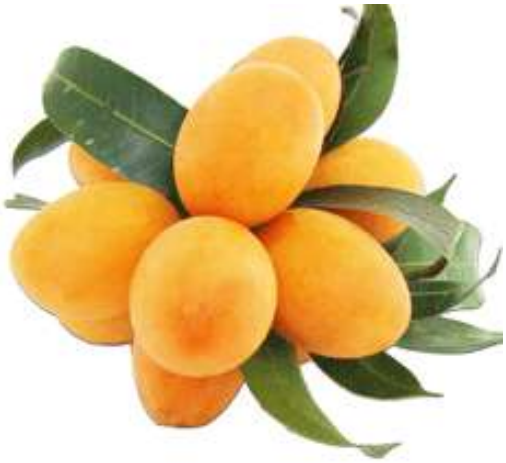

Regional Training on IPM for Fruit Flies

Area-Wide Integrated Pest Management of Fruit Flies in South and Southeast Asia

Asian Institute of Technology
P.O. Box 4, Klong Luang
Pathumthani 12120,
THAILAND

http://ipm.ait.asia

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07-14 December 2010

Southern Horticultural Research Institute

Tien Giang, Vietnam

Training Report

Regional Training on IPM for Fruit Flies

Area-Wide Integrated Pest Management of Fruit flies in South and Southeast Asian Countries

Participating Agencies from Asian Fruit Fly IPM Project Countries:

Participating agencies from other Asian Countries:

Project Partners:

Project Donor:

TAIWAN ICDF

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How to obtain the digital copy:

Report of the Regional Training on IPM for Fruit Flies can be electronically down loaded from the website of the Asian Fruit Fly IPM Project (http://ipm.ait.asia) and also from FAO Regional Vegetable IPM Programme's website (www.vegetableipmasia.org).

About the project

"Area-wide Fruit Fly Integrated Pest Management in South and Southeast Asia" is a regional initiative coordinated by the Asian Institute of Technology with funding support from Taiwan's ICDF (www.icdf.org.tw). The project has a focus on adaptation and adoption of fruit fly IPM practices among vegetable and fruit smallholder using Farmer's Field School (FFS) in the Mekong river basin countries. While the Asian Institute of Technology (AIT; www.ait.asia); Bio-Control Research Laboratory (BCRL; http://www.pcilindia.com/bcrl.html), Bangalore, India, and the FAO Regional IPM Programme (http://www.vegetableipmasia.org/) are the collaborating project partners, the project is implemented by National IPM Programmes in Lao PDR, Cambodia, Vietnam; Department of Agriculture Extension (DoAE) Thailand, and Ministry of Agriculture and Irrigation (MAI) in Myanmar. The project is intended to test, promote and socialize among smallholder farmers a range of novel IPM options for fruit fly management within the context of ongoing IPM farmer training and action research programmes in the Mekong basin countries.

Contact

The regional office of the project is housed in its host institute (Room # 207, AFE Building AIT, Bangkok, Thailand). Further information on the project could be obtained from the following contact:

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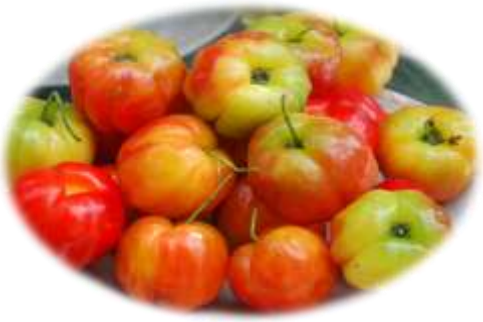

Abbreviations

ACIAR	Australian Centre for International Agricultural Research
AIT	Asian Institute of Technology
ASE	Agricultural Systems and Engineering
AW-IPM	Area-wide Integrated Pest Management
BAT	Bait Application Technique
BCRL	Bio-Control Research Laboratory, Bangalore India
MARD	Ministry of Agriculture and Rural Development, Vietnam
FAO	Food and Agriculture Organization of the United Nations
FFS	Farmer's Field School
FoS	Field of study
GHI	Global Horticulture Initiative
GMS	Greater Mekong Sub region
IPM	Integrated Pest Management
CUE	Cue Lure
MAT	Male Annihilation Technique
ME	Methyl Eugenol (4-allyl-1,2-dimethoxybenzene)
MRBC	Mekong River Basin Countries
PB	Protein Bait
TOT	Training of Trainers
SOFRI	Southern Horticultural Research Institute, Tien Giang, Vietnam
PPD	Plant Protection Department, Ministry of Agriculture and Rural Development, Vietnam
CSP	Country Strategy Paper for Fruit Fly Management

Summary

A Regional Training on IPM for Fruit Flies under the auspices of the project "Area-wide Fruit fly Integrated Pest Management in South and Southeast Asia" was organized at the Southern Horticultural Research Institute, Tien Giang in Vietnam from 07 - 14 December 2010. Attendees (some 35 persons) included resource persons, country representatives from project implementation countries and other countries in South and SE Asia, representatives from partner institutes (FAO, BCRL India) and personnel from the host institute SOFRI and PPD of Ministry of Agriculture and Rural Development, Vietnam.

The overall objective of the training was to provide participants with information, education and hands-on experiences on fruit fly IPM to prepare them to assist farming communities in developing location-specific and effective area-wide strategies for sustainable fruit fly management. The training course sessions were divided into learning blocks on: (1) Fruit Fly Species Diagnosis, Biology and Ecology; (2) Damage Symptoms Recognition and Assessment; (3) Management Options for Fruit Fly; (4) Design of Area-wide Best-bet Management Strategies for Fruit Fly; and (5) Training Curriculum and Materials Development.

As a result of the training, participants can now: (1) identify tephritid fruit flies (*Bactrocera dorsalis*, *B. cucurbitae and B. correcta*) and understand the biology, ecology and host preferences of these species; (2) recognize symptoms and assess damage levels caused by fruit flies; (3) set up science-based and tested technologies - e.g. protein baits, lures, bagging and good sanitation practices - to suppress fruit fly populations; (4) design best-bet strategies for area-wide management of fruit fly; (5) use a modified Agro-Ecosystem Analysis tool as to integrate population monitoring mechanism for fruit flies and as a basis to decide the nature and timing of treatments that integrate a variety of management options; and (6) have access to curriculum, session guides, reference materials, and methodologies to train farmers on fruit fly IPM, preferably within the context of FFS and follow up training activities.

Key IPM Trainers associated with ongoing National IPM Programmes in the AFF project countries and trainers from other Asian countries under FAO-supported projects in the Asia region are now ready to work with farming communities in innovating strategies and providing opportunities for farmers to learn about and experiment with the latest innovative fruit fly integrated management options using FFS approaches. This is expected to translate into pilot activities that will demonstrate improved productivity and quality of fruits and vegetables.

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1. Background

The Asian Institute of Technology (AIT), in collaboration with the Bio-Control Research Laboratory (BCRL), Bangalore, India, the Food and Agriculture Organization of United Nation's (FAO) Regional IPM Programme and associated National IPM Programme in Lao PDR, Cambodia, Vietnam and Thailand, was awarded a regional Mekong river basin project "*Area-wide Fruit Fly Integrated Pest Management in South and Southeast Asia*" funded by ICDF (International Cooperation and Development Fund) and supported by the Global Horticulture Initiative (GHI). The project is intended to test, promote and socialize among smallholder farmers a range of novel IPM options for fruit fly management within the context of ongoing IPM farmer training and action research programmes in the Mekong basin countries.

