggplants (since 1999).

	1994	1995	1997	1998	1999
Tonnes	590	470	256	261	417
Value (NZ$,000 fob)	504	466	253	250	

Table 7: Cook Islands papaya exports to New Zealand (1994-98) (after McGregor, 2000); source: SPTO Auckland.

Before a commodity can be treated and exported, confirmatory tests are required. These involve artificially infesting fruits with late eggs (the most heat tolerant stage of development), treating the infested fruits with other fruits as though carrying out a normal treatment, and holding the fruits to check if eggs hatch and larvae develop. Confirmatory tests were required for all commodities presently exported. Fiji Is has conducted confirmatory tests in 1999 and 2000 to allow papayas to potentially become exportable to Australia. Results have been submitted to AQIS, but no reply has yet been received.

KEY ACHIEVEMENTS

- Discussions on generic heat treatments held with NZ MAF Regulatory Authority – concept accepted.
- Conducted a Workshop on the Generation of Heat Tolerance Data for Immature Stages of Fruit Flies in Port Vila for three participants from PNG, two from Solomon Islands, two from Vanuatu and one from the ACIAR Fruit Fly Project in PNG on 31 October-5 November 1999. Aim was to standardize techniques throughout the region. Equipment and supplies for undertaking heat tolerance research on immature stages of fruit flies provided to the three PNG Centres, to Solomon Islands and to Vanuatu.
- Forced Hot Air treatments allows to export papaya, fresh and pickling mangoes, eggplant from Fiji to New Zealand.
- In Fiji, quarantine treatment using forced hot air developed for breadfruit to New Zealand. Confirmatory tests completed in March, 1999. Quarantine pathway for export to New Zealand developed and breadfruit cleared by Fiji MAFF for export to New Zealand with HTFA treatment. Exports to commence soon.
- Conducted in Nadi, Fiji Islands, confirmatory tests on High Temperature Treatment of papayas in February and May 2000 in view of submitting results to AQIS Australia. Report and data submitted to Australian regulatory authority for technical assessment.
- Cook Islands obtained clearance for heat treatment of eggplants and mangoes under generic concept.
- Heat tolerance data from Cook Is and Samoa (done by NZ Hort+Research) accepted by New Zealand.
- Hot forced air facility in Tonga certified for export of papaya to New Zealand.
- Hot Forced Air facility established in New Caledonia by Government and private sector.
- Heat tolerance testing of early and late eggs, first instar larvae and feeding and non-feeding third instars of *Bactrocera trilineola* completed in Vanuatu. Data has been be analyzed in New Zealand by consultant statistician in New Zealand (Dr. Chris Frampton). Results will be submitted to MAF Regulatory Authority for acceptance.

- MOU on information exchange and collaborative work on fruit flies with the USDA-Agricultural Research Service Laboratories in Hilo, Hawaii negotiated. Heat tolerance database is only one of a number issues for discussion. Others include technical advice and new techniques for eradication of Oriental fruit fly in Palau, alternatives to malathion as the toxicant in protein bait sprays, and 'generic' or recipe quarantine treatments for fresh fruits and vegetables.
- Palau Government to receive technical and financial assistance to carry out heat tolerance studies on immature stages of *B. frauenfeldi* from USDA-ARS Pacific Island Basin Research Centre in Hilo, Hawaii. The RMFFP is setting up laboratory and fruit fly colonies. Attachment training of Fernando Sengebau (Palau) in Hawaii in August on heat tolerance research as part of RMFFP agreement with USDA-ARS.
- For complete chronological list of achievements, see progress report in annex under outputs 1.5, 3.2, 3.5, 4.4.

Non-host status

The Non-Host Status standard specified in the New Zealand Ministry of Agriculture and Forestry (MAF) Regulatory authority Standard 155.02.02 Specification for Determination of Host Status as a Treatment, was developed to assist PICTs export fresh fruits and vegetables to New Zealand without additional quarantine treatments. This standard aims to determine the susceptibility of the fruit or vegetable that is tested to fruit flies. There have been numerous fruit and vegetables tested under this standard in Fiji Islands, Tonga, Samoa, Cook Is, New Caledonia, Solomon Is, Vanuatu and FSM. Lists of tested commodities and results in PICTs have been published in the Proceedings of the 1996 Symposium. Highlights from non-HST testing in each country are:

Fiji Islands has exported to New Zealand two chilli varieties, "Hot Rod" and "Red Fire" without the use of other quarantine treatments. Chilli exporters are required to follow an approved quarantine pathway before export takes place. The total export of these two varieties of chilli, from 1994 to 1999, was over 112 tonnes. HST has also proved that 'Smooth Cayenne', 'Viamama' and 'Ripley Queen' pineapple from colour break to fully ripe, and squash/pumpkin are not susceptible to *B. xanthodes* and *B. passiflorae*.

Cook Islands demonstrated that mature green banana, eggplant, Birdseye chilli and squash cultivars Delica and Blue Max are non-host for *B. melanotus* and *B. xanthodes*. Birdseye chillies are exported to New Zealand on that basis. The export value in 1998 was NZD 89.000.

