

HANDOUTS

FOR

COMBINED EVALUATION/REVIEW

of

REGIONAL FRUIT FLY PROJECT
(RAS/90/004)

and

ACIAR FRUIT FLY PROJECT
(Project No. 8920)

(21 - 23 July 1993)

July, 1993

Agenda

Review of ACIAR Project No. 8920 "The identification and control of pest fruit flies of the South Pacific" and

Evaluation of Project No. RAS/90/004 "Fruit fly control strategies in the South Pacific"

Warwick Fiji Resort, Fiji
21 - 23 July, 1993

Day 1

- 9.00am - 9.30am 1. Opening remarks
. UNDP Mr. Nurul Alam
. SPC - Mr. Semisi Pone
. FAO - Mr. Lars Jacobsen
. ACIAR - Dr. Paul Ferrar
. USAID - Dr. Andrew McGregor
- 9.30am - 10.00pm 2. Overview of objectives and activities of projects and linkages between related projects - Allwood.
- 10.00am - 10.30am Morning Tea
3. Presentation of results of projects.
- 10.30am - 11.15am (a) Taxonomy/Pest species - their distributions and pest status - Drew.
- 11.15am - 12.00noon (b) Identification of larvae of pest species - Drew
- 12.00noon - 1.15pm Lunch
- 1.15pm - 4.30pm (c) Computer database
. Methods of field surveys and laboratory procedures
. Structure of database
. Trapping data
. Host data
. Parasitoid data
. Damage Assessment
- Drew/Allwood

Day 2

- 9.00am - 9.45am (d) Video on adult feeding
Testing of attractancy of protein baits - Lloyd
- 9.45am - 10.30am (e) Development of new bait spray formulations and techniques for increasing shelf-life - Lloyd.
- 10.30am - 11.00am Morning Tea

11.00am - 12.00noon (f) Results of pre-harvest control trials using bait sprays - Allwood

12.00noon - 1.15pm Lunch

1.15pm - 3.00pm (g) Results of post-harvest studies
. Laboratory culture techniques
. Comparisons of artificial diets
. Life history studies
. Host status testing
. Heat treatment developments
- Allwood/Tora

3.00pm - 3.30pm Afternoon Tea

3.30pm - 4.15pm (h) Training - Allwood

4.15pm - 5.00pm 4. Proposals for future extension and/or expansion of projects - Drew/Allwood.

Day 3

8.30am - 9.15am 5. Project Management
(a) Project travel
(b) Budget reports
(c) Problems and solutions - Drew/Allwood

9.15am - 10.00am 6. Country perceptions
. Cook Islands
. Fiji
. Tonga
. Western Samoa

10.00am - 10.30am Morning Tea

10.30am - 11.15am 7. Further comments by donor agencies.

11.15am - 12.30pm 8. Final question time for reviewers. Report summary and draft recommendations (Reviewers).

12.30pm - 1.30pm Lunch

1.30pm - 5.00pm 9. Travel to Suva and visit fruit fly laboratories Koronivia Research Station.

PARTICIPANTS LIST

(Warwick Fiji Resort : 21-23 July, 1993.)

Australian Centre for International Agricultural Research (ACIAR)

Dr Paul Ferrar - Coordinator, Crop Sciences, Canberra

Food and Agriculture Organisation for the United Nations (FAO)

Mr Lars Jacobsen - FAO Representative, a.i.

United Nations Development Program (UNDP)

Mr Nurul Alam - Deputy Resident Representative, Suva

Ms Sabine Roth - Program Officer-Regional, Suva

USAID Commercial Agricultural Development Program

Mr Andrew MacGregor - Program Co-ordinator

South Pacific Commission (SPC)

Mr Semisi Pone - Plant Protection Officer, Suva

Ms Paulini Naituivau - Program Assistant, Agriculture Program

ACIAR Fruit Fly Project

Dr Richard Drew - Project Leader, Plant Protection Division,
Queensland Department of Primary Industries

Dr Annice Lloyd - QDPI, Brisbane

Ms Meredith Romig - QDPI, Brisbane

Regional Fruit Fly Project (RFFP)

Mr Allan Allwood - Chief Technical Adviser, Suva

COUNTRY REPRESENTATIVES

Cook Islands - Ministry of Agriculture

Dr Matarangi Porea - Director of Research, Totokoitu Research Station,
Rarotonga

Fiji - Ministry of Agriculture, Forests and Fisheries

Mr Fauoro Vilisoni - A/Principal Research Officer (Plant Protection)
Koronivia Research Station
Mr Sada Nand Lal - Entomologist
Mr. Moti Autar - Entomologist
Ms Ema Tora - Entomologist, Fruit Flies

Tonga - Ministry of Agriculture, Fisheries and Forests

Mr Ofa Fakalata - Head of Research, Vaini Research Station,
Tongatapu

Western Samoa - Department of Agriculture, Forests and Fisheries

Dr Semisi T. Semisi - A/Director Research, Nu'u Research Station, Apia

PROJECT EVALUATION TEAM

Mr Tom Passlow - Retired Director of Entomology Branch
Queensland Department of Primary Industries, Brisbane
Dr Gordon Hooper - Director, Australian Plague Locust Commission, Canberra
Dr. Wallace C. Mitchell. - Professor Emeritus, Department of Entomology,
University of Hawaii, Honolulu.

Agenda Item No. 2

BACKGROUND AND OBJECTIVES OF THE REGIONAL PROJECTS ON FRUIT FLIES IN THE SOUTH PACIFIC

INTRODUCTION

This paper provides background to the two current regional projects on fruit flies, being conducted in the Cook Islands, Fiji, Tonga and Western Samoa. It specifically identifies the objectives of the two regional projects, i.e., the Regional Project on Fruit Fly Control Strategies in the South Pacific (RAS/90/004) (short title - Regional Fruit Fly Project (RFFP)) and the Regional Project on the Identification and Control of Pest Fruit Flies of the South Pacific (Project No. 8920)(ACIAR/FFP). The paper also emphasizes the relationship of activities carried out by these projects and the relationships between these projects and other projects involved in fruit fly research or the promotion of production and export of fresh fruits and vegetables in the four project countries.

REGIONAL FRUIT FLY PROJECT (RFFP)

In response to requests for technical assistance by the Cook Islands and other Pacific Island countries to overcome export restrictions on fresh fruits and vegetables caused by the presence of fruit flies, the South Pacific Commission (SPC) sponsored an Expert Consultation in Apia, Western Samoa in August, 1989 to address this issue. The meeting was attended by representatives of Pacific Island countries, SPC, Australia, New Zealand, and the USA. The aim of the meeting was to discuss the problems resulting from the presence of damaging fruit flies in Pacific Island countries, particularly in those countries which exported fresh fruits and vegetables. The meeting also focussed on the implications of the restrictions or bans on the use of fumigants such as ethylene dibromide and methyl bromide on future exports of horticultural commodities. The meeting recommended the establishment of a regional project encompassing the Cook Islands, Fiji, Tonga and Western Samoa, to overcome the constraints on the export of fresh fruits and vegetables caused by the presence of fruit flies.

The first phase of the RFFP was initiated through a one-year project under the FAO Technical Co-operation Programme (Project No. TCP/RAS/0055), that commenced in September, 1990. FAO provided US\$184,000 for one year's operations. FAO provided the Chief Technical Advisor for the project. Although the project was funded by FAO, the activities were carried out under the umbrella of the SPC.

The overall objective of this component of the project was to commence activities that would eventually overcome quarantine restrictions on the export of fruit and vegetable commodities imposed by importing countries. These activities included surveys of fruit flies using trapping and collections of wild and commercial/edible hosts, establishment of laboratory colonies of

economic fruit fly species, development of laboratory rearing techniques appropriate to the project countries, initiation of bait spray testing for damaging species, and commencement of post-harvest disinfestation research.

Part of the charter of this component of the project was to assess the need for continuation of the research. It became obvious very quickly that, unless countries solved their fruit fly problems through gaining a full understanding of their fruit fly fauna and developing acceptable pre-harvest and post-harvest control systems, export of fresh commodities would always be severely constrained.

As a result, a new project document was formulated by December, 1990 and was approved in January, 1991, thus ensuring that the project (RAS/90/004) would continue until September, 1993. The funding for the RFFP was provided jointly by the Australian International Development Assistance Bureau (AIDAB), United Nations Development Programme (UNDP) and SPC. The total funding comprised US\$255,839 from AIDAB, US\$100,000 from UNDP and US\$36,000 from SPC. The project is executed by SPC, with FAO providing the Chief Technical Advisor under a Co-operating Agency Agreement.

United Nations Volunteer Entomologists (UNV's) were provided in Fiji, Cook Islands and Tonga initially for two years under the Japanese Trust Fund (SPF/89/V01). Funding of US\$96,000 was provided. In November, 1991, an additional UNV Entomologist was approved by the British Government for two years for Western Samoa. In August, 1992, UNDP under its 5th Cycle Funding, approved funding of US\$63,000 for extension of the UNV's in the Cook Islands, Fiji and Tonga for a further 12 months.

The Development Objective of RAS/90/004 is to increase the level of production and quality of fresh fruits and fleshy vegetables, leading to enhanced availability for local consumption, increased exports and higher farmers' incomes.

The Immediate Objectives of the project are:

- . to upgrade the technical knowledge and understanding of the impact of fruit flies on the production and export of fresh fruits and fleshy vegetables by plant protection, quarantine and extension staff and the private sector;

- . to reduce the levels of damage to fresh fruits and fleshy vegetables caused by fruit flies; and

- . to strengthen the capacity of quarantine services and the private sector to overcome quarantine restrictions on fresh fruits and fleshy vegetables imposed by importing countries.