The Regional Training on IPM for Fruit Flies was organized as a follow-up of the Inception Workshop (September 2010) and assisted selected IPM trainers to refine their country strategies for project implementation, assisted them to develop FFS-based area-wide IPM for fruit flies in selected fruits and vegetables, modified population monitoring tools (i.e. AESA) and helped them develop learning-centered non-formal education based training materials.. Attendees were IPM trainers nominated by respective IPM programmes and agriculture ministries from the project implementation countries, including Myanmar. In addition, upon request of Governments, representatives from six more Asian countries (Bangladesh, China, Indonesia, Nepal, Timor-Leste and the Philippines) attended the regional training with support from FAO-IPM and other ongoing IPM programmes in the region as to learn about area-wide IPM on fruit flies from the Mekong basin project (*see* Annex 1 for List of Participants). The key resource person in the training course was **Dr. Vijay Shanmugam**, FAO Consultant and former Deputy Director and Senior Research Fellow at Griffith University, Queensland, Australia, who has over 36 years of experience on the identification, biology, ecology and integrated management of tropical fruit flies in Asia. Personnel drawn from the AIT, FAO-IPM, BCRL, SOFRI and PPD, Vietnam also served as resource persons and assisted in the workshop. SOFRI hosted the workshop in close collaboration with the Vietnam National IPM Programme lodged in the Plant Protection Department, Ministry of Agriculture and Rural Development and other project partners. The workshop was organized at the training and laboratory facilities of SOFRI, Tien Giang, Vietnam from 07-14 December 2010.

2. Workshop Aims, Objectives and Expected Outputs

The regional training on IPM for Fruit Flies served the purpose of providing a common platform for Asian IPM trainers to share available knowledge and experiences on implementation of FF trainings. The training aimed to develop the needed monitoring skills for FF, development of pertinent training curricula and guides, learn newer management options, and develop plans for area-wide FF IPM using the FFS as a platform for successfully implementing the projects in AFF project countries and in other Asian countries.

2.1. Objectives

The overall objective of the training was to provide participants (nominated IPM trainers) from AFF project implementation countries with information, education and hands-on experiences on fruit fly IPM to prepare them to assist farming communities in developing location-specific and effective area-wide strategies for sustainable fruit fly management.

The ***specific objectives*** included, for participants to be able to:

- Identify the 3 major tephritid fruit fly species in the GMS, i.e. the Oriental Fruit Fly *Bactrocera dorsalis,* the Melon Fly *Bactrocera cucurbitae* and The Guava Fruit Fly *Bactrocera correcta*, and understand the biology, ecology and host preferences of these species;
- Recognize symptoms and assess damage levels caused by fruit flies;
- Exchange practical experiences and gain new knowledge on fruit fly management options;
- Design best-bet strategies for area-wide management of fruit fly using FFS as educational platform;
- Modify the Agro Ecosystem Analysis tool as to integrate population monitoring mechanism for fruit flies and as a basis to decide the nature and timing of treatments that integrate a variety of management options;
- Develop curriculum, session guides, reference materials, and methodologies to train farmers on fruit fly IPM, preferably within the context of FFS and follow up training activities.

2.2. Expected Outputs

- Knowledge of fruit fly ecology and biology and skills in recognition and identification of species and assessment of damage caused by fruit flies;
- Skills in setting up science-based and tested technologies (e.g. protein baits, lures, bagging and good sanitation practices) to suppress fruit fly populations;
- Skills in the design of best-bet strategies for area-wide management of fruit fly;
- Draft training curriculum and session guides on IPM for fruit flies for use in ToT and FFS.

3. Workshop Schedule

The workshop was organized in two (2) parts:

Part 1: ***The demonstration booth***

A number of posters on ongoing IPM programmes in the region on fruit flies were set-up in the training venue to share the available information on fruit flies management. The posters were set-up on 07 December and were kept on display until the end of the workshop. Apart from the fruit flies posters, some other posters on successful FFS on vegetable crops were also displayed by the various countries.

Part 2: ***Plenary and planning session*****s**

From 7th December sessions, the training contents primarily designed as hands-on exercise, were carried out in 5 blocks. After each session and related hands-on work, participants developed the draft session guides for use in TOT/FFS implementation (*see* Annex 2 for schedule of the workshop) leading to the development of draft work plans:

- Opening session and country work plan presentations
- Block 1: Fruit Fly Species Diagnosis, Biology and Ecology
- Block 2: Damage Symptoms Recognition and Assessment
- Block 3: Management Options for Fruit Fly
- Block 4: Design of Area-wide Best-bet Management Strategies for Fruit Fly
- Block 5: Training Curriculum and Materials Development

4. Workshop Opening, Plenary and Country Presentations

Under the auspices of the "Area-wide Integrated Pest Management of Fruit Flies in South and South East Asian Countries" and in collaboration with FAO Asia-IPM Programme (FAO-IPM) and Biological Control Research Laboratory (BCRL), India and the Plant Protection Department, MARD, Vietnam, the informal Opening Session was held at the Southern Fruit Research Institute (SOFRI) on 7TH December 2010, the first day of the 'Regional Workshop on IPM for Fruit Flies'.

Dr. Hguyen Minh Chau, Director of Southern Horticulture Research Institute (SOFRI), Vietnam inaugurated the workshop. **Dr. Ho Van Chien** of Southern Region Plant Protection Centre, Plant Protection Department, Vietnam and gave a welcome speech**. Dr. Prabhat Kumar**, Project Coordinator, AIT, Bangkok provided an overview of the project and also discussed the achievements till date and work plan for the coming six-months. During his presentation he introduced the project's website and also encouraged IPM trainers from the region to join the Asian Fruit Fly IPM Network using the project's website. **Mr. Jan Willem Ketelaar**, Chief Technical Advisor and Team Leader of the FAO-IPM Programme added information on the overall objectives of the workshop within the context of ongoing IPM work in the region.

The first technical session of the day was delivered by **Dr. Vijay Shanmugam** (formally with Griffith University, Australia), who was recruited as FAO consultant to provide the technical backstopping to the workshop. He gave a presentation entitled *" General overview of Fruit Flies in Asia – Species, Life cycle, Biology, Crop Losses and Management Strategies"* that required a very large amount of information to be delivered and understood by the participants, most of whom had little experience or knowledge of fruit flies. It was thus presented in 6 parts as follows: i) Taxonomy and pest species of economic importance; ii) Life cycle; iii) Crop damage and economic losses; iv)Aspects of fruit fly biology, behavior and ecology that are used in control programs; v) Management strategies and control methods; and vi) Examples of successful area-wide control of fruit flies in S. E. Asia using protein bait spot sprays. This comprehensive information provided participants with the fundamental knowledge on fruit flies they require to plan and implement area-wide fruit fly IPM programs in their respective countries.

Key points from presentations are:

- The majority of fruit flies of economic importance in Asia belong to the genus *Bactrocera*. Prior to 1989, these pest species belonged to the genus *Dacus*, but following a revision in 1989 they are now classified under the genus *Bactrocera*
- The life cycle of fruit flies consists of four developmental stages i.e. egg, larvae (3rd instar larvae drops to ground), pupa and adults. The total life cycle from egg to adult is about three weeks for most tropical FF species. Adult FF may live up to 3 months or more in the field and lay eggs continuously during this period. Flies can lay about 15-20 eggs in a day
- Many microbes are passed on into the fruit during oviposition that leads to rotting of the fruit flesh and make them unsuitable for storage, sale and human consumption
- There are over 480 species of *Bactrocera* in the Asia-Pacific region and of these, 22 species are currently considered as being of major economic importance in Asia. A list of these species, their distribution and pest potential was provided.
- In the GMS region, the three FF species of major economic importance are the Oriental fruit Fly *Bactrocera dorsalis,* the Guava Fruit Fly *B. correcta* and the Melon Fly *B. cucurbitae*.
- Fruit fly identification can be a tricky problem in Asia because of the *Bactrocera dorsalis* complex, which is a group of closely related species that are morphologically very similar to the Oriental Fruit Fly *Bactrocera dorsalis* but the various species, may infest different host's fruits and are found in different countries. There are more than 75 species currently described in the *B. dorsalis* complex but only 9 are listed as pests.
- Some simple morphological traits on the wing and face of adult flies could help to distinguish between three commonly occurring FF in Mekong countries i.e. *B. dorsalis, B. correcta* and *B. cucurbitae*
- The data collected by SOFRI in Mekong delta shows that *B. correcta* causes more damage and is of greater economic importance than B. dorsalis in the GMS. Adult populations of *B. correcta* reached an annual peak from March- July 2010 with Flies per Trap per Day (FTD) of 30-35 against 4-5 for *B. dorsalis*.