Samoa exports green bananas to New Zealand (152 tonnes in 1998, valued NZD200,000) under non-host status quarantine treatment, a good substitute to taro that has been decimated by taro leaf blight since 1993. In 1999, a speciality niche market was established for organically certified Samoan "Lady Finger" bananas and two airfreight containers were shiiped weekly (as of June 1999). They also proved that sapodilla, Tahitian and West Indian limes are not susceptible to fruit flies *B. kirki* and *B. xanthodes*. The results for sapodilla and limes have recently been accepted by New Zealand.

Tonga exports 'Candy Red' and 'Sugar Baby' watermelon varieties under non-host status quarantine treatment, and proved that cucumber, zucchini, "Bird eye" chillis are not susceptible to *B. facialis* and *B. xanthodes*.

New Caledonia exported watermelon, lime and squash to New Zealand under non-host status quarantine treatment. Values of exports in 1998 were 233,000 NZD for watermelon, 89.000 NZD for lime and 54,000 NZD for squash.

Vanuatu has proved that pineapples, cucumbers and squash are not hosts to *Bactrocera trilineola*, and have already started exporting cucumber and squash to New Zealand on that basis. "Long Red Cayenne" chilli and Tahitian lime are also non-hosts and, subject to New Zealand accepting the results and subject to developing acceptable quarantine pathways, Vanuatu may export these commodities as well.

Solomon Islands proved that pineapple is not susceptible to fruit flies in Solomon Islands and New Zealand accepted results. An export protocol for pineapple was developed but exports have not yet started. Demonstrated that Lisbon Lemons are also non-hosts.

In FSM tests demonstrated that limes (*Citrus aurantifolia*) and Yapese lemons (*C. hystrix*) are not hosts to *B. frauenfeldi*. Initiated negotiations with USDA for an eventual or conditional lift of the ban to lime and Yapese lemon export to Guam.

KEY ACHIEVEMENTS

- Host status reports on pineapple, squash and cucumbers completed in Vanuatu. Reports and data submitted to New Zealand. Squash and cucumber data accepted at this stage, and Vanuatu has clearance for their export.
- Reports from non-host status testing in Vanuatu of three varieties of cucumbers and one variety of chilli finalized and ready to be submitted to New Zealand.
- One cucumber variety and 'Tahitian' limes recently tested in Vanuatu and are non-hosts to *B. trilineola*.
- Reports from host status testing of mango fly on pineapple and Lisbon lemon in Solomon Islands written and nearly ready to be submitted to New Zealand MAF.

- Carried out non-host status testing on zucchini, capsicum, ripe chillies, bittergourd and jakfruit in Fiji Islands, and abiu in Samoa.
- Colonies of *B. dorsalis* and *B. frauenfeldi* established in Palau for host status testing on betel nuts to allow their export to Guam.
- For complete chronological list of achievements, see progress report in annex under outputs 1.5 and 3.2.

D. Improved Technical Capacities

Training

Several formal training courses and hands-on training workshops were organized and delivered jointly with ACIAR during the Project. A training course on "Identification, biology and Surveillance of Fruit Flies in Solomon Islands, Vanuatu and Papua New Guinea" was jointly funded and delivered by RMFFP and ACIAR. It took place at Griffith University, Brisbane, on 23-27 June, 1997. Seven participants from Vanuatu (3), Solomon Islands (2) and PNG (2) attended the course. In-country fruit fly identification workshops were organized and funded by ACIAR, with RMFFP involvement, in Vanuatu (October 1997) and Solomon Islands (January 1998). In August 1999, 21 staff attended a training workshop on fruit fly biology, monitoring, control and identifications at UNITECH Rainforest Habitat in Lae in August 1999, funded by ACIAR and run by the PNG Fruit Fly Project (RMFFP+ACIAR Projects). Participants were scientists and technicians from National Agricultural Research Institute (NARI), quarantine officers (National Agricultural Quarantine Inspection Authority or NAQIA), Provincial Departments of Primary Industries extension officers, Coffee Industry Corporation (CIC) and Fresh Produce Development Company (FPDC).

The RMFFP conducted two other training courses. A hands-on practical training workshop on the Generation of Heat Tolerance Data for Immature Stages of Fruit Flies was conducted in Port Vila on 31 October to 5 November 1999 for three participants from PNG, two from Solomon Islands, two from Vanuatu and one from the ACIAR Fruit Fly Project in PNG. The aim of the course was to standardize and harmonize heat tolerance research methods throughout the region. One thermocirculator and a complete Heat Tolerance Testing equipment kit was handed to each of the three PNG Centres (Laloki, Kerevat, Bubia), and to Solomon Islands. A refresher training course was run on fruit fly management in Samoa on 15-18 August, 2000. Participants came from Samoa (26 participants), American Samoa (2), Tonga (1), Cook Islands (1), Tuvalu (1), Tokelau (1) and Niue (1). Topics covered were biology of fruit flies, importance of quarantine surveillance, field control methods, quarantine treatments, emergency response planning and an ERP simulation exercise using the Samoa ERP. Most of the trainers were National staff from Samoa Fruit fly programme.

A total of 41 research, plant protection and quarantine officers from all PICTs (except CNMI, French Polynesia and Pitcairn), and from New Zealand and SPC have received hands-on practical training on fruit fly eradication techniques, control methods, trapping and host surveys, and developing emergency response plans to cope with the incursion of exotic fruit flies as part of the Nauru Fruit Fly Eradication Programme (FFERAD). Many of them have drafted Emergency Response Plans against exotic fruit flies for their countries.