In each of these objectives is a requirement to provide training of counterpart staff on techniques related to surveillance for fruit flies, pre-harvest and post-harvest control, and quarantine issues, such as quality assurance schemes and pest risk assessment as a tool for quarantine decision-making.

The achievements of the project have been regarded as being substantial and, as a result, various regional meetings of representatives of South Pacific countries and organizations have recommended strongly that the RFFP be extended in the four project countries and that it be expanded to include research into fruit flies in the Federated States of Micronesia, Solomon Islands and Vanuatu. Recently, an informal request has come from New Caledonia to be included in the

project has been received. The concept of extension/expansion of the project has been endorsed by the Regional Technical Meeting on Plant Protection, the Conference of the Permanent Heads of Agriculture and Livestock Production Services, the Meeting of the Committee of Regional and Government Organizations, and the 32nd South Pacific Conference. Similarly, the Tripartite Review held by UNDP on 20 November, 1992 made recommendations along the same lines.

UNDP has committed US\$400,000 to the possible extension/expansion of the project, dependent upon the results of the evaluation to be held in July, 1993. In addition, application has been made to FAO's Technical Co-operation Programme for technical assistance to maintain the activities of the project to the end of December, 1993 and to undertake preparatory work in FSM, Solomon Islands and Vanuatu.

ACIAR FRUIT FLY PROJECT (ACIAR/FFP)

At the Expert Consultation organized by SPC and held in Apia, Western Samoa in August, 1989, ACIAR undertook to develop a proposal to complement the research efforts of the RFFP and to run in parallel with this project. The ACIAR/FFP was designed to provide specialized research expertise, particularly in the taxonomy of adult fruit flies and their immature stages. host fruit studies, and development of appropriate protein baits for local production systems. Like the RFFP, the ACIAR/FFP operates in the Cook Islands, Fiji, Tonga and Western Samoa. The project commenced in January, 1991 and activities were scheduled for three years, ie to be completed by December, 1993.

The project is executed by the Plant Protection Branch of the Queensland Department of Primary Industries, Brisbane, under the direction of Dr Richard Drew. ACIAR provided funding support to the level of AUD\$476,227. Other support provided by the commissioned organization and the overseas partners totalled AUD\$283,380.

The principal research objectives are as follows:

- . to collect and identify all species of fruit fly breeding in commercially significant fruits and vegetables in Cook Islands, Fiji, Tonga and Western Samoa;
- . to ascertain the complete host fruit range of each fruit fly species (including wild hosts such as forest trees and plants, and weeds);
- . to gather information on the seasonality, abundance and damage levels of each fruit fly species;
- . to investigate the parasite fauna attacking fruit flies in each of the four countries, and to evaluate their significance as natural enemies; and
- . to identify and test locally available materials in each country that could be used as protein baits to attract fruit flies for orchard control by bait spraying.

To ensure consistency, the ACIAR/FFP was modelled on the very successful project conducted in Malaysia and, consequently, the project also assumed the responsibility for developing the database for the fruit flies in the South Pacific and inputting data generated by the ACIAR/FFP and the RFFP. This

entailed confirmation of identifications of many thousands of fruit fly specimens from the trapping and host surveys in each project country.

OTHER PROJECTS INVOLVED IN FRUIT FLY RESEARCH

USAID's Commercial Agricultural Development Project

The Commercial Agricultural Development (CAD) Project was set up under USAID to foster agricultural development, with particular reference to private sector development and export of agricultural commodities. With respect to fruit flies, the CAD Project provides funding and technical support to transfer appropriate technology on quarantine treatments for disinfecting horticultural commodities of fruit flies from Hawaii to Pacific Island countries. The technology focuses on the use of various forms of heat treatment to treat fruits and fleshy vegetables, such as hot forced air and hot water immersion. This approach was necessary to overcome the virtual loss of ethylene dibromide fumigation as a treatment for disinfecting fresh fruits and vegetables.

The CAD Project provides equipment such as a static temperature hot water bath, an experimental hot water immersion unit and an experimental hot forced air unit for Tonga and Fiji. The project also provides the services of Dr Jack Armstrong and other staff at the USDA-Agricultural Research Laboratories, Hilo, Hawaii to advise and assist with heat treatment research in Fiji, Tonga and Western Samoa. As part of this technical assistance, the CAD Project supports the involvement of project staff in Tonga and Fiji in undertaking Masters Degree studies on heat treatment work in each country and relevant training of candidates in Hawaii.

Project on Heat Treatment Development in the Cook Islands

The New Zealand Horticultural and Food Research Institute, in conjunction with the Ministry of Agriculture in the Cook Islands, commenced research, in 1991-92, on heat treatments for fresh fruits and vegetables destined for export. This project is linked to the efforts of the RFFP and the ACIAR/FFP as these two projects were responsible for establishment of laboratory colonies of *Bactrocera melanotus* and *B. xanthodes*. The RFFP also has undertaken research into the host status of various fruits and vegetables to the two fruit fly species in the Cook Islands.

New Zealand provided to the Cook Island Government a fruit fly laboratory, equipment and expertise to develop treatment for pawpaw for export to New Zealand as a model for this type of research. Commercial hot forced air units are to be provided, together with the infrastructure for storage of export commodities.

LINKAGES BETWEEN FRUIT FLY ACTIVITIES IN THE SOUTH PACIFIC

The Regional Fruit Fly Project has consciously become the focal point of fruit fly research in the South Pacific. It was necessary to adopt this role to ensure the most efficient and effective use of limited resources in this region and to keep to an absolute minimum, the amount of duplication of effort that could arise in such a widely dispersed region with several organizations running fruit fly related projects. This approach has worked in favour of the countries involved in this work and benefited, immensely, the accumulation of applied research knowledge with the ultimate objective of controlling fruit flies at all stages of the production and marketing chain. This coordination role is an

additional activity taken on by the project and has contributed significantly to the success of the project.

The approach has resulted in very close cooperation with the ACIAR/FFP. These two projects have operated as sister projects, with the Regional Fruit Fly Project being able to call upon the considerable expertise in the ACIAR funded project based in the Queensland Department of Primary Industries, Brisbane and vice versa.

Similarly, close ties were fostered with the USAID funded CAD Project. Part of the charter of this project is to transfer the recently developed hot forced air technology for disinfestation of fruits and vegetables of fruit flies for quarantine purposes, to South Pacific Countries. The close liaison resulted in experimental equipment to carry out heat tolerance studies on immature stages of fruit flies and horticultural produce being made available to Tonga and Fiji at no cost to the Regional Project. Also, expertise from the USDA Fruit and Vegetable Laboratories in Hilo, Hawaii is now available to the South Pacific countries through the association between these two projects. This co-operation also provided access to the Graduate Research Assistant Scheme, so that staff in Tonga and Fiji are able to undertake post-graduate studies on heat treatments at the University of the South Pacific under the supervision of Dr Jack Armstrong, USDA-ARS, Hawaii.

In addition, the project maintains regular contact with the FAO Fruit Tree Development Project based in Western Samoa and the project on developing disinfestation treatments for fresh fruits and vegetables in the Cook Islands being run by New Zealand's Horticultural and Food Research Institute. This results in free exchange of information on new developments. The technology on field control will facilitate private sector development and small holder agricultural diversification into fruit tree production.

The Regional Project has become the authority for fruit fly advice from the South Pacific Commission and consequently there is a regional consistency to advice on the species present, their distributions, control technologies and quarantine issues such as pest risk assessments and quality assurance schemes for fruit flies.

Table 1 shows the responsibilities of each project for particular activities and demonstrates the close co-operation that developed between project staff and counterpart staff.

Table 1 - Division of responsibilities for fruit fly activities in Cook Islands, Fiji, Tonga and Western Samoa.

	ACIAR	REGIONAL	CAD
Trapping	*	**	
Commercial Host Surveys	*	**	
Wild Host Surveys	**	**	
Fruit Fly Identifications	**	*	
Parasitoid Studies	**	*	
Damage Assessment	*	**	
Laboratory Colonies		**	
Database Development and Inputs	**	*	
Biol. Studies (e.g. Life cycles)		**	
Host Status Testing		**	
Bait Spray Development	**	*	
Bait Spray Field Testing	*	**	
Quar. Tmt. Development	**	**	
Training	**	**	**

NOTES:

1. ACIAR - Australian Centre for International Agricultural Research.
2. REGIONAL - FAO/AIDAB/UNDP/SPC Regional Fruit Fly Project.
3. CAD - USAID's Commercial Agricultural Development Project.
4. ** - Major responsibility for activity.
* - Support responsibility for activity.
5. New Zealand Horticulture and Food Research Institute has responsibility for Laboratory Colonies and Quar. Tmt. Development work in the Cook Islands.

Agenda Item 3 (c)

ASSESSMENT OF DAMAGE LEVELS CAUSED BY FRUIT FLIES IN FIJI, TONGA AND COOK ISLANDS

INTRODUCTION

Prior to the commencement of the RFFP and the ACIAR/FFP, documented information on the economic significance of fruit flies in Fiji, Tonga, Cook Islands and Western Samoa was lacking. It was known that some fruit crops were heavily infested by fruit flies, but recently acquired information on the levels of damage was not available. For example, in all countries, if guavas are left to ripen on the trees, the percentage of fruits infested with fruit fly larvae is high. For this reason, fruits are eaten when they are green mature, rather than fully ripe. Mangoes in Fiji are similarly eaten at a much greener stage than they are in countries like Australia, primarily to escape fruit fly attack. Thus, the consumer is aware of the problem of fruit fly damage to fresh fruits. Extension and Plant Protection Officers, when asked for information on the levels of damage caused by fruit flies, responded in qualitative terms, not quantitative terms. Similarly, farmers commented that fruit flies are a severe problem to fruit production, but were not able to estimate losses caused by this pest. Exporters, on the other hand, were very aware of the significance of fruit flies to export of fresh fruits, because of the restrictions imposed on overseas markets due to the presence of damaging fruit fly species.