Dr. Vijay Shanmugam further provided details on fruit fly biology and behavior that have been utilized to control pest fruit flies. These include vision, odor, feeding behavior and reproduction aspects of fruit flies. He then outlined the 3 basic FF IPM strategies of 1) Direct damage prevention; 2) Population suppression; and 3) Eradication, which could be adopted to manage the fruit fly problem (Box 1). Various successful and working IPM management tools including protein baits, lures, cue-lures, sanitation, habitat management etc. were presented and discussed with the participants so that they could learn and adapt one or more strategies for development of FF IPM in their own countries (Box2).

Box 1: Common FF IPM Strategies and their features

a.) ***Direct damage prevention***: Protect fruits from direct oviposition of FF by bagging; Used at the level of individual commercial farmers or domestic orchards; Usually have little impact on FF breeding;

b.) ***Population suppression to a minimum level***: Aimed at the entire breeding population for a major part of a large population of flies in a specific area; usually carried out over large areas or in regions that are relatively isolated; Benefits to many small farmers in the area; Community-based approach

c.) ***Eradication to completely eliminate all FF***: Aims at eliminating all flies; Total freedom from FF; After eradication no control is needed; usually undertaken for introduced pest not for endemic species; crucial to protected against re-infestation

Box 2: Common techniques used for FF IPM

a.) ***Biological control:*** the eggs and larvae are the main stages parasitized by a number of Hymenopterans parasitoids belonging to the family Braconidae; however, biological control alone does not provide high degree of control of close to 100% required in commercial fruit cultivation

b.) ***Crop hygiene/sanitation:*** removal of fallen fruits/old crops; each fruit can produce up to 400 FF adults. Removal and destruction of unwanted fruit is very import for FF IPM; collected fruits should be buried 0.5 meters deep in soil; Sichuan and Shaanxi province in China have reported good success in reducing population of FF using sanitation for fruit flies infesting citrus

c.) ***Bagging/ netting***: young fruits should be completely bagged to prevent oviposition by female flies; bags must not have any holes; Initially labor intensive but once done no further intervention is required to harvest; also increases cosmetic value of fruits; age of bagging of different fruits varies depending on fruit type

d.) ***Insecticides:*** generally not recommended in IPM as there are other robust tools available; however, a systemic insecticide like dimethoate, even in a single application, may be useful to arrest serious fly infestations in fruit;

e.) ***Bait sprays***: adult FF need protein to fully develop their sexual organs, mate and lay eggs; beer waste based protein baits mixed with a very small amount of insecticide and applied as a spot spray to the foliage have been successfully used in Vietnam for the past 7-8 years

f.) ***Early harvesting:*** Some fruits when mature green are fairly resistant to FF infestation , in such cases this method could be employed; e.g. for green banana, papaya and mango

g.) ***Male annihilation***: using lures (ME) and cue- lure; ; male lures in traps are excellent tools for monitoring adult fly populations; for control, large number of lure baited blocks are needed to be distributed over a wide area to be effective

h.) ***Sterile Insect Technique (SIT):*** available in some countries like in Thailand and the Philippines; good when working with a low population; can also be used in combination

The discussion on the presentation was initiated by a question (raised by **Dr. Malvika Chaudhary, BCRL, India**) regarding the identification of the larval stage of FF and other secondary decomposers in the fallen fruits. The presenter remarked this to be a tricky issue and suggested to rear the larvae until emergence of adult as the best way for trainers and smallholder farmers to separate fruit flies from secondary decomposers in an FFS setting. Next discussion was based on a question (raised by **Mr. Damaso P. Callo, the Philippines)** related to simultaneous trapping of FF and its parasitoids while using Yellow Sticky Traps (YST). Careful selections of monitoring tools are important for example the use of lures and cue-lures are more appropriate than the use of yellow sticky traps, replied the Presenter. Expanding the horizon of discussion **Mr. Ashraful Islam, DoAE, Bangladesh** added that use of mashed pumpkin-based baits is commonly used to trap melon flies in their country.

4.1 Work plan presentations from AFF project countries

In this series of presentations, each of the four (4) AFF project countries and Myanmar presented a summary of their country strategy papers for wider discussions and possible suggestions for improvement of their work plans. The session was chaired by **Mr. Jan Willem Ketelaar** and **Dr. P. Kumar** acted as Rapportuer. **Dr. Vijay** provided some initial suggestions on each of the work plans. Detailed comments and suggestions on these CSP from him will follow in the coming weeks.

The first presentation, from Cambodia, was given by **Mr. Chhit Mak** from the National IPM Programme. After informing the workshop participants on the general features of Cambodian agriculture he moved on to information about fruit flies. A number of cucurbits crops are host of melon flies and similarly a number of important fruit crops are host of fruit flies. He added that around eight various species of the FF have been recorded from Takeo and Kampot provinces. He informed the workshop of comparative loss assessment on fruit and vegetable crops based on initial survey carried out by the provincial IPM team in Kandal and Kampong Cham provinces. Pesticides-based management along with some bagging using newspapers is currently practiced by most farmers. The practice is not sustainable due to high cost (10 cover sprays of a cocktail of 4-5 various active ingredients of insecticides on cucurbits). As proposed in their CSP, Cambodia included pilot area-wide IPM programme development, Training of Trainers, FFS, Field Day and other activities that will be undertaken with support from the AFF project. Several questions on method of loss assessment were raised and discussed. It was suggested to the Cambodia team to utilize the workshop to learn better and scientifically robust methods for pest population monitoring as well as the loss assessments. The Cambodia team was further advised to learn the newer and safe IPM strategies planned in the workshop and their inclusion in their work plan.

Mr. Khanxay Somchanda from Plant Protection Center, Lao PDR presented the country paper from Laos. After providing background information on the fruits and vegetable statistics from Laos, he gave information about the presence of 13 various FF species in Laos. He further informed participants that there is no sufficient information available on the losses, abundance of the species, host range, etc. The work plan presented from Laos included identification of species, developing IPM strategies, training of farmers and trainers, creating awareness on FF, etc., largely drawn from the CSP.

Questions on reliability of the identification were raised by workshop participants. Similar concerns were expressed for the need of basic information on FF in Laos. Although not directly, some basic scientific information could be forthcoming from the activities that will be undertaken under the auspices of the AFF project in Laos.

Third presentation came from **Ms. Kaythi Wai**, Plant Protection Division, MAI, Myanmar, who after providing background details on the horticulture sector provided more information on Mango fruit flies in the context of ongoing efforts to export fresh mango export to China and elsewhere. According to her the losses caused by FF are in the range of 30-100% in some fruit and vegetable crops, if not protected. The current management focuses on the use of insecticides and bagging by farmers. For the AFF project Shan State, Mandalay and Yangon have been selected. The work plan included the details from the CSP which is being developed.