In Papua New Guinea, the two Junior Scientific Officers (JSOs) recruited in April 1998 have received four months of intensive practical training on all aspects of fruit fly management by the United Nations Volunteer. In August, one of them moved to Bubia Station and initiated the whole fruit fly programme component there. The third JSO was recruited for Laloki in June, 1999. The three JSOs are now running the programme by themselves.

Short-term attachments have also been provided to some of the national fruit fly workers to cover more specific needs that are relevant to their countries. Fernando Sengebau (fruit fly entomologist in Palau) spent two weeks on attachment in February 2000 in Fiji Islands on fruit fly rearing and surveillance methods (Koronivia lab) and on confirmatory tests for HTFA treatments (in Nadi). He was also sent in August, 2000 on attachment at USDA-ARS Pacific Basin Agricultural Research Centre laboratories in Hilo, Hawaii, to become further acquainted with fruit fly rearing, heat treatment research and biological control. The fruit fly entomologist from Tonga (Tuipulotu Langi) was sent to Samoa in April 2000 for training on rearing techniques for *Bactrocera kirki*, as Tonga expects to carry out heat tolerance research on the species. An attachment training is scheduled to take place in late November at Koronivia Research Station for fruit fly technicians Geoffrey Oliouou (Solomon Islands) and Albert Arbedul (Palau).

A special project was developed in collaboration with UNDP-ICARE: "Promotion of Income Generation Opportunities from Fruit Production in Island Communities in Vanuatu". Objective 2 involves training of farmers from Aniwa, Anatom, Futuna, Tanna and northwest Santo on fruit fly control and orchard management, sponsored by UNDP-ICARE. Two citrus farmers from each island have been intensively trained by working at Des Park's orchard, a commercial fruit grower on Efate, on fruit fly control and citrus and guava orchard management. As part of Objective 1, involving the purchase of waste yeast modification unit for the brewery, funded by RMFFP and ACIAR, an engineer from Tusker Brewery will be sent on a one-week attachment to Royal Tonga Brewery in January (funded by NZODA) to learn about installation and running waste yeast conversion unit.

KEY ACHIEVEMENTS

- Collaboration with ACIAR in running training workshops on fruit fly management in Brisbane (June 1997), Vanuatu (October 1997), Solomon Islands (January 1998), and Papua New Guinea (August 1999).
- Conducted a subregional practical training workshop on heat tolerance research in Vanuatu (November 1999) for participants from PNG, Solomon Islands and Vanuatu.
- Ran a subregional refresher training course on fruit fly management in Samoa (August 2000) for participants from Samoa, American Samoa, Tonga, Cook Islands, Tuvalu, Tokelau and Niue.
- 41 research, plant protection and quarantine officers from all PICTs (except CNMI, French Polynesia and Pitcairn) and from New Zealand and SPC received training on fruit fly eradication techniques and management and emergency response planning.
- JSOs in Papua New Guinea received intensive practical training on all aspects of fruit fly management.
- Five short-term attachments provided to fruit fly workers to address specific needs of countries.
- Training of commercial citrus farmers from Aniwa, Anatom, Futuna, Tanna and northwest Santo on fruit fly control and orchard management as part of the project on "Promotion of Income Generation Opportunities from Fruit Production in Island Communities in Vanuatu".
- Engineer from Tusker Brewery of Vanuatu will be sent to Royal Tonga Brewery to learn about installation and running waste yeast conversion unit purchased for Vanuatu.
- For complete chronological list of achievements, see progress report in annex under outputs 1.2, 1.3, 1.5, 2.2, 3.2, 3.3, 3.5, 4.5.

Laboratory establishment and refurbishment

The RMFFP has financially assisted in establishment of fruit fly facilities through refurbishment of available buildings in PNG, Solomon Islands, Nauru and Palau. In PNG, buildings at Kerevat, East New Britain (Lowland Agricultural Experiment Station (LAES)) and Bubia, Morobe Province were renovated and modified into fruit fly laboratories. In Kerevat, there is a complete laboratory occupying a two-story building, with a colony room and two laboratory rooms (since April 1999), and a screenhouse used for holding fruit samples (since October 1997). In Bubia, there is one building with a colony room and an office (since August, 1998), and a screenhouse (since August 1998). In Laloki, one building in the large entomology complex was renovated in June 2000, and holds fruit fly colonies and HTT research equipment. All three Centres are now operational and fully equipped to carry out fruit fly surveillance and research.

In December 1998, the laboratory facilities at Dodo Creek Research Station (DCRS), Solomon Islands were rejuvenated so that activities related to laboratory colonies, trapping, fruit surveys and heat tolerance studies of eggs and larvae could be re-activated. Deteriorating security conditions in Solomon Islands however forced to move equipment and staff associated to SPC's Fruit Fly and Taro Beetle Projects away from Dodo Creek Station, to the Malaria Centre mosquito breeding laboratory in Honiara. Funds were again committed to refurbish the run-down laboratory, although this is a temporary arrangement valid until December 2000.

There are no prospects of returning to Dodo Creek Research Station in Solomon Islands, as buildings have been recently destroyed by fire. The Ministry of Agriculture has agreed to make the veterinary laboratory available to house the fruit fly and taro beetle project components, as soon as it is has been refurbished with funding from the European Union, theoretically in late 2000.