METHODS OF DAMAGE ASSESSMENT

One of the tasks of the projects was to generate data on the economic importance of fruit flies as part of the overall activities on host fruit surveys. Two types of host surveys were embarked upon to collect this information. Broad host surveys were used to determine the host ranges of the fruit fly species. This method consisted of sampling fruits and fleshy vegetables at monthly intervals from research stations and farms where insecticide usage was minimal. Where possible, about 1kg of fruit or vegetables was collected per sample. As part of the data collection, fruits were weighed and counted on each occasion and the stages of maturity were recorded. Fruits were held in bulk, ie not held in individual containers, and were not dissected to determine whether they were infested or not. Based on these measurements, it was possible to calculate the numbers of fruit fly puparia and adults per unit weight of fruit or per fruit recovered from particular fruit types at a particular stage of maturity.

Though these data do not give a direct measurement of damage levels, these data may be useful in allocating a degree of risk of infestation with respect to pest risk assessment, often carried out by importing countries prior to establishing quarantine protocols with exporting countries. When combined with the frequency and size of consignments exported, importing countries may accept a lower efficacy level of post-harvest treatments than Probit 9, based on the degree of risk. This is a concept being considered by New Zealand. The thinking behind this concept is that guavas, a highly susceptible fruit, should be treated

differently to eggplant from Fiji, a very low risk crop based on the results of fruit surveys where no fruit flies have been recorded despite large samplings over a long period. The data from this type of sampling can be extracted from data in the Pacific database and will not be discussed in this paper.

The second type of host survey can be referred to as an intensive survey, where about 1000 pieces of fruit were sampled with each fruit being set up in an individual container over sieved, sterilized sawdust, dissected after 7 days to determine if they were infested or not, and then held for emergence of adults. An alternative method of handling the fruit was to hold the fruit in bulk for 5-7 days, dissect it to determine if it was infested, and then hold the infested pieces of fruit in individual containers for adult emergence. This type of sampling provided data on the species of fruit flies present, stage of maturity at which fruits become susceptible, levels of damage, numbers of larvae in each fruit, numbers of adults recovered from fruits, and an indication of where the larval instars fed in each type of fruit. The latter piece of information may be valuable in carrying out post-harvest quarantine treatment development research, especially when artificial infestation with late instar larvae is necessary.

RESULTS OF ASSESSMENTS

Table 1 shows examples of the results that have been obtained from the intensive host survey method. Some of this work has been done in conjunction with bait spray testing.

The most interesting results include the fact that fruit flies have not been recorded from fleshy vegetables such as eggplant, chilli, tomato, bitter gourd or okra in Fiji. This has resulted in the Fiji Government's commencing host status studies on these commodities in the hope that they can be exported without post-harvest disinfestation treatments. Similarly, low levels of infestation of fruit flies in chilli and tomato at the green mature stage in Tonga have resulted in their undertaking host status testing of these commodities. In contrast, the levels of damage to capsicum is very high and this has forced Tongan authorities to undertake field trials on fruit fly control using the bait spray technique.

In the Cook Islands, intensive surveys have shown differences between levels of damage at various stages of maturity in mangoes and in pawpaw. In mangoes, the level of damage is very low at the ripe stage (2.5%), and even lower at the green mature stage (0.1%), the stage at which mangoes are normally harvested for export. Sampling of pawpaw showed that there is a distinct difference in damage levels in the warmer months compared to that in the cooler months. It seems that pawpaw at the colour break stage is susceptible to fruit fly attack in the warmer months but it does not become susceptible until the half-ripe stage during the cooler months. The level of damage at the stage regarded as greater than 50% ripe is 1.8% in the cooler months as against 12.4% in the warmer months. This information may provide options for the Cook Islands as far as future exports are concerned. These low levels of damage may also mean that the achievement of effective field control using bait sprays may be relatively easier than if the normal levels of damage were higher. A similar situation occurs in mango production in Fiji where the level of damage is about 10.4%.

Some local fruits that are not produced commercially but are grown for local consumption and appear in the markets, sustain very high levels of fruit fly damage. For example, kavika (*Syzygium malaccense*), rose apple (*S. jambos*) and

star apple (*Spondias dulcis*) commonly sustain levels of damage of 60%, 100% and 40%, respectively.

Though the levels of damage caused by fruit flies in Pacific Island countries are somewhat lower than the levels of damage caused by fruit flies in Australia, Hawaii, Malaysia and Thailand, sufficient losses in fresh fruit production occur to warrant the development of effective field control systems based on protein bait sprays.

Agenda Item 3 (f)

FIELD TESTING OF BAIT SPRAY TECHNIQUE

INTRODUCTION

Fruit flies (family Tephritidae) cause significant losses to fruits and fleshy vegetables during production in each of the project countries, i.e. Tonga, Fiji, Western Samoa and the Cook Islands. In Tonga, up to 90% damage to capsicum may occur as a result of infestations by *Bactrocera facialis*. Similarly, over 90% of guava fruits may be rendered useless because of infestation by *Bactrocera kirki* and *B. facialis*. In Fiji, damage levels to guava and mangoes caused by *Bactrocera passiflorae* are about 40% and 25% respectively. Local fruits such as kavika, *Syzygium malaccense*, may sustain damage levels of about 60%. In the Cook Islands, 12% of pawpaw fruit allowed to ripen on the tree, are damaged by *Bactrocera melanotus* and *Bactrocera xanthodes*.

Despite the losses in fruit and vegetable production caused by fruit flies, no concerted effort has been made to develop or use methods of control to reduce this loss, prior to the commencement of the ACIAR/FFP and the RFFP. Neither cover sprays using dimethoate or fenthion nor bait sprays using protein autolysate plus an insecticide have been used to specifically control fruit flies in the Pacific Islands. Control of fruit flies probably occurs as a result of using insecticide sprays to control other insect pest species, particularly in fleshy vegetable crops such as tomato and capsicum.

The RFFP and the ACIAR/FFP undertook:

- . to test the attractancy of Mauri's Protein Insect Lure to fruit fly species in each of the project countries;
- . to develop bait spray systems appropriate to each project country in order to reduce the levels of damage to fruit and vegetable crops caused by fruit flies; and
- . to develop and test in the laboratory and field, bait sprays using modified brewery waste yeast as a cheap, local source of protein autolysate.

This paper summarises the results of field attractancy tests and field trials on the effectiveness of Mauri's Protein Insect Lure as the basis for bait sprays to control fruit flies. Attractancy testing of the modified brewery waste yeast was reported on in Agenda Item 3 (d).

FIELD ATTRACTANCY TESTING

The aim of this testing was to determine if the damaging fruit fly species in each of the project countries are attracted to and killed by a bait spray applied to the foliage of various host fruit trees.

The bait spray consisted of 100ml of Mauri's Protein Insect Lure made up to 1 litre with water. Added to this was 4ml of 50% emulsifiable concentrate malathion. The bait was applied at the rate of 100ml per tree. Dead flies were

collected on calico sheets placed on the ground under the sprayed foliage. The flies were identified.

The results showed that, in Tonga, *B. facialis*, *B. xanthodes*, *B. kirki* and *B. distincta* are attracted to the bait and killed. In Fiji, *B. xanthodes* and *B. passiflorae* respond to the bait. In the Cook Islands, both *B. melanotus* and *B. xanthodes* are attracted to the bait.

Initially, it was thought that *B. xanthodes* in Fiji did not respond to the bait spray or, at best, was poorly attracted to the bait. To answer this question, two further tests were undertaken. Protein starved, laboratory reared *B. xanthodes* that had been fed on blue dye, were released into a citrus orchard at Naduruloulou Research Station and into a guava orchard at Nadi. Bait consisting of 50ml of Mauris Protein Insect Lure plus malathion was applied to one pomelo tree in the citrus orchard and four trees in the guava orchard. Dead flies were collected on calico sheets placed on the ground under the treated area of foliage.

The tests showed that *B. xanthodes* was very responsive to the bait in both situations. During the test in the guava orchard, 150 of the 200 flies released were dead on the sheets in 4 hours. The bait also attracted wild *B. passiflorae* and *B. xanthodes* in both instances. Wild *B. xanthodes* were differentiated from laboratory reared flies by the absence of blue dye in the gut.

In summary, the results showed that all the damaging species of fruit flies in the four countries are attracted to a bait based on Mauri's Protein Insect Lure plus malathion.

In Tonga, Cook Islands and Western Samoa, attractancy tests, using the waste yeast products from the Royal Brewery, Cook Islands Brewery and Vailima Brewery respectively, were done. None of these yeast sources showed any attractancy to fruit flies in its raw state. This was not unexpected as brewery waste in its raw state contains live yeast cells and relatively high concentrations of ethanol. The lack of attractancy led the ACIAR/FFP to commence research to modify the brewery waste yeast products through a heating process and possibly adding enzymes to assist the autolysis of the yeast cells.

SMALL SCALE FIELD TESTING OF BAIT SPRAY TECHNIQUE

In Fiji, testing of the bait spray technique on a small scale commenced in early 1992 in a patch of wild guava on a dairy farm at Koronivia. The guava (local pink variety) grew along the fence-lines of the dairy farm and consisted of about 70 trees, intermingled with starfruit, cherry guava, orange, kumquat, breadfruit, rose apple and some wild hosts.

The bait was mixed at the rate of 100ml of Mauri's Protein Insect Lure + 4ml of 50% emulsifiable concentrate malathion made up to 1 litre with water. It was applied weekly for 8 weeks, at the rate of 100ml to the foliage of the guava trees every 10 metres along the fence-lines. Other fruit trees in the paddock were baited also. 100 pieces of ripe guava fruit were sampled weekly, held for 5-7 days and dissected to determine levels of damage. An untreated area of wild guava about 500 metres away was used as a control plot. 100 pieces of ripe fruit were sampled from this area weekly and levels of damage were determined using the same method as for fruits from the treated area.