Several questions were raised by the workshop participants for more thoughts from the Myanmar team, e.g., how the non-formal education based FFS could be carried out in Myanmar as there is little to no prior experience; how soil-based insecticides are suggested and how it kills the pupal stages of FF, etc. The team expressed the desire to learn from the training workshop on all these aspects to further develop capacity among Myanmar plant protection and extension workers in collaboration with the private sector for successful implementation of the AFF project.

The fourth presentation came from **Ms. Arunee Chareonsaksiri**, DoAE Nakhon Nayak Province Thailand, wherein she provided interesting insights into the horticulture sector in the Kingdom. Fruits and vegetables constitute respectively 10 and 3 % of total agriculture export from the Kingdom. There is a long-standing FF IPM programme in Thailand, primarily based on SIT concept and other approaches. Fruit flies are the major concern for Thailand for its primary export markets.

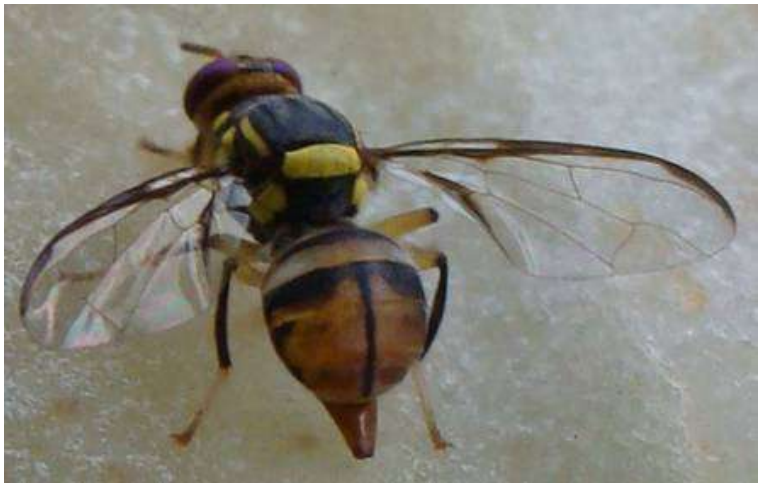
Utilizing the support from the AFF project, FF IPM work in two provinces Samut Sakhon and Nakhon Nayak will be strengthened. Marian plum, cucurbits and guava are the chosen crops for this project. Developing pilot area for area-wide IPM using protein bait + sanitation, training of farmers and trainers, creating awareness among grower association and developing public relation campaigns will be the major activities undertaken by the project.

The discussion on this presentation covered the issue related to the modification of the FFS platform, expanding and forging links with the FFS group within DoAE. The country team will deliberate on these issues and modify the CSP. Further like other countries, availability of Cue lures, lures and protein baits were requested. The project team assured them of availability of these options for the project implementation. On another question on using SIT as a part of AFF project design (raised by **Dr. Nguyen Van Hoa, SOFRI**), the country team replied by saying that currently there are no plans to use the SIT in the project implementation plans. Similarly more questions on the effectiveness of SIT were raised (**Dr. Vijay Shanmugam**). Later during a presentation on the SIT, the country manager, **Dr. Watchreeporn Orankanok** provided more information on these questions raised.

The final presentation came from **Dr. Nguyen Van Hoa, SOFRI**, and Vietnam, who after providing a quick background on the country's horticulture sector moved to the work plan for fruit flies in Vietnam. He added that large scale use of artificially induced flowering by farmers resulted into extended season of fruiting for the many fruit crops and consequently the fruit fly infestation and year round damage from fruit flies. For AFF project implementation two southern provinces have been selected where 26 fruit crops are infested by FF and 16 vegetable crops by melon fly. The peak infestation season starts from March until June every year for the major FF species. Initial years saw a major use of cover spray by the farmers but due to safety concerns, bagging of fruits (mango, guava, star fruits); trapping by ME, and up to some extent sanitation are practiced by the farmers. In the past 7-8 years, through ACIAR supported projects, the protein baits have been able to substantially reduce fruit losses in some key crops like acerola in the south and peach in the north. Using this background Vietnam would expand AFF project implementation to Dragon Fruit, Sapodilla and cucurbit crops. Development of pilot area-wide IPM of these crops, farmers training, TOT, development of extension materials are major activities planned under this project. Vietnam, which is currently producing a protein bait (SOFRI protein) is also willing to provide it (for sale if supplies are available) for development of pilot area-wide IPM in other countries in the region.

The follow-up discussion on this presentation focused on (raised by **Mr. Jan Willem Ketelaar)**, improving the plans for AFF project by expanding success to other important export fruit crops. Further discussions focused on monitoring of the FF population (as FTD) and how the FTD can be used as threshold for protein bait spray. It was clear that currently there are not enough empirical experiences available to do so, therefore, preventive spray using protein baits should be used. On other discussions, it was also concluded that alone protein bait cannot provide good level of FF population suppression and therefore it should be complimented by sanitation and other available IPM strategies.

The Chair finally concluded the session by emphasizing that further fine tuning of the work plans are needed in light of the learning form this workshop and also utilizing the forthcoming comments on CSP by **Dr. Vijay Shanmugam**. A list of the crops from each country, amount of various products like protein baits, lures, cue lures and others also needs to developed and added into the budgets. Finally, if GPS instruments are not available in the country, then one GPS set each should be added in the project implementation budget. The GPS instrument could help to identify coordinates of the project implementation location for the purpose of setting population monitoring system.



4.2. Hand-on Exercise (Species Diagnosis, Biology and Ecology)

A hands-on exercise was organized to provide needed diagnostic skills to the participants to be able to distinguish three commonly occurring FF in the region i.e. *B. dorsalis, B. correcta* and *B. cucurbitae*. The session was co-chaired by **Dr. Vijay Shanmugam** and **Dr. Watchreeporn Orankanok** and delivered by **Dr. Vijay Shanmugam.**

Activity 1: Species diagnostic of common fruit fly species in Mekong region

- Important morphological characteristics of the three above-mentioned species of FF were discussed
- Collected specimen was provided to the participants to observe and discuss with the resource persons to be able to identify these three species on their own.
- Discussion on the methods of trapping of FF for identification

Box 3: Why Identification of the FF species is important?

Each species has different:

1. Preference of lure (so that farmers can determine what lure / kind of trap to use)
2. Preference of host (so that farmer can determine what fruits/ vegetable to grow)
3. Behavior, biology, ecology and natural enemies (so that farmer can develop proper strategy for control)

Activity 2: Observation of various life and development stages of the FF

- Laboratory cultured life and development stages of the FF were demonstrated to the participants to familiarize themselves with the three larval, pupal and adult stages of the FF
- Freshly fallen infested fruits (Guava, Sapodilla, Jujube, Bitter gourd, Carrabolla) were provided to learn about the signs and symptoms of the nature of damage
- Participants were also asked to dissect the fruits, collect various stages of the larvae and compare with the provided specimen to fine tune their abilities in identification

Activity 3: Setting of insect-zoo to learn about the life cycle of the fruit flies

A simple process of learning various life and development stages of the FF was introduced as follows:

- Collection of available stage from the infested fruit
- Placing them along with fruits on a sterilized saw dust carrying container
- Daily observations and recording time lapses between the various larval stages, from larval to pupal stages and from pupal to adult stages (total no. of days)
- Discussion on the observations

Figure 1: 2ND, 3Rd (jumping stage) and pupal stages of the *B. dorsalis* (*from left to right*)

Homework: As home work, each country team was asked to develop the non-formal education based draft session guides on two topics:

- Species identification of the fruit flies
- Learning life and development stages of the fruit flies in the FFS/TOT

A compilation of all session guides developed by participants has been edited and available at project's website (http://ipm.ait.asia) to be used for Fruit Fly IPM FFS.