In Nauru, the RMFFP has provided financial assistance and human resources (first team of quarantine and plant protection officers from PICTs) to assist in establishing a fruit fly facility dedicated for quarantine surveillance and running the eradication programme. The facility was open in November 1998. In September 2000, all equipment was moved to a new building. The facility will be also hosting the newly established Nauru quarantine inspection service, once it becomes activated and running.

The RMFFP and the Plant Protection in Micronesia Project have also financially assisted the Palau Government in refurbishing a building into a fruit fly facility, which includes a rearing laboratory, a host sample holding room and an office. In American Samoa, RMFFP funded the refurbishing of the fruit fly laboratory.

E. Information

Status reports

Status reports serve the purpose of summarizing results from fruit fly trapping and host fruit surveying carried out in a country, with data on fruit fly species distribution, seasonal abundance and host records. They describe the present status of the quarantine surveillance in the country. They include, among others, in depth data analysis from host record databases to provide an appreciation of the impact of fruit flies on commercial crops. Other aspects, such as summaries of pre-harvest control research and current practices and post-harvest treatment development, may also be included. Country status reports may be submitted to potential importing countries as a basis for negotiation of quarantine export pathways.

The first country status report was completed for Vanuatu in December 1997. It was subsequently submitted to New Zealand MAF Regulatory Authority. It is in fact the first section of the comprehensive “Fruit Fly Project Manual”, which also includes sections on specifications and procedures for quarantine surveillance, procedures for host status testing and heat tolerance testing, and procedures for expenditure reconciliation. A draft status report on fruit flies and quarantine surveillance in Solomon Islands was completed in April 1998. A revised second edition of the status report is in good progress. Preliminary drafts of status reports for FSM and PNG were compiled and released during the mid-term Review of the RMFFP in October 1998. The FSM status report was revised and up to date second edition published in December 1999. Compilation of the PNG report is an ambitious task given the size and complexity of the country. Data is however being compiled and analyzed for the report, which is likely to be a combined effort between RMFFP, the ACIAR project, NARI staff and NAQIA. The status report on fruit flies in Fiji Islands has been completed in July 2000 and is nearly ready for release. The status report on fruit flies in Tonga is progressing and expected to be completed in 2001.

Database

Data generated by fruit fly trapping and host fruit surveying in the seven countries originally covered by the RFFP have been entered in a large database, using R-Base software, developed at Queensland DPI under the parallel ACIAR Project. During a training course in October 1995, participants were introduced to the use of R-Base. Generally the feedback was that R-Base is not user friendly. Instead of using a multidimensional database system, they tend to store country trapping and host fruit survey data using EXCEL spreadsheet system. Software or printed copies of databases from most countries have been provided to the Project.

Following approaches by the Chief Technical Adviser and the SPC Plant Protection Adviser, the Queensland Department of Primary Industries (QDPI) agreed verbally to make available on request, information contained in the Pacific Fruit Fly Database, a computerized compilation of species distributions and host records for Cook Islands, Fiji Islands, FSM, Samoa, Solomon Islands (partial), Tonga, and Vanuatu. The information was compiled by joint activities of the RMFFP and the ACIAR Fruit Fly Projects run in these countries between 1991 and 1996 and has always been owned jointly. The information in the Database is no longer complete, as more trapping and fruit surveys have been conducted since the ACIAR projects ceased. Also, the progressive compilation of country status reports on fruit flies (FSM, Fiji Islands, Vanuatu, Solomon Islands) is superseding the database as these become the most complete and up-to-date information packages. Representative specimens, provided by the RMFFP and ACIAR Projects, are stored

and curated in the QDPI Insect Collection and these form a valuable record resource. Discussions were held with Griffith University regarding a Memorandum of Understanding on sharing of data accumulated from Solomon Islands, Vanuatu, and PNG. However, no formal arrangements were seen as necessary because information is readily available on request under the joint PNG Fruit Fly Project.

More recently, the RMFFP has started developing a database on fruit fly distribution and host records in all PICTs. It cites all host records, based on host survey data from the countries and on previously published literature, including a reference as to where each record was published, including published literature and unpublished internal reports. A critical screening of data has been done to avoid including erroneous records published in early literature. The table included below cites all species for which there are known host records in the geographic area covered the 22 PICTs. Information from database has been partly released in the Pacific Fruit Fly WEB: Http://www.pacifly.org. The site covers only host record information previously formally published. Although the data are stored in spreadsheet format, a format for computerized information system using Access software is being developed to make it become a user friendly interactive database. The interactive database will later become available in the Pacific Fruit Fly WEB site, covering previously published host records.