Figure 1 (not included) shows the results. Damage was reduced from 35.5% to 0-1% after 5 applications and maintained at the reduced level for a further 3 weeks to the end of the fruiting season.

LARGE SCALE OR COMMERCIAL TESTING

Fiji

Two large scale trials using Mauri's Protein Insect Lure were conducted in Fiji. The first consisted of controlling fruit flies in a commercial mango orchard of 4000 trees in the Nadi area.

In an attempt to reduce the cost of bait spraying, the bait was mixed at the rate of 50ml of Mauri's Protein Insect Lure per litre of water and the bait was applied at 7 day intervals to each tree in every second row. An untreated area about 1km away was used as a control. 100 pieces of fruit were sampled from both sites weekly, held for 5-7 days and dissected to determine levels of damage.

Figure 2 (not included) shows the results obtained. Unfortunately, the trial had to be terminated prematurely because two cyclones (one in early December, 1992; the other in early January, 1993) destroyed the fruit. The results indicated that the bait spray was beginning to have an effect. However, as the crop did not go through the peak fruit fly population in December-January, the trial will have to be repeated in October, 1993 to February 1994.

The second trial was designed to control fruit flies in a guava orchard of 100 trees in the Nadi area. In this instance, all trees were treated. Only 50ml of the bait preparation was applied per tree. This was done every 7 days. Baiting was not repeated if rain fell after treatment. Sampling of fruit followed the same procedure as previously. An untreated plot was located over a hill, approximately 300 metres away.

Figure 3 (not included) shows the results of this trial. The results showed that it was possible to maintain the level of damage to guava in the treated area at less than 6% compared to damage levels in the untreated area ranging from 18.2% to 41.6%. The trial was terminated after 5 applications of bait spraying because of a shortage of fruit.

A sample of 100 fruits was taken from the untreated area 6 weeks after the cessation of bait spraying to see what happens without fruit fly control. The level of damage was 45%. One of the interesting observations was that, though the trial was run over a very wet period when rain fell on most days, the bait treatment remained effective without having to re-apply the bait following rain.

Tonga

A large scale trial to reduce the level of damage in wild guava caused by *Bactrocera kirki* and, to a lesser extent, *B. facialis*, was undertaken on Tongatapu in March-April, 1993. The area selected comprised 0.9 hectares of wild guava, where *B. kirki* activity was very high. The area could be described as almost a pure stand of wild guava with small amounts of beach hibiscus dispersed amongst the guava. The plot measured 182 metres long by 50 metres wide. To make the plot accessible for spraying, 14 narrow paths were cut perpendicular to the length of the plot.

An untreated area of wild guava at least 5km away was identified as a control. Activity of *B. kirki* was high as evidence by the number of flies on fruit.

Ripe fruits from both areas were sampled for 2 weeks prior to the commencement of bait spraying and during the trial to assess levels of damage caused by fruit flies. Bait spraying commenced on 16 March, 1993 and continued at intervals of 3-7 days, depending on rainfall. It was decided to respray if rain fell, thus 7 bait sprays were applied over 5 weeks. The bait was mixed at the same rate as that in Fiji. The bait was applied as spots of 100ml over the whole area. 40 litres of bait spray mix was applied to the area on each occasion.

Figure 4 (not included) summarises the results.

Again, the trial was faced with the same problems as those that occurred in Fiji, where the quantity of ripe fruit became a limiting factor. Even over this area, sampling of 100 ripe fruit per week put pressure on the number of mature or ripe fruits available for oviposition and also for sampling. This probably explains the decrease in levels of damage in the untreated area, i.e from 95% to 26% by the time the trial was terminated. Nevertheless, the level of damage in the treated plot decreased from 96% to 6.2% over the corresponding period. This shows a difference in percentage fruit damage of 20% between treated and untreated areas at the end of the trial period. These results imply that the bait spray technique, even under very high fruit fly pressure is effective.

Plans were developed to conduct a further field trial on the bait spray technique using capsicum. Two large areas have been planted on Vaini Research Station for field trials that will commence in July, 1993.

Cook Islands

Early work on bait spraying in 1992, focussed on the attractancy of the two fruit fly species in the Cook Islands to Mauri's Protein Insect Lure and an attempt to determine the effects of bait spraying on parasitoids and pollinating agents. The work on parasitoids and pollinating agents was terminated until research on the effectiveness of bait sprays in reducing fruit fly damage levels to various fruits and vegetables is done.

At the time of this report, two large fields trials on bait spray use in pawpaws and avocados are in progress in the Cook Islands.

The pawpaw trial was designed to demonstrate the effectiveness of applying 2 litres of bait spray per hectare of pawpaws, using spots distributed over the orchard. Because of planting intensity not every tree will receive a spot of bait. Because of the relatively small leaf area of pawpaws, it was decided to apply 25-50ml of bait spray per tree, thus ensuring that about one tree in four will receive bait.

Damage assessments are being done at four stages of maturity - colour break, 25% yellowing, 50% yellowing, fully ripe. The trial will continue for 12 weeks and will yield, for the first time, data on fruit fly control in pawpaws using bait sprays based on protein autolysate. Results will be provided an addendum to this paper.

The second trial in progress (avocados) approaches what is likely to be the situation in many production areas of the project countries. Avocados are not grown in well defined blocks, but in clumps or as single, scattered trees. It

has become necessary to attempt to control fruit flies in avocados almost on an "area control" basis, i.e. bait spraying single or clumps of avocado trees, together with nearby host trees over a sizeable area in the hope that the population of fruit flies over the whole area will be significantly reduced. In turn, the reduced population over the whole area may result in reduced damage levels in avocados.

The effectiveness of this treatment will be assessed by measuring the changes in damage levels to avocados between treated and untreated areas.

SUMMARY

The work on the bait technique has progressed to a point in Fiji, Tonga and Cook Islands where farmers are wanting to obtain supplies of Mauri's Protein Insect Lure for immediate use. Farmers now realise the value of this technique and are interested in not only increasing production of fruits and vegetables for local consumption, but also see this technique as an appropriate technology to reduce the pressure on post-harvest quarantine treatments.

Agenda Item 3 (g)

POST-HARVEST STUDIES AND RELATED ACTIVITIES

INTRODUCTION

Pacific Island countries rely heavily on agricultural production as a major component of their small economies, with fresh fruits and vegetables being an important money earner at the village and commercial levels. Governments recognize the importance of agricultural production and consequently, have included in their respective development plans, objectives to expand and diversify agricultural production. The aim is become more self-sufficient in many commodities and to be in a healthier position to take advantage of lucrative, overseas niche markets, particularly in fresh fruits and vegetables.

Also, Pacific Island countries and regional organisations such as the Forum Secretariat, are encouraging the development of linkages in trade between small Pacific Island nations. This trade will include agricultural commodities such as fresh fruits and fleshy vegetables.

One of the major constraints to entering these markets, is the presence of damaging fruit fly species and the lack of acceptable post-harvest quarantine treatments against fruit fly species. These constraints have been exacerbated by the banning or restrictions imposed on the use of the fumigant, ethylene dibromide, and by the likely banning of methyl bromide during this decade. The result is that Pacific Island countries will no longer be able to export fresh fruits and fleshy vegetables to Pacific rim countries, such as USA, Japan, Australia and New Zealand, unless alternative quarantine treatments are developed. Similarly, trade between Pacific Island nations will be restricted because of the lack of acceptable quarantine treatment for endemic fruit fly species within each country.

Alternative treatments are likely to rely on some form of heat treatment, such as hot water immersion, hot forced air or vapour heat. Treatments based on insecticidal dipping or spraying using dimethoate or fenthion, may offer other alternatives. The use of low temperatures is unlikely to be appropriate as these treatments are likely to have deleterious effects on the quality of the commodities treated, with the exception of some citrus such as lemons, oranges and limes.

With the exception of Tonga, none of the Pacific Island nations had experience with undertaking research on the development of quarantine treatments against fruit flies, prior to the commencement of the RFFP and the ACIAR/FFP.

This paper summarize the activities in the four project countries, related to research into the post-harvest quarantine treatment development.

REARING TECHNIQUES FOR LABORATORY COLONIES

Species in culture

As a precursor to developing quarantine treatments, the RFFP and the ACIAR/FFP established laboratory colonies of the economic fruit fly species in each country. Colonies of the following species were established:

Tonga	<i>Bactrocera facialis</i> , <i>B. distincta</i> , <i>B. kirki</i> , <i>B. xanthodes</i>
Fiji	<i>B. passiflorae</i> , <i>B. xanthodes</i>
Cook Islands	<i>B. melanotus</i> , <i>B. xanthodes</i>
Western Samoa	<i>B. kirki</i> , <i>B. xanthodes</i>

Development of Rearing Techniques

It was necessary to develop techniques for rearing large numbers of flies, that were appropriate to the countries in the Pacific. These techniques included:

. development of artificial diets from locally available components because diets used overseas, e.g. dehydrated carrot in Australia and bran based diets in Hawaii, were too expensive. Mr. E. Hamacek (ACIAR/FFP) introduced the use of the cassava/pawpaw diet to the Cook Islands and the sugarcane bagasse/pawpaw diet to Fiji. In the Cook Islands, work has been done recently on the use of pureed pawpaw only.

. testing of eggng devices based on hollowed out domes of pawpaw, apple, pear, plums and guava. It was found that domes of pawpaw are the most effective for most species.