4.3 Damage symptom recognition and loss assessments

During the second day of the workshop, the morning session focused on increasing capabilities among the participants to recognize the damage symptoms caused by fruit flies and how loss assessments can be made. The session was chaired by **Mr. Jan Willem Ketelaar** and **Dr. Vijay Shanmugam** acted as rapportuer of the session. The **Laos** and **Indonesian** delegates acted as host team for the day.

For the session, field trips were organized in the morning to a sapota (*Manilkara zapota*) growing area in Kim Son village where some farmers were practicing IPM for fruit fly management and some were not. The participants were divided into two groups of 16 persons each and one group visited the IPM sapota farms while the other group visited the non-IPM sapota farms. The purpose of the exercise was for participants to make a comparison between the IPM and non-IPM systems of fruit fly management. The two groups interviewed farmers on their fruit fly management practices as well as sampled 100 pieces of sapota fruit at random. The sapota fruits were then brought back to the laboratory and dissected to observe and record fruit fly damage levels. After the assessment of damage a discussion session resulted in outputs and learning from the hands-on exercise (*see* annex 3 for details).

The later part of the afternoon was utilized for country presentations from the ***non-AFF project countries t***o learn about their FF management experiences.

Mr. Ashraful Islam from **DoAE, Bangladesh** gave the country presentation**.** 80 types of vegetables and 120 types of fruit are cultivated, with the acreage increasing yearly. Banana (34%) is the main fruit crop followed by mango (28%). Fruit exports are also important to the country with exports increasing annually. The main fruit fly species recognized as being of economic importance are *Bactrocera dorsalis* and *B. cucurbitae*, especially from April to July which is the main cropping season. Poisoned fruit baits (mashed sweet gourd + Dipterex or Sevin or Mipsin) and CUE trapping are currently the main control methods used by farmers. Infestation can be brought down to less than 10% using these methods. There are also several government sponsored programs on fruit fly

From **China PR, Mr. Xie Yiling**, Section Chief, PPS Guangxi delivered the country presentation. His report represents Guangxi only not all of China. The 1st TOT was carried out in August 2008 with 32 participants from 25 counties in eight prefectures. In 2009, 129 FFS were conducted in 30 counties for 3871 farmers but the main crops in the training were rice and vegetables and fruit flies were not the main target. FFS on kumquat has been successful. Farmers are now familiar with beneficial organisms and reducing pesticide use.

A question was raised to his presentation 'Is fruit fly important in kumquat'? Mr. Xie replied that farmers so far have not complained about presence of FF in the area. Finally the chair of session suggested that Mr. Xie add more pertinent information related to fruit flies and return a copy of the revised presentation to the organizing team.

Next presentation was delivered by **Mr. Arief Lukman Hakim**, **Field-Indonesia**. He added that many fruit types are cultivated with exports to Japan, India, China, S.E. Asia, Middle East, etc. Fruit fly control at present is achieved mainly with Methyl Eugenol male trapping, sanitation and fruit bagging, especially in Carrabolla. He added that some work on FF has been carried out but dedicated extension and training materials are yet to be developed. The chair summarized the various comments on this presentation as, 'Many different groups and individuals in Indonesia are doing fruit fly work in Indonesia and this is not coordinated. The Indonesian team should contact these groups in their country for more information'.

Mr. Anisur Rahman Ansari, Senior Scientist, **NARC, Nepal** presented his country report. The major fruits and vegetables are mango, citrus and apple, litchi, guava, banana cucumber, gourds and melons. Fruit flies are a big problem on most of these crops with the main pest species being *Bactrocera dorsalis* and *B. cucurbitae*. The fruit fly fauna, however, remains un-surveyed and this needs to be done in Nepal. Fruit flies are also listed as quarantine pests in Nepal. Current fruit fly management practices include by traps for monitoring sanitation and poison baits. IP-FFS in cucurbits in some districts using male lures, sanitation and poison baits (jiggery + molasses + insecticide). As a final comment to him it was suggested that there is a need for a scientific survey on the fruit fly species and host-range in Nepal.

The next presentation from the **Philippines** was delivered by **Mr. Damaso P. Callo**, Crop Protection, Bureau of Plant Industry. Banana (39% of cultivated area) and mango (11%) are the main fruit types, but many other fruits are also grown. The mango variety Carabao is an important crop as it makes up 3.8% of world mango production. There are about 155, 852 ha of mango with 7 million bearing trees. The two fruit fly species identified as being of major economic importance are *Bactrocera dorsalis* and *B. philippinensis.* A large fruit fly SIT program is in place in Guimaras Island with quarantine to prevent reinfestation. Farmers are trained as pest scouts and form the Bantay Pest Volunteer Brigade. There is limited data on the vegetable industry in the Philippines and these needs to be collected. A question was raised on knowing the other methods than SIT on mangoes in Guimaras island. Mr. Callo replied that fruit bagging is widely used for protection from other borers of mango.

The final presentation from **Timor Leste** was delivered by **Mr. Severino Sousa Costa**, Department of Plant Protection. He informed the participants that Timor Leste is a small country with 13 districts and 450 villages. Fruit and vegetable cultivation is mainly small scale for the local market and no large scale commercial farms are present. The main pest species fruit flies are *Bactrocera papayae* and *B. cucurbitae.* Not much information is available on losses caused by fruit flies and this information needs to be collected.

As a final activity of the day participants carried out observations on their insect-zoo activities.

Homework: As a home work each country teams was asked to develop non-formal education based draft session guides on:

- Identifying damage symptoms and estimating damage caused by fruit flies on fruit and vegetable crops

A compilation of all session guides developed by participants has been edited and available at project's website (http://ipm.ait.asia) to be used for Fruit Fly IPM FFS.

4.4. Management options for fruit flies

The purpose of this session was to introduce the basic concept about the various management options, allow participants to practice those options and eventually debate and discuss on each options and their possible synergies for developing a robust IPM package for chosen crops and fruit fly species in their own countries. Several resource persons lead the various management option sessions under this block which was chaired by **Dr. Vijay Shanmugam**. **Dr. Malvika Chaudhary** acted as rapportuer for the session and the Philippines and Vietnam delegates acted as host team.

4.4.1. Traps and their use in fruit fly IPM (Methyl Eugenol and Cue-lure)

Dr. Malvika Chaudhary and **Mr. Prabhakara M.S**, BCRL, India delivered the session in a very interesting and participatory manner. The session started with a short questionnaire to make the participants think about lures and traps. This was done in groups of eight. This was followed by activity of matching words to familiarize them with the terms used in the presentation. Mr. M. S. Prabhakara gave the presentation explaining about the role of Bio-control Research Laboratories pioneering commercialization of biocontrol in India. He talked about the present technology of MAT with BCRL a lure based on ME and Cue lure dispensed on wooden block. The dry trap which is cost effective and user friendly is used with the lures. Importance of using different traps and lures was emphasized. Precautions to be observed while employing traps and lures and the procedure were also described. A difference between parapheromones and pheromone was explained. Application strategy of traps, i.e., for monitoring, mass trapping according to the purpose and area was explained. Two different lures marketed by PCI, i.e., Bacu lure (Cur lures) and Bador lure (ME) contain 1gm of chemical and last for 90 days and 60 days respectively.

Dr. Vijay Shanmugam, Chairman of the session, summarized the session and gave the following additional information. “Male lures can be used both for monitoring and for control. However, the existing lures ME and CUE attract only male flies. Only protein bait can attract both male as well as female fruit flies. Fruit essence is also a weak attractant that may be used but it is not comparable to ME or CUE. Large numbers of flies are often encountered in traps in the field and counting dead flies is easier with dry traps than with liquid traps.