Species	# host families	# host genera	# host species	# commercial / edible hosts	Countries with host records
B. aenigmatica	1	1	1	0	Samoa
B. alyxiae	1	1	1	0	PNG
B. aneuvittata	1	1	1	0	New Caledonia
B. anomala	1	1	1	0	Vanuatu
B. atramentata	1	1	1	1	PNG
B. atrisetosa	3	6	7	7	PNG
B. barringtoniae	1	1	1	?	PNG
B. breviaculeus	1	1	2	0	PNG
B. bryoniae	5	5	5	3	PNG
B. bullata	2	2	2	0	PNG
B. caledoniensis	2	2	2	0	New Caledonia
B. calophylli	3	3	5	0	Solomon Is, Vanuatu
B. chorista	1	1	1	0	PNG
B. cucurbitae	3	9	9	13	PNG, Nauru, Solomon Is, CNMI
B. curvipennis	13	16	20	17	New Caledonia
B. dapsiles	1	1	1	0	PNG
B. decipiens	1	1	1	1	PNG
B. distincta	2	5	6	4	Fiji, Tonga, Samoa
B. dorsalis	12	13	14	13	CNMI, Nauru, French Polynesia
B. eximia	1	1	1	1	PNG
B. facialis	29	48	62	28	Tonga
B. frauenfeldi	29	45	72	48	FSM, PNG, Solomon Is
B. fulvifascies	1	1	1	0	New Caledonia
B. gnetum	1	1	1	0	Fiji Is
B. grandistylus	1	1	1	0	New Caledonia
B. hastigerina	1	1	1	0	PNG
B. kirki	22	29	46	33	Tonga, Samoa, Fr. Polynesia, Fiji (Rotuma)
B. melanoscutata	1	1	1	1	PNG
B. melanotus	19	29	36	26	Cook Is
B. minuta	2	2	3	0	Vanuatu
B. moluccensis	1	1	1	1	PNG
B. mucronis	3	3	3	2	New Caledonia
B. musae	2	2	2	2	PNG
B. neohumeralis	1	1	1	1	PNG
B. nigrovittata	2	2	2	0	PNG
B. obliqua	3	4	5	4	PNG
B. obscura	1	1	1	0	Samoa
B. ochrosiae	4	4	4	1	CNMI
B. papayae	?	?	?	?	PNG
B. paraxanthodes	1	2	2	0	New Caledonia
B. passiflorae	29	40	53	37	Fiji Is, Tonga
B. passiflorae (nr)	1	1	1	0	Fiji Is
B. perfusca	4	4	4	3	French Polynesia
B. psidii	11	15	18	14	New Caledonia
B. quadrisetosa	1	1	1	1	Solomon Is, Vanuatu
B. redunca	1	1	1	0	Vanuatu
B. samoae	7	10	10	1	Samoa

B. simulata	3	3	3	2	Solomon Is
B. strigifinis	2	2	2	2	PNG
B. terminaliae	2	2	2	0	PNG
B. tinomiscii	2	3	3	0	PNG
B. trilineola	18	26	31	20	Vanuatu
B. trivialis	7	8	8	8	PNG
B. tryoni	23	31	38	34	New Caledonia, French Polynesia
B. umbrosa	2	2	3	2	PNG, Solomon Is, Vanuatu, New Caledonia
B. xanthodes	19	26	34	26	Fiji Is, Cook Is, Tonga, Samoa, Nauru
D. solomonensis	2	4	4	3	Solomon Is

Table 8: Fruit Fly species for which host records are known in the PICT region.

The extensive data from trapping in PNG, based on samples sorted under the ACIAR component of the PNG Fruit Fly Project, has been entered in a Microsoft Access database. Identifications provided by the ACIAR Project have shown that, up to December 1998, 95 species of fruit flies were recorded – 68 species were known and 27 species were new to science (two species belonging to the genus *Dacus* and 25 belonging to the genus *Bactrocera*). Distribution of the described species in each province based on trapping database has been compiled in the project web site: http://www.pacifly.org/Country_profiles/species_PNG.htm. The ACIAR Project at Griffith University continues managing trapping result database with up to date versions regularly sent to RMFFP and to the three fruit fly centres in PNG. Host fruit surveying data in PNG are managed and entered on spreadsheets by the Junior Scientific Officers themselves in PNG, and regular updates are sent to RMFFP and ACIAR.

Negotiations have been progressing since 1998 on RMFFP taking an editorial role on fruit flies for the Global Pests and Plant Information System (GPPIS) with FAO, Rome with the view of adding a substantial amount of the data on Pacific fruit flies to the GPPIS. There have not been recent developments on the issue, and GPPIS has become obsolete and has been replaced by ECOPORT database. The issue will be re-addressed in 2001. Meanwhile, all published host record data and data already entered in ECOPORT are being critically reviewed by the Project.

Reference collections

Reference collections of pinned fruit fly specimens from trapping and host fruit surveys have been developed in countries with a large species diversity, especially PNG, Solomon Islands and Vanuatu, and by ACIAR and the RMFFP. ACIAR fruit fly project has provided representative fruit fly specimens as reference collection to Solomon Islands, Vanuatu and PNG.

On request from RMFFP, 15 PICTs have kindly collected and provided material to RMFFP develop a regional reference collection, housed at SPC in an air-conditioned room. It contains 3463 pinned and labeled specimens belonging to 117 species (as of November 2000). There are representatives from Palau, FSM, Kiribati, Nauru, Tuvalu, PNG, Solomon Islands, Vanuatu, New Caledonia, Fiji Islands, Tonga, Samoa, American Samoa, Cook Islands, French Polynesia and Pitcairn, as well as modest collections from Australia, Hawaii and Southeast Asia. All economically important species and a large diversity of rainforest species are represented. Reference collections of about sixty species will be provided to PICTs with collection storage and curation facilities in early 2001.

WEB site

The RMFFP has developed and launched a WEB site on fruit flies in the Pacific. Originally, one WEB page with a general outline of the Project was included in the UNDP web site in Fiji Islands. Development of the RMFFP WEB site project was initiated in late 1999, and was registered and on the Internet in June 2000. It was officially launched on 28 June at SPC in Suva.