. testing of artificial eggng devices made from plastic (used yogurt containers) and polystyrene cups. The used yogurt container with holes in the sides and end, smeared with guava juice, is very effective for *B. passiflorae*. No artificial eggng device has proved to be successful for *B. kirki* and *B. xanthodes* at this stage.

. determination of optimum number of eggs per gram of diet. Initial tests on *B. passiflorae* and *B. xanthodes* showed that 2000-2500 eggs per kg of sugarcane bagasse/pawpaw diet resulted in a good recovery of adult flies. Recently, the numbers of eggs per kg of diet have been increased to 5000-6000 with adequate recovery of adults.

. identification of conditions for pupation. When colonies were first established the pupation medium was untreated, sieved, sterilized dry sawdust. Experiments in Fiji showed that, by adjusting the moisture content of the sawdust to 15% by weight, pupal (or third instar) mortality could be reduced from 60-70% to about 10%. Also, pupal weight increased significantly, e.g. the weight of 100 puparia of *B. xanthodes* increased from 1.10 to 1.40g and for *B. passiflorae*, from 0.9g to 1.10g. This pupation medium was adopted as a standard.

. isolation of fruit fly bacteria. Bacteria from the crop and mid-gut of fruit flies were isolated and submitted to the ACIAR/FFP for identification and

purification. Laboratory colonies in Fiji are fed on bacterial plates of *Klebsiella pneumoniae* and in Tonga, are fed with plates of *Citrobacter freundii*.

. development of alternative feeding system. *Drosophila* spp. are a major problem in laboratory colonies in all project countries. Except for bacteria plates, all other food (protein hydrolysate + sugar, sugar alone) are provided inside the cage. The protein hydrolysate + sugar mixture is fed on absorbent cards suspended from the top of the cage. Sugar alone is fed from platforms inside the cage.

. rejuvenation of laboratory colonies. Every 6 months, the colonies are rejuvenated by introducing wild flies into cages by crossing wild males with laboratory reared females and wild females with laboratory reared males.

. adjustment of laboratory temperatures. Problems with egg production and egg hatchability resulted from high temperatures (31-34°C) in the laboratories in each country during the October - March period. Air-conditioning now maintains the rearing room temperature at 26-27°C.

Mating Behaviour Studies

Mating behaviour studies in the Cook Islands, Tonga and Fiji showed that *B. passiflorae*, *B. distincta*, *B. facialis* and *B. xanthodes* mate at dusk. *B. kirki* and *B. melanotus* mate during the middle of the day. As a result, it was necessary to provide additional lighting in areas where these species were being reared to improve mating and egg laying.

Parasitoid Rearing Techniques

Though there is no intention, at this stage, to mass rear parasitoids of fruit flies, it was necessary to transfer rearing techniques from the USDA-Agricultural Research Service, Hawaii to the Pacific and test these here. This was done in Fiji only. The method used was slightly different to that used in Hawaii in that larvae in artificial diet were covered with parafilm with pin-holes in it, instead of using fine cloth gauze. This was to ensure the diet did not dry out too much. The parasitoids used were reared from larvae in guava. The rearing technique is available to any country if required.

It was found that the parasitoid *Diachasmomorpha longicaudata* would complete its development in first, second, or third instar larvae under laboratory conditions.

DIET COMPARISONS

The development of a standard larval diet was undertaken by Mr. E. Hamacek of the Queensland Department of Primary Industries (QDPI) and the RFFP staff in 1991. This diet consists of pawpaw, sugarcane baggase, torula yeast, nipagin and distilled water. Its development has assisted in reducing costs in the culturing of fruit flies and ensuring the availability of a larval diet all year round.

A comparison of larval diets was conducted in Fiji to determine the diet preferences of *B. passiflorae* and *B. xanthodes*. These tests served in determining a substitute for the standard diet during times of natural

disasters, such as cyclones, and if there is an introduction of insecticides into sugarcane production.

The diets tested included the standard pawpaw/baggase diet, dehydrated carrot diet, the USDA larval diets for Medfly, Melonfly and *B. latifrons*. There were 2 tests conducted at different times. 5 replicates per diet were used in the first test and 4 replicates in the second.

Each fruit fly species was tested by seeding 500 eggs on 250g of each diet in the first test and 1000 eggs on 500g in the second test. The eggs were allowed to develop in the diet under normal culturing practices. Larvae pupated into moistened, sieved, sterilized sawdust. The puparia weights and the numbers of puparia were recorded. The puparia were then held for the emergence of adults.

Table 1 shows the comparative recoveries of puparia from the five diets.

Table 1 - Mean percentage recovery of *B. passiflorae* and *B. xanthodes* puparia from 5 larval diet (Fiji, 1992).

Species	Diet Type	Mean % Recovery of puparia	
		TEST 1	TEST 2
<i>B. passiflorae</i>	Pawpaw/Bagasse	73	68
	Dehydrated carrot	42	75
	<i>B. latifrons</i> diet	71	54
	Melonfly diet	35	6
	Medfly diet	14	5
<i>B. xanthodes</i>	Pawpaw/Bagasse	58	53
	Dehydrated carrot	72	53
	<i>B. latifrons</i> diet	28	47
	Melonfly diet	28	23
	Medfly diet	23	26

These results showed that pawpaw/baggase, dehydrated carrot and *B. latifrons* diets gave adequate recoveries of puparia and, consequently, adults. However, using the 5 diets for mass culturing of both species showed that pawpaw/baggase and dehydrated carrot diets produced adults more consistently than the *B. latifrons* diet. More importantly, the development times for the *B. latifrons* diet, and the melonfly and medfly diets were significantly longer than for diets based on pawpaw/baggase or dehydrated carrot. Pawpaw/baggase has become the standard diet for Fiji, Tonga and Western Samoa.

LIFE CYCLE STUDIES

As a precursor to the host status testing and the research into post-harvest quarantine treatments, it was necessary to determine the life histories of the economically important fruit fly species in each country.

Eggs from 4-5 week old flies were seeded onto the standard artificial diets used in each country, viz., pawpaw/baggase diet in Tonga and Fiji and pawpaw/cassava diet in the Cook Islands. Observations included the time taken for eggs to

hatch, the duration of each of the three larval instars, and the time taken for adults to emerge.

Table 2 provides a summary of the development rates for four species of fruit flies, *B. facialis*, *B. melanotus*, *B. passiflorae* and *B. xanthodes*.

Table 2 - Development rates of economically important fruit flies in the South Pacific

Species	Time from Egg-laying (days) at 27oC				Adult emergence
	Eggs	1st Instar	2nd Instar	3rd Instar	
<i>B. passiflorae</i>	1.5 -2.0	1.5 - 4.0	3.5 - 5.5	4.5 - 15.0	20.0 -25.0
<i>B. xanthodes</i> (Fiji)	1.5 - 2.0	1.5 - 4.0	3.0 - 5.0	4.0 - 11.0	21.0 - 25.0
<i>B. xanthodes</i> (Cooks at 26oC)	1.0 - 2.5	1.0 -5.0	3.0 - 7.0	4.5 - 12.0	20.5 - 25.0
<i>B. xanthodes</i> (Tonga)	1.0 - 2.5	1.5 - 4.5	3.0 - 5.5	4.5 - 14.5	18.5 - 28.0
<i>B. facialis</i>	1.5 - 2.0	1.5 - 4.0	3.0 - 5.5	4.0 - 15.5	18.5 - 30.0
<i>B. melanotus</i>	1.5 - 3.0	1.5 - 5.5	4.0 - 6.5	5.5 - 12.0	22.5 - 25.5

There are few differences between the duration of the egg, first instar and second instar stages of all species. For culturing purposes, the eggs hatch in 36-48 hours, the first instar lasts about 2 days, and the second instar exists for 1-2 days. Larvae exit the diet after 7-8 days and pupate. Sieving for pupae occurs after 14-15 days. Adults start to emerge at around 20 days.

As part of the life history studies, the period for peak egg production was determined. For most species, flies are most productive over a 3-5 week period after emergence. For this reason, flies are held for a minimum of 3 weeks before egging for host status testing, colony maintenance, or post-harvest quarantine treatment research, is done.

HOST STATUS TESTING

The host surveys during the project showed that damaging fruit fly species are not bred from certain fruits and fleshy vegetables despite collections of large quantities of these commodities. For example, in Fiji, neither *B. passiflorae* nor *B. xanthodes* were bred from fleshy vegetables such as eggplants, chilli, capsicum, tomato, squash, bitter gourd, and angle gourd. Similarly, neither species have been bred from pineapple, watermelon or limes.

It is possible, therefore, that some fruits and vegetables are not hosts for fruit flies in some countries or some commodities are not hosts at a particular stage of maturity. If this is the case, there is no need to develop post-harvest quarantine treatments for these commodities, i.e. they may be exported without treatment.

Unfortunately, it is very difficult to prove the non-host status of a particular commodity. The USDA-Animal and Plant Health Inspection Service (USDA-APHIS) requires that 100,000 pieces of fruit are sampled over several seasons to "prove" non-host status. Sampling of fruits and vegetables of this magnitude is impractical in Pacific Island countries. More importantly, the cost of such an exercise to some countries would be prohibitive. For example, sampling of 100,000 watermelons in Tonga would cost about \$0.5m, without the problems of manually handling this quantity of fruit in the laboratory.

For this reason, it was necessary to develop an alternative method of testing the host susceptibility of a fruit or vegetable on a smaller scale. The New Zealand Ministry of Agriculture and Fisheries - Regulatory Authority, in conjunction with the RFFP, developed the NASS Standard 155.02.01.08 - Specification for Determination of Fruit Fly Host Status as a Treatment in November, 1991.

This component of the paper outlines briefly the procedures used in the Standard and reports on tests conducted by the RFFP in conjunction with counterpart staff in each of the project countries.