The purity of the male lure is very important in determining its attractiveness. Male lures mixed with an insecticide and impregnated into wooden blocks have been widely used area wide programs. In smallholder farm situations, traps can be of various types ranging from a simple bottle trap to dry traps that BCRL has developed. McPhail traps baited with fruit essence or a protein solution can be used to attract and monitor females in the field".

A query was raised by **Mr. Ashraful Islam,** Bangladesh whether BCRL is using dry or wet trap and whether they use pesticide with the lures, which was cleared by **Mr. Prabhakara**, BCRL stating that no insecticide is being used in current traps.

4.4.1.1. Practical work on using traps (lures and cue lures)

Participants were briefed by Dr. Vijay on the field trip and methods of trapping. He suggested the method for installing traps with lures: Blocks have been loaded with fipronil. Malathion may also be used if rapid kill is needed but it has a strong odor and may be unpleasant to handle. Fruit farm and vegetable farmers often use traps to obtain an indication of fly populations in their farms. Traps should be hung in the field in pairs of ME and CUE with each pair considered as a replication. The traps will be looked into, adults taken out, identified and counted. After coming from the field it was observed that the population in the trap was not very high because they were hung for a very short time and also the fields were sprayed with the pesticide which has affected the population of the flies.

After briefing, participants travelled in two teams to a fruit orchard and bitter gourd field where traps had been pre-set by the workshop teams. The participants collected the traps and brought them back to the class room for processing of data and further discussions. The concept of FTD (flies per trap per day) was also introduced to enable participants to learn the method of calculating FTD *(see* annex 4 for output of this exercise).

Fly/trap/day = FTD

$$= \frac{\text{total number of flies trapped}}{\text{No. of trapping days x number of traps.}}$$

In summary, numerical comparisons can be made between the catches of different species. An excel sheet with built in formula can be made for the participating countries to collect the data. Monitoring depends on the area but two traps per hectare are ideal. Most of the programs that we are doing involve 30 farmers but for the area wide management, the use of 1farmer/1 trap is suggested. Finally, the Project Coordinator, **Dr. Prabhat Kumar** emphasized that: One of the challenges for the AFF project team would be to think about processes that would allow the FF IPM FFS platform to be used in a community wide (area-wide approach). And, monitoring of the FF population using CUE and ME as pre- and post-project interventions should be taken up strongly in the planning process to come-up with robust analysis that will prove the success of the FF IPM area wide project.

4.4.2. Protein baits and their use in fruit fly IPM

Dr. Ngyuen Hoa from SOFRI, Vietnam provided background information and shared practical experiences on using protein baits for successful area-wide FF IPM from Vietnam. He added that the molasses or sugar solution combined with the insecticide can be used for attraction of FF. Since 1950 onwards protein hydrolyses and also acid hydrolyses of plant derivative especially maize has been put into use. The protein is used by the female FF to develop maturing eggs. In Queensland this has been used over 25 years and has proven very successful. Some protein baits used were discussed. In Tonga Island it has been used in many crops. Highly attractive protein bait was developed under AICAR project in Vietnam. Waste yeast from the beer factory is converted by heat and enzyme treatment into protein bait for fruit flies. He further discussed about the differences in mode of action of parapheromones, pheromones and baits as FF attractant. He added that pheromone can be used for long distance attraction and attracts only males whereas the protein baits attracts both males and females. The suggested spraying schedule should be carried out on 5-7 day intervals and only area-wide (large scale application) to reduce the FF population.

4.4.2.1. Practical laboratory work on using protein baits

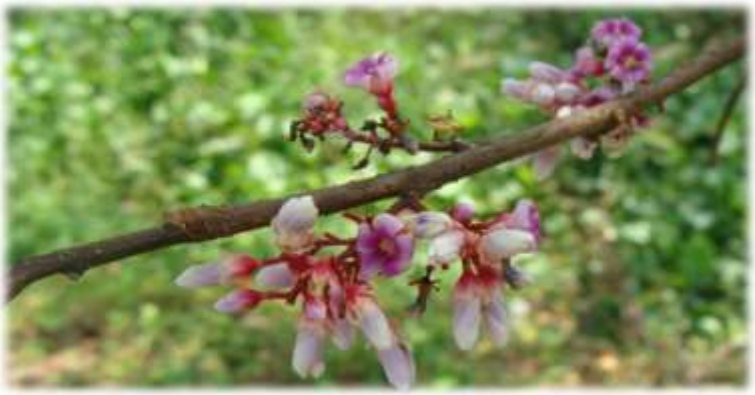
Two groups were formed. A 1:10 dilution of the bait was sprayed on the top of cage containing about 200 starved adult flies to simulate the spot application (as normally carried out for protein spray; 100ml protein + 5% reagent Fipronil +1 liter of water). The groups counted the initial number of flies in the cages and later recorded mortality every 10 minutes until majority of the flies were dead (see Annex 5 for output of the session). In addition, a short movie on FF feeding and regurgitation behavior was shown by Dr. Vijay to explain that after feeding the flies regurgitate food and consume this later. In the mean time, other flies can take-up these regurgitated liquid and be killed as well.

At the end of the day, participants reviewed their insect zoos and submitted their homework to the host team.

Homework: As a home work each country team was asked to develop the non-formal education-based draft session guides on:

- Use of male lures as component of fruit fly management strategy
- Understanding effect of protein baits on fruit fly population

A compilation of all session guides developed by participants has been edited and available at project's website (http://ipm.ait.asia) to be used for Fruit Fly IPM FFS.



Box 4: Points to remember - Protein Bait Spot Spray Technique (Dr. Vijay Shanmugam)

1) Protein baits are very effective because they attract and kill both male and female fruit flies especially after they emerge from the pupae in the soil and are protein hungry. This breaks the life cycle and rapidly reduces adult fly populations in fruit and vegetable farms. The bait also attracts and kills sexually mature fruit flies.
2) To prepare a protein bait solution for use in your IPM programme, use the following dilutions of protein bait, pesticide and water:
    - 100 mL SOFRI Protein or PRIMA Fruit Fly Bait
    - 2 mL of Success 120 SC insecticide
    - 900 mL of water

    Prepare the volume of bait spray you need according to the ratios above

The ***spot spray technique consists of applying a 50mL spot of spray to the foliage of a tree and repeating this for every tree in the orchard.*** Thus the bait is applied to only a small spot or part of the leaves in a tree and no bait is applied to the fruits and flowers. For vegetable crops that are planted in rows, the bait may be applied as a strip to a row, and to every fourth row. Importantly, both spot and strip applications should apply 10-20 litres of spray per hectare of crop. A higher volume is not needed.

A knapsack sprayer is most suitable for application of protein baits. Calibrate your knapsack sprayer so that you know approximately how many seconds it takes to depress the trigger to apply about 50 mL of spray as different sprayers deliver different spray volumes. The spray nozzle should deliver medium to coarse droplets and not fine droplets. Power sprayers and mist blowers are not suitable for use with protein bait sprays.

3) Apply a spot of about 50mL of the bait to the underside of the foliage of your fruit tree where possible as this will help to preserve the spray deposit on the leaves in case it rains. The bait can also be applied to the upper side of the leaves.
4) In this manner apply a spot of bait to each tree in the orchard until all trees the trees have been treated. For vegetable crops planted in rows, apply the bait as a continuous strip to alternate rows in the plot.
5) **The total volume of protein bait applied per hectare of crop area is only about 10-20 litres to be effective**. The bait spray will be less effective if applied at a volume of less than 10 litres per hectare, so make sure that you apply a spray volume of not less than 10 litres per hectare of your crop.
6) Because adult flies are active and feed soon after sunrise, **start your bait application in the early morning and try to complete it before 9 or 10am** before its gets too hot.
7) The spot sprays give the **best results when they are applied beginning at about 1 week after fruit set or pollination and then weekly until harvest**. The number of bait sprays applied will vary depending on the crop and the time it takes from fruit set to harvest.