The site contains 145 pages covering project description and document, success stories pages (fruit exports from PICTs, quarantine surveillance throughout the Pacific, Nauru eradication programme, local production of protein bait), fruit fly control (bagging and protein bait spraying), country profiles, species profiles and project publications. Country profiles covers, for each of the 22 PICTs, the fruit fly fauna, data on their economic impact, the status of quarantine surveillance, and a list of achievements on fruit fly research and management. Under species profiles, each of the 24 economically important species is covered, with distribution, host plant records, economic importance, notes on biology, and options for surveillance, response and control. Each species is illustrated with a colour photograph. In the Publications section are included abstracts of publications and copies of all Pest Advisory Leaflets published. To visit the site, you can consult http://www.pacifly.org.

Pest Advisory Leaflets

SPC Plant Protection Service has published a series of Pest Advisory Leaflets (PALs) on plant pests and diseases. The first fruit fly PAL was published in 1983 on Queensland fruit fly (*B. tryoni*). The RFFP produced one PAL on fruit flies of Cook Islands (in 1994) and one on mango fly (*B. frauenfeldi*) (in 1997). During the First Steering Committee Meeting, it was recommended to produce one PAL on biology and control of each main pest species in the Pacific. Subsequently, the decision was taken to produce PALs on fruit flies on a country basis rather than a species basis, to avoid duplication of general information on fruit flies and recommendations on their control. It was further decided that country PALs would not include sections on fruit fly control, and that control would constitute a separate PAL, that can re-edited with up-to-date latest control technology coverage.

A professional photograph was hired by the RMFFP and traveled to New Caledonia, Fiji Islands, Tonga, Samoa, Vanuatu and Solomon Islands in 1998, and to PNG in 2000. During his trips, he took hundreds of photographs of every species he could observe. In total, 48 species were photographed. These photos are used for the production of PALs, posters and other printed material. Sets of 15 transparency slides of 13 fruit fly species were duplicated and one set of slides has been distributed to each PICT, the ACIAR Project and the SPC Library have each received one set for reference.

During RMFFP phase, PALs have been produced and one thousand copies of each printed on fruit flies of Solomon Islands, Vanuatu (English and French), Fiji Islands, New Caledonia (French and English), French Polynesia and Pitcairn (French and English). Additionally, a species leaflet was produced on melon fly. The first leaflet on control was published in late 1999, about fruit bagging for fruit fly control. Another PAL on protein bait spraying and cultural control is in preparation. Electronic copies of all fruit fly PALs are available for downloading on the Pacific Fruit Fly WEB site.

PALs for all other PICTs will be completed and published in early 2001. Drafts have been produced for one PAL on fruit flies in Tonga, one on fruit flies in Samoa, one on fruit flies in American Samoa, Samoa, Niue, Tuvalu, Tokelau and Wallis and Futuna, and one fruit flies in Palau have been drafted. A large PAL on fruit flies in PNG and their surveillance is also in preparation.

Scientific publications

Numerous technical and duty travel trip reports have been produced during RMFFP time. A comprehensive list has been compiled and is included in annex.

The Proceedings of the Symposium on Regional Management of Fruit Flies in the Pacific (October 1996) was published by ACIAR in October 1997. It contains 52 papers; 22 of which were written by national staff from PICTs. Within months after its release, it was already out of print.

As an outcome of the RFFP and ACIAR collaboration in Vanuatu and Solomon Islands, a taxonomic revision of fruit flies in Solomon Islands and Vanuatu has been finalized by Prof. R. Drew and manuscript submitted for publication. Vanuatu counts 9 previously described and three new species are described and Solomon Islands has 39 described and 9 described new species.

Scientific paper on host records of *B. frauenfeldi* in FSM written by L. Leblanc and A. Allwood and an ecological monograph on fruit flies in Solomon Islands prepared by Dr. Robert Hollingsworth nearly ready for submission to journal.

Manuals on fruit flies completed for Vanuatu and Solomon Islands. 200 copies were produced in Solomon Islands. A practical guide for fruit fly surveying in PNG was also published in early 1998. A high quality Handbook on fruit fly rearing has been produced by fruit fly staff in Samoa and used as reference guide during the August refresher training course.

Andrew McGregor's "Socioeconomic evaluation of the Regional Fruit Fly Projects" has recently been published and 1000 copies were printed.

Extension material

In Nauru, a newsletter (FFERAD News) has been published after each eradication campaign and circulated to make the travelling public aware of the dangers of moving fruit around the Pacific and to keep the public and Government informed of progress in the eradication programme. Thirteen issues have been published between October 1998 and December 2000. A newsletter has also been published in Papua New Guinea (INFOFLY-PNG) for wide distribution to government and private sector. Five issues have been released, on an introduction to the PNG Fruit Fly Project (2 issues), on bagging, on protein bait spraying and on trapping for quarantine surveillance. One issue, one on banana fruit fly and banana bagging, is due for release in December 2000, and will be widely distributed to farmers, particularly in East New Britain, to encourage them to protect their bananas by bagging whole bunches with canvas bags. The issue will be translated into Tok Pisin language.