Testing Procedures And Interpretation Of Results

The Standard provides for two tests to be carried out on a candidate fruit or vegetable. The first test is referred to as a Laboratory Cage Test, which includes exposing damaged fruit or vegetable (referred to as Test Fruit) to gravid females for 24 hours, holding the fruit for 10-14 days and rearing flies. A control is run simultaneously to prove the fitness of the laboratory reared flies and constitutes exposing damaged fruits of a recognized host to gravid females. e.g. for *B. passiflorae*, guava or citrus may be used as a control.

The results may be categorized as follows:

- . Flies emerge from Test Fruit and Control, the Test Fruit is regarded as a Potential Host and can then be submitted to a Field Cage Test;
- . Flies emerge from Test Fruit but not the Control, the Test Fruit is regarded as a Potential Host and can be submitted to a Field Cage Test;
- . Flies do not emerge from Test Fruit or Control, the test must be repeated;
and
- . Flies do not emerge from Test Fruit but emerge from the Control, the Test Fruit is regarded as a non-host and no further test is required.

The second test is referred to as a Field Cage Test where an area of crop is enclosed in a large cage (say, 3m x 3m x 2m) or branches or bunches of fruit are caged. Gravid females are released into the cage, the fruit being undamaged and exposed to infestation for 48 hours. The fruits are harvested, weighed, counted, held in the laboratory for 10-14 days and flies are reared from the fruit. Again, a control is run to ensure fitness of the laboratory reared flies.

The results may be categorized as follows:

- . Flies emerge from Test Fruit and Control, Test Fruit is regarded as a host at the stage of maturity tested;

. Flies emerge from Test Fruit but not the Control, Test fruit is regarded as a host at the stage of maturity tested;

. Flies do not emerge from the Test Fruit and the Control, the test is invalid and must be repeated; and

. Flies do not emerge from the Test Fruit but emerge from the Control, Test Fruit is regarded as a non-host at the stage of maturity tested and no further test is needed.

While both of these tests are artificial and there is, at this stage, no choice experiment included, it appears to be a more practical option than sampling 100,000 fruits. Unfortunately, the results are biased in favour of the importing country.

Results of Host Status Testing

The RFFP and counterpart staff in Tonga, Fiji and the Cook Islands carried out a wide range of tests since January, 1992. The results are listed in Table 3.

The results indicated that the three pineapple varieties are not hosts to *B. passiflorae* and *B. xanthodes* at colour break in Fiji. Two varieties, Smooth Cayenne and Viamama are not hosts to fruit flies at the fully ripe stage. Squash (pumpkin) is not a host to these species.

In Tonga, Field Cage Tests indicate that zucchini and watermelon (var. Sugar Baby) are not hosts for *B. facialis*. Both of these commodities are now being tested using *B. xanthodes* and *B. kirki*.

The Host Status Testing has clearly identified those commodities, for which post-harvest quarantine treatments need to be developed, e.g. eggplant in all three countries.

HEAT TOLERANCE STUDIES

Restrictions imposed by New Zealand and bans imposed by the USA, Japan and Australia, on the use of the fumigant, ethylene dibromide for disinfestation of fruits and vegetables of fruit flies, have forced Pacific Island countries to commence developing alternative disinfestation treatments. As a result, the RFFP and the USAID's Commercial Agricultural Development(CAD) Project embarked upon providing technical assistance to develop alternative acceptable quarantine treatments. The assistance took the form of providing equipment and methodologies for carrying out heat tolerance tests of early and late eggs and first, second and feeding and non-feeding third instars of economically important species of fruit flies in Tonga and Fiji. The aim is to determine the most heat tolerant stage of the most heat tolerant species. To undertake this research, the CAD Project provided static hot water baths and various pieces of temperature monitoring equipment in December, 1992.

The second step in developing treatments is that, once the most heat tolerant stage is identified in each country, efficacy testing of a particular heat regime (ie, a particular temperature at the centre of a fruit or vegetable) and its effect on mortality of eggs and/or larvae within the fruit, can be commenced. At the same time, heat tolerances of the commodities that are likely to be exported will be tested. A hot water immersion bath is already in both

countries and an experimental hot forced air unit will be provided from Hawaii in early 1994. The final step in this research is to carry out confirmatory tests of the treatments developed, using commercial scale hot forced air or hot water immersion units.

To ensure that prospective treatments are acceptable to the authorities in importing countries, regular contact with these countries is maintained. New Zealand is one of the few countries in the world, that has developed Standards for development of post-harvest quarantine treatments for fresh fruits and vegetables. These are the standards that will be followed initially.

Testing of the heat tolerances of *Bactrocera facialis*, *B. kirki* and *B. xanthodes* in Tonga commenced in February, 1993 and of *B. passiflorae* and *B. xanthodes* in Fiji in March, 1993. Similar tests on *B. melanotus* and *B. xanthodes* in the Cook Islands were done in 1992 by staff in the Cook Islands and from the Horticulture and Food Research Institute (NZ) Ltd. It is expected that results related to testing of *B. xanthodes* will be applicable to all countries where it occurs, providing the heat tolerance tests show that the tolerances to heat in each country are similar. It should be noted that no specific work on heat tolerance is planned for Western Samoa at this stage because the results of work in Tonga will be directly applicable. Western Samoa has similar damaging fruit fly species to those in Tonga. Only *B. facialis* does not occur in Western Samoa.

The heat tolerance testing schedule for each species is exhaustive and very time-consuming. The test for each species involves exposing naked eggs and larvae in specially designed tubes that allow unimpeded water flow, to temperatures between 44 C and 49 C (one degree intervals) for a range of exposure times of 0.5, 1.0, 2.0, 4.0, 8.0, 16.0, 32.0, 64.0, and 128.0 minutes, in a static hot water bath. Each test comprises 100 individuals and must be replicated up to 10 times. Although a considerable number of tests have been run in both Fiji and Tonga, results are too premature to report on at this stage. The standards that will be followed initially.

Agenda Item 3 (h)

TRAINING ON FRUIT FLIES

INTRODUCTION

Although training in technologies relevant to fruit fly research and control was not identified as a specific objective in the ACIAR/FFP or the RFFP, it was treated as a high priority activity by both projects. Training of counterpart staff belonging to plant protection, quarantine and extension services was seen as essential to enhance the long-term sustainability of the project's activities in all four project countries. Coupled with this training were workshops, seminars and field days to increase the awareness of farmers and exporters of the importance of fruit flies to production and export and of the methods of pre-harvest and post-harvest control of fruit flies.

The training provided under the projects targeted Ministry of Agriculture staff in each country rather than staff in regional organisations such as the South Pacific Commission. The thinking behind this approach was to ensure that there is a corps of well trained entomologists in several countries. After working with fruit flies for 3-6 years under the guidance of project personnel, these staff will be sufficiently experienced to provide advice to other small Pacific Island countries contemplating new work on fruit fly control, particularly related to fruit fly surveys and field control.

This paper outlines the training provided by the two projects in each of the four project countries and to staff from other countries in the Region.

REGIONAL TRAINING

International Training Courses

The major effort in training of plant protection, quarantine and extension staff on fruit flies centred on the running of two International Training Courses on Understanding and Managing Fruit Flies, viz.,

. First International Training Course held in Brisbane at the Queensland Department of Primary Industries on 5-23 November, 1990; and

. Third International Training Course held in Suva, Fiji at the University of the South Pacific on 23 November - 5 December, 1992.

(The Second International Training Course on Understanding and Managing Fruit Flies was held in Kuala Lumpur in May, 1992, primarily for South-East Asian countries).

These Courses were sponsored by the Crawford Fund for International Agricultural Research (Australia) with considerable funding and organisational support from ACIAR, Queensland Department of Primary Industries (QDPI), FAO/AIDAB/UNDP/SPC

Regional Fruit Fly Project (RFFP), and AIDAB. The First Course was organised by QDPI, while the Third Course was organised and hosted by the RFFP.

The First Course was attended by 14 participants from 7 Pacific Island countries, with the remainder of the 20 participants coming from South-East Asian countries. The Third Course was attended by 24 participants from 14 Pacific Island countries.

These courses provided tuition and practical laboratory and field training on a very wide scope of fruit fly topics, including taxonomy of adults and immature stages, morphology, biology/ecology, host surveys techniques, trapping techniques, pre-harvest control methods, fruit flies and quarantine, and post-harvest quarantine treatments. Resource staff were drawn from world experts on fruit fly research from the QDPI, the RFFP and the USAID's Commercial Agricultural Development (CAD) Project.

To encourage the commencement of fruit fly work in countries not included in the ACIAR/FFP or the RFFP or not currently undertaking fruit fly work, basic fruit fly collecting kits were provided to country representatives at the Third Course. This kit provided sufficient materials to commence trapping and host surveys in their respective countries.

Use of PEACESAT Satellite Facility

The RFFP commenced to use the PEACESAT Satellite system for training within the South Pacific in 1992. One session on "Fruit Flies and Quarantine" was conducted in early 1993, involving 57 participants from most SPC countries, New Zealand and Hawaii. This proved to be an excellent mode for providing up-to-date information on fruit fly issues and technology.

The satellite system is now being used for regular monthly liaison between project and counterpart staff in Tonga, Fiji, Western Samoa and the Cook Islands. The main purpose of these one-hour sessions is to ensure there is cross-flow of information on fruit flies between the four project countries, thus facilitating problem-solving in relation to fruit fly research and policies.

WITHIN COUNTRY TRAINING

Cook Islands

Major emphasis has been placed on training of counterpart staff in plant protection, quarantine and extension services and of farmers and exporters. The following summarizes the activities:

. Ministry staff from Aitutaki, Mangaia, Mitiaro, Atiu and Mauke received on-the-job training in Rarotonga for 2-6 days (Funded by the RFFP and ACIAR/FFP).