4.4.3. Sanitation measures as a fruit fly control strategy

On 10th December 2011, the morning sessions began with a presentation on 'sanitation measures as fruit fly control strategies' by **Dr. Le Quoc Dien**, SOFRI, Vietnam. The session was chaired by Dr. Vijay Shanmugam and ***Dr Nguyen Van Hoa*** acted as rapportuer. The delegates from Thailand and Nepal acted as host team for the day. Following key points were shared by **Dr. Le Quoc Dien**:

- Introduction about risk when the fallen fruit is left lying on the field, the life cycle of fruit fly still goes on, increase in population of FF.

The solution:

- Collect as many fallen fruits as possible out of the orchard and then use for fish meal or keep in the plastic bag and keep under high intensity sunlight to destroy or we can bury them deeper than 50 cm depth.
- Depending on the fruit harvesting time; the sanitation should be done accordingly.
- Remove of alternate or secondary hosts.

Box 5: Points to remember on Sanitation (Dr. Vijay Shanmugam)

1. Fallen fruits are a major source of fruit flies in an orchard.
2. Regularly (weekly if possible) collect all fallen fruit and destroy either by burning, burying in soil at a minimum depth of 0.5 meters or converting such unwanted fruit to compost/fertilizer.
3. Some host plants that are non seasonal and bear fruits throughout the year such as star fruit (carambola) can serve as a breeding source of fruit flies. If fruits from these plants are not being harvested, they should be collected and destroyed as well. Such host trees if located close to your Fruit Fly IPM site will impact heavily on the success of your program. Thus where possible, such host trees should be cut and removed (as has been done in the area wide fruit fly control program in Thailand).

4.4.4. Bagging and its use in fruit fly IPM

In the next session, **Dr. Le Quoc Dien** SOFRI, Vietnam gave a presentation on bagging as an option for fruit fly management. The following key points regarding bagging were presented followed by a discussion to summarize the experiences in the region on bagging (see Annex 6 for more details):

- Different materials for bagging (new paper, brown paper, cloth, plastic) can be used;
- Different colors for bagging for different stages of fruit development are used in the region;
- In the case of fruits where flowering has been induced by chemicals, it is recommended that bagging should be undertaken at the same time; whereas in case of natural fruit setting conditions, bagging should be followed as per prescribed days after pollination (annex 6);
- A number of fruits can be bagged to prevent it from losses due to FF (list can be seen in Annex 6);
- Correct timing of bagging is crucial to prevent oviposition by FF;
- Different bagging materials from news paper, plastic bags, and cloth bags can be used for different fruits e.g. paper bags are best for carambola and plastic bags for guava.

Box 6: Points to remember on fruit bagging (Dr. Vijay Shanmugam)

1) Bagging of young green fruit is an effective method of protecting the fruit from ovipositing flies. The bags act as a physical barrier that prevents flies from laying their eggs into the fruit.
2) A wide variety of materials (newspaper, telephone directory paper, plastic, fine cloth, etc) can be used to make the bags, which are usually about 20cm x 30 cm in size.
3) The bag should cover the fruit completely and not have any holes as fruit flies will enter through these holes and damage the fruit.

4.4.4.1 The field visit to practice bagging on different fruits

The participants practiced bagging of Guava, Rose apple, Star fruits in the SOFRI orchard using various materials, under close observation of the resource persons, to practice the correct bagging methods.

4.4.5. Other activities

4.4.5.1. Practical Exercise Session: Fruit Fly Infestation

To further provide first-hand information on the FF oviposition behavior, egg laying, development of eggs and early larval instars (as to reinforce the knowledge on FF life cycle, ecology and biology), a practical hands-on exercise was organized. The participants were organized into four groups to carry out this exercise. The following materials were used: Four cages – four fruit crops (Jujube, Star fruit, Rose apple and Barbados cherry); each cage contained 25-30 mature and protein fed flies; Water and sugar supply; Hand lens.

Steps followed:

a. Enclose the adult FF in a cage with one type of fruit per group (4-5 fruit per cages)
b. Observe the behavior of the flies
c. Leave them for 24 hours
d. After 24 hrs, observe fruits again for oviposition marks

e. Dissect one fruit vertically through the oviposition mark and observe the eggs (if any) and marks inside fruit flesh

f. Fruit should be kept there and observation process should be repeated daily for 4 days

g. Entire fruit containing the 3rd stage larvae (after 8 days) should be kept on sawdust for emergence of adults.

After setting-up the experiment, participants took observations every day.

4.4.5.2. Development of Ecosystem Analysis – based Decision Making Guidelines

Homework for developing guidelines on Agro-ecosystem analysis for FF monitoring was given to each country team. Based on random selection, the Indonesian team was selected to give a presentation on the topic. Since every crop has other important pests too, it was broadly agreed that in the current form of ASEA, where Components / "PLAYERS" in the agro ecosystem (biotic and abiotic); ecological functions and interaction between components will be observed and recorded for making informed decisions, The following three additional parameters will have to be included (called **1-2-3 of FF IPM AESA**):

1 . Percent fruit infestation:

- Random collection of 100 immediately fallen or ripe fruits;
- Out of these 100 , counting how many fruits have oviposition marks;
- The counts will be the percent infestation

(Note: In case of fruits that will be harvested many times, you should repeat the process at least three times during the fruiting season. In case of fruits where only one harvesting is carried out, check for percent fruit infestation just before the final harvest. In case of vegetables, calculations should be done 3 times during the entire fruiting cycle)

2. Number of larvae/adult emergence/parasitoids/ unit weight of fruit:

- Similarly 100 or 50 fruits can be randomly collected and individually enclosed in separate plastic containers with sawdust;
- Emergences of adult FF and/or parasitoids from IPM and non-IPM fields can help to establish the percentage emergence of FF;
- Similarly, the farmers group could dissect the fruits and count the number of larvae/fruit to establish number of larvae/unit weight of fruit. The fruits should be weighed before the process.

3. Flies per trap/day (FTD): By using ME for *B. dorsalis and B. correcta* and using CUE for *B. cucurbitae* in fruits and vegetable fields respectively, the FTD could be calculated on a weekly basis.

These three indicators would provide a scientifically robust monitoring system to strengthen the capacity of trainers and farmers to observe and make informed decision for area-wide IPM programmes.

Box 7: Points to remember on handling of ME and CUE traps for fruit fly population monitoring (Dr. Vijay Shanmugam)

1) The ME and BCRL ME and CUE blocks contain 1 gram of ME each but do not contain any insecticide.
2) Before using in bottle traps, add 5 drops of malathion insecticide to each block and let it absorb into the block. Use the pure undiluted insecticide, i.e. do not dilute with water. Do not worry about the strong smell of the malathion as adult fruit flies are not affected by this odor. Always use gloves when handling insecticides.
3) Prepare the bottle traps and hang 1 ME or CUE block in each bottle trap. Number each trap with a marker pen.
4) Hang the traps at about eye level in the shade within a host tree at a density of approximately 1 trap per hectare. Thus if you have 6 hectares in your project site, you must use 6 traps.
5) Collect, identify and count the trapped flies weekly.
6) Start trapping 4 weeks before fruit set/pollination and continue this for the rest of the year.
7) Cross-contamination between ME and CUE is a common problem caused by handling. Avoid this by having different persons handling the ME and CUE traps.
8) Replace ME blocks in the traps monthly and the CUE every 2 months.
9) Collect the old blocks and bury them in the soil at a depth of more than 30cm
10) Wash your hands and all equipment with ethyl alcohol (about 50-70% strength) to remove traces of ME and CUE after handling these lures

Note : Normally, a 4:1 mixture of ME or CUE : Malathion is prepared and 5 mL of this mixture is added to a cotton wick, and this will last for 1 month in the field. In case of AFF project implementation, the trainers need to make sure that the Malathion impregnated CUE or ME is remain effective for a month. In the case, their efficacy is not up to the mark, it is suggested that additional impregnation with 5 drops of Malathion should be carried out.