A radio show in Tok Pisin ("Nius bilong prut plais") was recorded in PNG in August, 1998, and regularly broadcasted in Provincial radio stations. The series is in are five separate parts that may be played in consecutive weeks: 1. PNG fruit fly project and pest fruit flies (11 minutes). 2: Fruit fly trapping (9 minutes). 3: Fruit flies and quarantine (14 minutes). 4: Fruit fly control by trapping (9 minutes). 5: Fruit fly control by protein bait spraying (12 minutes). A similar series of radio shows on fruit flies and quarantine awareness were subsequently produced in local languages by fruit fly teams in Solomon Islands and Vanuatu.

Video footage has been produced on the fruit fly eradication programme in Nauru and on fruit fly control in orchards in Papua New Guinea. A long-term project is to produce with SPC Media Centre a video documentary on fruit flies, their quarantine and economic importance and control.

KEY ACHIEVEMENTS

- Country Status Reports on fruit flies and quarantine surveillance completed for Vanuatu, FSM, Fiji Islands and Solomon Islands, and in draft form for PNG.
- National staff in each country manage databases on Excel spreadsheets with trapping and host survey data.
- Database compiled by RMFFP on fruit fly distribution and known host records in all PICTs.
- Negotiations with FAO for RMFFP to take the editorial role on fruit flies in the Pacific for the GPPIS (now under ECOPORT).
- Regional reference collection, housed at SPC, that contains 3463 specimens belonging to 117 species.
- Developed and launched a WEB site on fruit flies in the Pacific: http://www.pacifly.org.
- Hired a professional photograph to get high quality shots of 48 species to be used in publications.
- Pest Advisory Leaflets published on fruit flies of Solomon Islands, Vanuatu, Fiji Islands, New Caledonia, French Polynesia, on melon fly, and on fruit bagging to control fruit flies.
- Proceedings of the Symposium on Regional Management of Fruit Flies in the Pacific (October 1996) published in October 1997.
- Manuals on fruit flies completed for Vanuatu and Solomon Islands.
- Handbook on fruit fly rearing methods produced by fruit fly staff in Samoa.
- Andrew McGregor's "Socioeconomic evaluation of the Regional Fruit Fly Projects" published.
- Country newsletters to promote public awareness on fruit flies produced in Nauru (13 issues and PNG (6 issues).
- Radio shows on fruit flies in local languages produced in PNG, Vanuatu and Solomon Islands.
- For complete chronological list of achievements, see progress report in annex under outputs 1.1, 2.4, 2.6, 4.1 and 4.3.

F. Management Issues

Workshops and Steering Committee Meetings

The RMFFP phase of the fruit fly project has introduced the use of Steering Committee Meetings to allow country representatives to get together regularly, informally assess progress in Project implementation and provide recommendations on priority activities to be carried out until the next meeting. During each meeting, the Steering Committee draws two representatives from each of the four sub-regional groups: 1. PNG, Solomon Is, Vanuatu; 2. Fiji Is, Tonga, Samoa, American Samoa, Tuvalu, Tokelau, Niue, Cook Is; 3. FSM, RMI, Kiribati, CNMI, Guam, Palau and Nauru; 4. French Polynesia, New Caledonia, Wallis and Futuna. At each meeting, different countries are selected to represent their sub-regions. The meetings are also attended by representatives from FAO, AusAID, UNDP, New Zealand Embassy, and SPC. A representative

from Fiji Islands government usually chairs the meeting. Country representatives from all sub-regions also attended the Mid-term review of the RMFFP. The Fourth Steering Committee meeting has been combined with the Terminal Review of the RMFFP. Country representation at the four Steering Committee meetings and the Mid-term review are summarized on the table below. The recommendations from the meetings and notes on their subsequent implementation are included in annex.

		Group 1			Group 2					Group 3					Gr 4	
		PNG	Solomon Is	Vanuatu	Fiji Is	Amer. Samoa	Samoa	Tonga	Cook Is	Nauru	FSM	Guam	Palau	Kiribati	N. Caledonia	Fr. Polynesia
Steering-1	15-16 Sep 97	X	X		X			X	X		X	X			X	X
Steering-2	4 Mar 98	X	X		X			X	X	X					X	X
Mid-term rev.	6-7 Oct 98		X	X	X			X	X	X	X	X			X	X
Steering-3	9-10 Feb 00	X	X	X	X		X	X		X		X	X		X	X
Steering-4	21-23 Nov 00	X		X	X	X	X		X	X			X	X	X	X

Table 9: Countries represented at each Steering Committee meeting and the Midterm Review.

Besides the Steering Committee meetings and the Project reviews, there have been a few regional meetings and workshops. In Papua New Guinea, an Implementation Workshop to initiate the Fruit Fly Projects in PNG took place in August 1997 and a Planning Workshop followed on 15-16 June, 1998. The RMFFP and USDA-ARS conducted a Workshop on Quarantine Treatment Development in Pohnpei (FSM) for representatives from FSM, Palau, Marshall Islands, and Guam in conjunction with SPC Plant Protection Project in Micronesia and College of Micronesia in May, 1998.

Collaboration with Governments, NGOs, private sector

In most countries, the RMFFP officially deals with host country governments Departments of Agriculture, or their equivalent, particularly plant protection and quarantine divisions, as official contacts and counterpart institutions. A full coverage of the linkages and collaboration is beyond the scope of this report, although the following list, far from exhaustive, shows some major linkages with international and national organizations.

Technical backstopping has been officially the role of FAO, through the CTA, until April 30 2000. It is now under SPC-PPS, though close contact is still maintained with FAO.