. Patrick Arioka (Technician, Rarotonga) spent 2 weeks in the Fruit Fly Laboratory in Fiji, learning techniques of trapping, host surveys, laboratory rearing of flies and field control. (Funded by SPC).

. A four-day workshop was run in Rarotonga in mid-1991 for 21 farmers (1 day) and 26 Ministry staff (3 days) to increase the awareness regarding fruit

flies and their control. The workshop was run in English with Maori translations.

. Workshops were run in Aitutaki (40 farmers and 17 Ministry staff), Mitiaro (15 farmers and 7 staff), Atiu (21 farmers and 12 staff), Mangaia (11 staff) and in Mauke (25 farmers and 14 staff) in 1992, to bring participants up-to date on developments from the RFFP and the ACIAR/FFP and on methods of fruit fly surveillance and control.

. During a visit to Rarotonga by ACIAR/FFP staff in May, 1991, a one-day workshop on the taxonomy of immature stages of fruit flies was done for Ministry staff.

. Further workshops/seminars are planned for Rarotonga, Mauke, Aitutaki, Mangaia and Atiu for 1993.

Tonga

Most of the training in Tonga in 1990-1991 focussed on visits to farmers as part of the trapping and host survey activities. These visits promoted awareness of the problems of fruit flies to production and trade in fresh fruits and vegetables. Formal workshops and seminars were commenced in 1992. These included:

. one day seminar on fruit flies, their importance to production and trade, their control and new developments by Dr. Richard Drew (ACIAR/FFP) and Allan Allwood (RFFP);

. a one-day seminar for Ministry staff and farmers on pre-harvest and post-harvest control methods by Allan Allwood (RFFP) and Dr. Jack Armstrong (USAID's CAD Project);

. a two-day workshop, consisting of one day for farmers and exporters and one day for extension and other Ministry staff. 30 farmers, exporters and other interested members of the public attended the first day. 24 Ministry staff attended the second day. The workshop allowed project staff to update attendees with the latest developments from the ACIAR/FFP and RFFP and to demonstrate laboratory rearing of fruit flies, host surveys and host status testing procedures, and bait spray techniques.

Fiji

Training in Fiji commenced in January, 1991 and has targeted Ministry staff on all island groups and farmers and exporters. It may be summarized as follows:

. In January, 1990, RFFP staff visited Labasa, Lautoka, Nadi and Sigatoka to brief Ministry staff on the objectives of the Project and the likely involvement of plant protection, quarantine and extension services.

. The ACIAR/FFP and RFFP conducted a one-day workshop on identification of adults and immature stages of fruit flies at the Fiji College of Agriculture in May, 1991. 24 quarantine and plant protection staff from Suva, Sigatoka and Nadi attended the workshop.

. The RFFP provided 5 days of training for each of 7 quarantine recruits in the fruit fly laboratory at Koronivia Research Station. Training included trapping and host survey methods, identification of adults and larvae, laboratory rearing of flies and bait spray techniques.

. 5 Ministry staff from the outer islands (Vanua Levu, Taveuni, Lau group, Rotuma) received training on fruit flies for 2 weeks each at the Koronivia Research Station. These staff will establish trapping systems and host surveys on each island group as part of future quarantine surveillance. Funding for this was provided by SPC.

. The Laboratory at Koronivia Research Station provided training on fruit flies for plant protection and quarantine from other countries in the Region, e.g. Tonga (1), Western Samoa (2), Cook Islands (1), Solomon Islands (1), Federated States of Micronesia (2) and Tuvalu (1). The training period was 2-3 weeks.

. A major field day to demonstrate the bait spray technology was held at the Garden of the Sleeping Giant, Nadi in April, 1993. 53 farmers and Ministry staff attended. This created enormous interest in the technology and received excellent television coverage.

Western Samoa

Training of Departmental staff and farmers in Western Samoa has not reached the same level as that in the other three project countries. The effect of Cyclones Ofa and Val on the vegetation and consequently the fruiting of commercial and wild plants, has led to slower progress of the project in Western Samoa. It seems that this period is over and Western Samoan staff have now produced excellent results, that will provide a sound basis for training. The training carried out so far is summarized below:

. one half day seminar by Dr. Richard Drew for Departmental staff (20) on the importance of fruit flies to production and trade and their biology and control;

. one day seminar by Allan Allwood and Albert Peters, following Albert Peters' attendance at the First International Training Course on Fruit Flies. (This was for 24 Departmental and University staff);

. one half day seminar by Allan Allwood on the results of the RFFP in Fiji, Tonga, and Cook Islands for 21 Departmental and University staff.

OVERSEAS TOURS AND TRAINING

The RFFP has been able to provide a limited number of overseas tours to fruit fly laboratories and for training courses. These are summarized as follows:

. Parei Joseph visited the USDA-Agricultural Research Services laboratory in Hawaii under the auspices of the FAO Technical Cooperation Programme of the RFFP in 1991 (10 days).

. Albert Peters (Western Samoa) and Jai Kumar (Fiji) attended the First International Training Course on Understanding and Managing Fruit Flies in Brisbane in November, 1990.

. Ema Tora (Fiji) and Ofa Fakalata (Tonga) visited the USDA-ARS Laboratories in Hawaii through the combined efforts of the RFFP and USAID's CAD Project.

POST-GRADUATE DEGREES

The RFFP has been able to tap into training in fruit flies being sponsored by USAID's CAD Project under its Graduate Research Assistant Scheme. The following higher degrees at the University of the South Pacific have been identified for staff within the project countries:

. Graduate Research Assistant (Masters Degree) at the University of the South Pacific Alafua Campus, Western Samoa to investigate the susceptibility of banana and plantain varieties at various stage of maturity to fruit flies (nominee to be named);

. Ms. Ema Tora (Fiji) to undertake an external Masters Degree on heat tolerance studies of eggs and larvae of fruit flies in Fiji;

. Mr. Sione Foliaki (Tonga) to undertake an external Masters Degree on heat tolerance studies of eggs and larvae of fruit flies in Tonga.

EXTENSION BULLETIN

The RFFP is compiling an extension bulletin for the four project countries, to be completed by September, 1993. This will cover topics such as species in each country, host ranges, biology, field control, fruit flies and quarantine, and post-harvest control.

Agenda Item 4

FUTURE EXTENSION AND/OR EXPANSION OF THE PROJECTS

INTRODUCTION

The ACIAR/FFP is due to terminate at the end of 1993. The RFFP was to terminate in September, 1993, but will now continue until the end of 1993, due to the provision of US\$130,000 by FAO under TCP/RAS/2360. This will allow the RFFP to continue operating in the Cook Islands, Fiji, Tonga and Western Samoa. Also, it will allow the RFFP to complete the production of a project document for the continuation of the project activities in the four project countries and for the possible expansion of activities into Solomon Islands and Vanuatu. As well, it is seen as necessary to investigate the possibility of expanding the project into the Federated States of Micronesia (FSM), but this will have to be done under another funding source, possibly from UNDP. Any extension or expansion of the RFFP will, of course, be dependent upon the findings of the evaluation now taking place.

This paper attempts to put into perspective the needs of the existing project countries for further fruit fly work and the possible collaborative involvement of the RFFP and ACIAR in future work in the Solomon Islands, Vanuatu and FSM.

ACHIEVEMENTS OF THE ACIAR/FFP AND RFFP

The two projects have assisted the Governments in the four project countries in understanding their fruit fly faunas, compiling extensive host lists for the fruit fly species in each country, compiling lists of parasitoids, determining the economic significance of fruit flies to production, and determining the host status of a range of fruit types. These data have been incorporated into a Pacific database that will be used for quarantine decision-making by exporting and importing countries and regional organizations, once project staff are absolutely certain that all data are valid.

The projects have also made considerable advances in developing a bait spray based on the use of protein autolysate plus an insecticide, as an effective, environmentally sound, cheap field control system. This system, using Mauris Protein Insect Lure as the source of protein autolysate, has been tested in the field on various crops in Fiji, Tonga and Cook Islands and has showed considerable promise. The ACIAR/FFP has undertaken laboratory research on modifying alternative types of waste yeast as a basis of protein baits. This research is at a stage where the technology for converting brewery waste yeast into a protein autolysate should be tested using a prototype plant in a Pacific Island country, followed by field testing of the product as a component in a baiting system for fruit fly control.

The RFFP, in conjunction with the USAID's Commercial Agricultural Development Project, has commenced research into heat treatments as an alternative to fumigants for the disinfestation of fresh fruits before export.

Counterpart staff in the project countries and several other SPC countries have received basic training in many facets of fruit fly taxonomy, biology and control. This places the respective Governments in a much sounder position technically.

FUTURE INVOLVEMENT OF ACIAR

In terms of field work, the involvement of the ACIAR/FFP in the four project countries will be completed by the end of 1993 with the possible exception of some field testing of baits based on modified waste yeast products from local breweries. However, a prototype plant for the production of protein autolysate is unlikely to come on stream until early 1994 so this work will not commence until then and is dependent on the approval of funding from ACIAR.

There are some areas of activity that require consolidation. These relate to the consolidation of the Pacific database, particularly the data from the host surveys. Identifications of positive and negative host records need to be reviewed and confirmed so that the authenticity of any record that appears in the database is guaranteed and can be used with confidence in quarantine decision-making. This exercise needs to be done urgently and must be done before the database is distributed to regional organizations or particular countries. It certainly has to be done before any scientific publication of results takes place. It is recommended that this be done before the end of October, 1993 by the combined efforts of the RFFP and the ACIAR/FFP.

With respect to the possible expansion of the project into Solomon Islands, Vanuatu and FSM, the role of ACIAR should be similar to that in the current project. Primarily, this would involve expanding the database into the new countries through providing expertise in fruit fly and parasitoid identifications, data processing, and field inputs such as assisting with wild and commercial host surveys in Solomon Islands and Vanuatu. As data on the development of bait sprays produced from waste yeast from local breweries becomes available, this technology could be transferred to, and tested in, the new countries in conjunction with the RFFP.