Donor funding to Project is basically made up of equal contributions from AusAID and UNDP, plus additional funding from the New Zealand government (NZODA). Extra funding for special activities has also come from ACIAR (contribution to the purchase of waste yeast modification unit for Vanuatu) and the Crawford Fund for International Agriculture Research (Australia), that has significantly contributed in funding for Pacific Islanders to receive hands-on training in Nauru.

Some of the overseas research organizations that have had linkages with the RMFFP are Queensland DPI, ACIAR, Griffith University Faculty of Environmental Sciences (Brisbane, Australia), Hort.+Res. (New Zealand), that has carried out heat tolerance research in Cook Islands and Samoa, International Atomic Energy Agency (Vienna), CSIRO (Australia), and CIRAD, in New Caledonia. A MOU on information exchange and collaborative work on fruit flies was signed with the USDA-Agricultural Research Service Laboratories in Hilo, Hawaii. Special assistance is provided to the Heat tolerance database, technical advice and new techniques for eradication of Oriental fruit fly in Palau, alternatives to malathion as the toxicant in protein bait sprays, and 'generic' or recipe quarantine treatments for fresh fruits and vegetables.

National Governments Departments other than Agriculture have also been involved, such as, just to cite a few examples, Fiji department of Education through the Fiji College of Agriculture, Nauru Department of Education (Secondary School students involved in the eradication programme), PNG Corrective Institutions (protein bait spraying in prisons), Solomon Islands Ministry of Health, that hosts the fruit fly laboratory, and Malaita Development Authority (Solomon Islands) that looks after Quarantine Surveillance.

Some private sector companies have generously contributed assistance to specific activities in the Project. Aventis CropScience has developed new Fipronil-based fruit fly control and eradication technology in the form of BactroMAT blocks and Bactrogel powder. Fipronil and Bactrogel and spraying equipment has been

provided free of charge for the whole Nauru eradication programme, and they have also provided free of charge enough BactroMAT M-E blocks to cover two full blocking campaigns in Tahiti. Bronson Jacobs has Contributed in funding the Nauru eradication programme. Nauru Phosphate Corporation is playing a key role in the eradication programme.

Royal Tonga Brewery is converting waste yeast into protein bait for fruit fly control. Price for Tongalure, is much lower than the price of MPPIL. Vanuatu Tusker Brewery will be converting waste yeast with a unit funded by RMFFP and ACIAR. Carlton Brewery (Fiji) Ltd have provided since 1998 brewery waste yeast for development of protein bait in Fiji.

Nature's Way Cooperative (Fiji) Ltd. Has provided support, in principle, for a levy of 1¢ per kg of produce exported for fruit fly research, and already providing in kind support by provision of test fruit for confirmatory tests, of HTFA facility and staff to assist in the tests.

The RMFFP also actively collaborates in negotiations with overseas quarantine Institutions to develop opportunities to export fresh fruits and vegetables from PICTs. These are AQIS (Australia), USDA-APHIS (United States), New Zealand MAF Regulatory Authority and Hawaii State Quarantine.

Linkages with governments and institutions in Asia include collaboration with MARDI (Malaysia), the Philippines Government, the Bhutan Government, and the Plant Research Institute (Vietnam). This collaboration has resulted in PICT staff (in Tonga and Fiji) being used to train plant protection staff in Vietnam and Philippines on protein bait spraying and fruit fly rearing techniques.

National Research Institutes in PICTs are involved, such as College of Micronesia Land Grant Program (FSM, PALAU), the Land Grant Program in American Samoa, Cocoa & Coconut Research Institute (PNG), Coffee Research Institute (PNG), Forest Research Institute (PNG), IRETA (Samoa), and Northern Mariana's College.

Some of the NGOs that significantly have assisted the RMFFP are Solomon Islands Development Trust, for demonstration to farmers of protein bait spraying and fruit bagging in Solomon Islands and carry out damage assessments, Farm Support Association (Vanuatu) for on farm testing and demonstration of bagging and bait spraying in special project on training of Citrus growers in Vanuatu, Fresh Produce Development Company (PNG) and Informal Employment and Sustainable Livelihoods (Palau).

Other United Nations projects that have close association with the RMFFP are the UNDP Bougainville Rehabilitation Project, the FAO-TCP project on Fruit flies in Vietnam, and UNDP-ICARE Small Grants, for funding training of Citrus farmers in Vanuatu.

The PNG Fruit Fly Project

The RMFFP involvement in Papua New Guinea initiated, in May 1997, is complemented by a parallel project under the Australian Centre for International Agriculture Research (ACIAR Project CS2/96/225 "Identification, biology, management and quarantine systems for fruit flies in PNG"), designed to run concurrently with RMFFP, but initiated with a delay in June 1998. The activities of the two Projects are carried out jointly under a common umbrella referred to as the PNG Fruit Fly Project (PNGFFP). The PNG Fruit Fly Project is coordinated by the PNG National Agricultural Research Institute (NARI). Activities are carried out at three Regional Centres: in Kerevat, East New Britain, Bubia, Morobe Province, and Laloki, Central Province. At each Centre, there are one junior scientific officer (JSO), one technician and one or two casual helpers. The JSO positions are funded by RMFFP, the technician positions by ACIAR and the casuals by NARI. A consultancy was carried out by Allan Allwood to assess the impact of Junior Scientific Officer system in May, 2000. Conclusions from the consultancy are presented separately.