Without inputs on identification of fruit fly and parasitoid species by the expertise within the ACIAR/FFP, it would be necessary for the RFFP to contract out this work, especially for the difficult and new species that are likely to be recorded in countries such as Solomon Islands and Vanuatu. It is regarded as imperative to have a central reference point as the authority for fruit fly (both adult and immature stages) and parasitoid identification and this should be provided through Dr Richard Drew, Queensland Department of Primary Industries.

INVOLVEMENT OF THE RFFP

The RFFP has achieved considerable progress with respect to the objectives set out in the project document for RAS/90/004. However, there are some activities that require additional inputs. In Fiji, Tonga and Western Samoa, because of the diversity of wild fruits, it is necessary to continue to collect wild fruit samples in an effort to complete these surveys. This activity will take a further 12 months.

Though the bait spray system testing has shown considerable promise and the technology could be released to farmers now, there are several aspects that need

to be consolidated. Refinement of the rates and frequency of application, particularly in relation to the effect of rainfall on efficacy of the bait, needs to be elucidated further. Further testing on particular crops, such as pawpaw, capsicum, and other vegetable crops in Tonga and Cook Islands needs to be done. In Fiji, the baiting system will be tested commercially during the mango season in October, 1993-January, 1994. As results from the modification of waste yeast from local breweries become available, these new protein sources need to be tested in the field.

The development of alternative treatments to fumigants for disinfestation of export fruits commenced only in early 1993. The generation of data on the heat tolerances of eggs and larval instars may be completed by late 1993-early 1994. It will be necessary then to carry out efficacy testing of heat treatments of immature stages in fruit, heat tolerance tests on fruits, and finally confirmatory tests of treatments under commercial conditions. To ensure that counterpart staff are confident in the generation of data acceptable to importing countries, it is necessary to develop quarantine treatments for 3-5 different commodities before the project terminates. Assistance may also be required to compile reports to be submitted to importing countries for assessment of data on disinfestation treatments. The involvement of RFFP staff in this activity is related to building up of confidence in negotiating with regulatory authorities in the importing countries.

The concept of extension of the RFFP in the existing project countries has been strongly supported by various regional meetings of plant protection representatives from countries in the South Pacific, and by the Permanent Heads of Agriculture and Livestock Production Services. The Tripartite Review of the project held in November, 1992 also recommended the extension of the project to 1996 to consolidate the progress made and to facilitate the sustainability of fruit fly activities in each country.

These meetings and review also recommended that the RFFP be expanded to include Solomon Islands, Vanuatu, and FSM in late 1993 or 1994. As a result, a Draft Project Proposal was prepared in early 1993 and has been circulated to Pacific Island countries, to ACIAR, AIDAB, FAO, UNDP, SPC, and other funding organizations. It is estimated that the costs of extending the project in the existing countries and expanding into the three new countries is US\$1.08 million. Depending on the results of this review, UNDP has committed US\$400,000 to the project, commencing in 1994.

The RFFP would address those uncompleted activities identified above in the existing project countries and commence activities in the three new countries. The activities in the three new countries would follow the model established during the current phase of the project, ie documenting the species present in each country, their host ranges, their parasitoids, and their economic significance, establishing laboratory colonies of economic species, undertaking biological studies, developing field control systems appropriate to each country, and, if necessary, developing post-harvest quarantine treatments for export of fresh commodities. Where possible, techniques developed during the current phase of the project will be transferred to the new countries, thus saving time and funds.

The training role of the RFFP and, if possible, the ACIAR/FFP will be maintained as an essential component of project activities.

PUBLICATION OF RESULTS

The combined efforts of the countries, the RFFP and the ACIAR/FFP have generated considerable data that need to be published scientifically. This information is critical to future exports and to the credibility of fruit fly information in these countries and therefore needs to be published in reputable scientific journals. Both projects will assist staff in countries in publishing this information under joint authorship. Topics to be covered include taxonomy (Dacines, Tephritines, Trypetines, larval stages), geographic distributions, seasonal abundances, parasitoids, biological information (life histories, mating behaviour), laboratory rearing techniques, results of bait spray trials, and quarantine treatments, including results of host status testing.

SUSTAINABILITY OF PROJECT ACTIVITIES

It is essential that the existing project countries progressively take over the project activities, particularly in the area of quarantine surveillance, using trapping and regular targeted host surveys. The project cannot continue this activity indefinitely and countries should make financial provision for this activity before the end of 1994. The cost of this activity is minimal in comparison to the export advantages of having up-to-date data on the composition of species in each country. Importing countries require this information before quarantine protocols can be negotiated.

Other activities should also be taken over so that, by the time the project ceases in 1996, countries have a corps of staff trained in fruit fly research and control techniques.

Item 5

PROJECT MANAGEMENT REGIONAL PROJECT ON FRUIT FLY CONTROL STRATEGIES IN THE SOUTH PACIFIC

INTRODUCTION

The management of the Regional Project on Fruit Fly Control Strategies in the South Pacific (RFFP) has been very complex, primarily due to the multiplicity of funding agencies and the administrative requirements of each of these agencies. Nevertheless, it has been possible to rationalize many of the management issues resulting from this complexity to make the project workable both administratively and operationally and to ensure that the project countries were not disadvantaged to a great extent.

PROJECT EXECUTION

All components of phase one of the RFFP (ie, TCP/RAS/0055, RAS/90/004, TCP/RAS/2360) have been executed under the umbrella of the SPC's Agriculture Programme, with FAO providing the Chief Technical Advisor under a sub-contractual arrangement. This arrangements has given flexibility to the operations of the project, particularly in relation to facilitating direct contact with the participating project countries at all levels of government.

Further, it was possible to introduce some innovative procedures within the SPC system to facilitate the operation of the project, e.g.

- establishing small imprest accounts (petty cash accounts) in each country to allow the United Nations Volunteers and national counterparts direct access to funds for minor or emergency purchases;

- convincing SPC of the need to have annual approval for travel within the Region based on an approved work plan (This meant that the Chief Technical Advisor did not have to obtain travel approval from SPC Management, Noumea for each time he had to travel. This has now become standard practice for most programme areas in SPC).

Though the process of appointing project staff was long and drawn out (e.g. the appointment of the Project Assistant, funded wholly by UNDP, took 9 months), SPC was, and still is, the appropriate regional organisation for execution of the project. It should be noted that the administrative support provided by the office in Nabua, Suva has been excellent. Other than the slowness in appointing project staff, the only administrative draw-back of SPC is the inadequacy of simple, regular, up-to-date financial reporting on project expenditure. Unless improved, the project will have to institute commitment registers generated by the project to effectively monitor expenditure, especially if a second phase is commenced.

PROJECT AND COUNTERPART STAFF

The only Project staff are the Chief Technical Advisor and Project Assistant both based in Suva and United Nations Volunteers (UNV) in each project country. The UNV's, as reported in the Tripartite Reviews of the project, have been instrumental in the success of the project. It is appropriate to say that, without the UNV's in each country, the project would not have achieved as much as it has. This arrangement should be extended to new countries if an expansion of the project occur.

As the complex nature of the funding of the project in the future is likely to be similar to that in the first phase and because the project may be covering seven countries, the need for a Project Assistant is readily justified.

The Governments in each country have provided counterpart staff to a level that has been adequate for the operation of the project. There are, however, some deficiencies that need addressing, e.g.

- Only one graduate trainee in Fiji, where, if rapid progress on quarantine treatment development is to occur, another graduate trainee is urgently required.

- There does not appear to be a graduate entomologist in the Cook Islands responsible for the overall fruit fly program as the graduate entomologist trained in fruit flies during the project is completely involved in quarantine treatment development only.

- Governments need to urgently identify operational and financial procedures to take over the responsibilities for some project activities such as quarantine surveillance to ensure that these activities are sustainable in the long term. This will have to involve national staff and Government funding.

- To a large extent, the sustainability of project activities is dependent on continued training of counterpart staff and this must be given high priority in future project activities.

FACILITIES AND EQUIPMENT

The RFFP and the ACIAR/FFP have provided financial support to upgrade laboratory facilities to a point where each country has adequate basic facilities and equipment to carry out the activities of the fruit fly work. There may be a need to replenish some of the equipment and supplies (e.g. traps, cages, consumables) over the next 1-2 years, but Governments should make budget provision for this eventuality sooner than later.

URGENT ISSUES

There are several issues that will have to be addressed urgently, but are dependent on the findings of this evaluation.

1. The most urgent issue is the offering of further contracts to UNV's, particularly in Tonga, Western Samoa and the Cook Islands. The intention is to extend the UNV's in Tonga and Western Samoa for a further 2 years, primarily to ensure that research in these countries is completed under their guidance and to ensure that counterpart staff are adequately trained so that they can take over the responsibility for the activities.

The UNV in the Cook Islands should be transferred to Vanuatu commencing in January, 1994, if the project is expanded.

There is no intention to replace the UNV in Fiji as the counterpart entomologist there is competent to run the project activities under the guidance of the CTA, providing an additional graduate trainee is provided.

2. As stated in Agenda Item 4, there is an urgent need to consolidate the data in the Pacific database and distribute this to project countries and SPC. Similarly, it is necessary to publish the data generated by the two projects so that these are available to Pacific Island countries, regional organisations, and prospective importing countries.

3. The shortage of adequate transport in some countries (e.g. Western Samoa and, in some instances, Cook Islands) needs to be overcome by the Ministries /Departments involved in the project. Access to transport is essential to the unimpeded operations of the project. This issue in new countries needs to be critically assessed before the project may be expanded.