4.4.5. Conservation and augmentation of natural enemies of fruit flies

On 11Th December 2011, two remaining sessions on fruit fly management i.e. on natural enemies and on bio-pesticides were discussed. The session was chaired by **Dr. Vijay** and **Dr. Le Quoc Dien** *acted as rapportuer. The delegates from Myanmar and Timor Leste acted as host team for the day.*

The first session was delivered by the Project Coordinator of the AFF project from AIT, Bangkok, Thailand, **Dr. Prabhat Kumar**. He began his session by providing first an overview of the life cycle and development stages of the FF and for each of these stages what commonly reported natural enemies exist. A range of predators and parasitoids, which on their own cannot provide success on sustainable basis, were discussed. Among them weaver ants and its utilization from Africa was discussed. Further he stated that the pupal stage, which is on ground, can be susceptible to a range of ground dwelling vertebrates and non-vertebrate predators, if the crop ecosystem is healthy. Most of the parasitoids belong to *Braconidae*, *Chalcidae* and *Europhydae* families. *Psyttalia fletcheri* is currently being used a parasitoid for the melon fly. Some birds, poultry or maggots are other natural enemies. Microbes especially *Wolbachia* is reported to induce cytoplasmic incompatibility. A healthy environment with less toxic pesticides will support augmentation and conservation of natural enemies. Case studies from Hawaii were discussed. Sustainability has not been observed in this case. It needs enormous amount of care to manage FF with parasitoid. Challenges: time and money are the constraints. Various links for more information on natural enemies of fruit flies were given. Practical protocol to experience and assess pupal parasitism was given. Some specimens were present in SOFRI that were observed after the presentation.

The second session of the day *'Biopesticides and their use in fruit fly IPM*' was delivered by **Dr. Malvika Chaudhary** from BCRL, India. She added that biopesticide are novel approaches, safe to the environment and applicators, for management of fruit fly populations and it has been tested worldwide and validated for integration into FF IPM programmes especially for med fly and oriental fruit fly. The spores, entomopathogens, germinated and enter into the host body upon contact leading to the germination of spores and their multiplication inside host body . The fungus multiplies inside the haemocoel and sporulates externally in suitable conditions.

There are some entomopathogens like *Beauveria bassiana* which also acts as a deterrent for oviposition of the fruit flies. There are products in the West based on this fungus, a cover spray of which manages 60-70% of fruit infestations. This concept has been validated in laboratory experiments at BCRL and is under field trials in India. Moreover the oil formulation of *B. bassiana* under trade name MycoJaal® was observed to be very effective in inhibiting ovipositional puncturing by the fruit flies. Fruit flies spend a part of its life cycle as pupal stage in the soil.

This is the most difficult stage to control as no chemical will give enough of persistence to be effective for long term and the site of application to target this stage is also critical. *Metarhizium anisopliae* is an effective entomopathogen to manage cryptic stages of insect. Its effective application strategy can be treating the infested fruits in the augmentoria. As a part of cultural practices the infested fruits are collected and dumped in a pit at least 10cms deep. But sometimes the emergence of fruit fly does take place in spite of all precautions. Application of 10% granular formulation of *M. anisopliae* is found to suppress 50-60% of emergence as compared to the control in field augmentoria at BCRL, Bangalore, India. Further field trials to evaluate feasibility and cost effectiveness of the applications are required. The above two novel approaches of management of fruit fly adds to a new paradigm in eco friendly control of fruit fly.

The final session on fruit fly management options on the topics of *Sterile Male Technology for fruit fly management* was delivered by **Dr. Watchreeporn Orankanok** from Department of Irradiation agriculture, DoAE, Thailand. In her presentation, Ms. Watchreeporn, provided an overview of history and concepts of sterile insect technique that has been put in practice in many countries to eradicate FF. She further informed that for four various strategic applications, SIT could be employed i.e. eradiation, prevention, containment and suppression. In many parts of the world, SIT has been successfully utilized to minimize or eradiate the FF for instance, the Mediterranean fruit fly, *Ceratitis capitata* (“ medfly ”). The fly was removed from invaded areas in southern Mexico and for 30 years a sterile fly barrier across Guatemala has maintained Mexico and the USA medfly-free. Chile eliminated medfly from northern Chile, Argentina from Patagonia and Peru from its two southernmost valleys. In Thailand, too, some success against B. dorsalis has been achieved. Finally, she also informed the participants that small projects on using SIT have been on the rise in the region, e.g., Vietnam and Myanmar.

4.4.6. Practical exercises

4.4.6.1.Monitoring of FF in Sapota orchard using ME

Practical exercise on monitoring of FF using ME in a sapota orchard was carried out. Traps were set-up during the period of 1-7 Dec. 2010 and later collected and preserved by the workshop organization team. The participants were divided into five groups and given traps with FF to count and calculate for FTD for a later discussion. The output is presented in a table below.

Group No.	*B. dorsalis*		*B. correcta*		*Bc/Bd*	*Location*
	Total	FTD	Total	FTD		
1	7	0.11	120	2	18.2	Long Hung
2	26	0.43	73	1.22	2.84	Duong diem
3	45	0.75	71	1.18	1.57	Vinh kim
4	92	1.53	101	1.68	1.07	Dong Hoa
5	42	0.7	311	5.18	7.4	Thanh Phu

Participants not only learned to calculate the FTD but also were able to successfully identify and distinguish between *B. dorsalis* and *B. correcta*. It was further observed and recorded that *B. correcta*, which earlier seemed to be a minor species, is fast becoming the dominant species in many areas in the region.

4.4.6.2.Visit to the SOFRI Vapor Heat Treatment Facility

Towards the end of the day, the participants were provided a guided tour to the SOFRI's VHT facility, which is housed in its premises, to learn about vapor heat treatment, which is a mandatory requirement for export of some fruits crops.

4.4.7. Field visit to area-wide FF IPM projects on Barbados cherry and Dragon Fruit

Participants were divided into two large groups and taken to two area-wide IPM implementation sites managed by SOFRI (with initial support from AICAR). The first group was taken to the Barbados cherry area-wide IPM site and the second group was taken to dragon fruit area-wide IPM site. The groups visited the fields, discussed with the farmers and observed the fields. Upon return the group discussed the findings and later made a presentation in the class room. The participants also carried out calculation of percent fruit damage and FTD as a part of the field visit.

Summary points from Barbados cherry area-wide IPM:

- Site of visit: Farmer's cooperative no. 1; started with 50 farmers (20 ha) in 2005 and now 300 farmers (80 Ha);
- IPM strategy includes sanitation and protein bait spot application since 2003; no bagging of fruits are carried out;
- Monitoring conduct by SOFRI using ME : 5 traps per hectare
- 2 rounds of protein bait spray per year (each round 4 sprays at weekly interval) 8 sprays/year are practiced
- Cost 1,800,000 VND/ha/year for protein baits (80 US$)
- Before IPM 32 spraying/year of various pesticides were the common practice
- The overall level of fruit infestation :year 2000: 70%;2003:46% Now : 1%
- Findings from participants: B. dorsalis 7 FTD: 0.11; B. correcta: 120 FTD : 2; Bc/Bd Ratio = : 18.2; Fruit Damage: 1 %;
- The current prices are 6000 VND/Kg;
- The fruits are collected and sold through the farmer's cooperative to a private company which is exporting juice (known for very high vitamin C content) to Japan and to some extent to EU and USA.

Summary points from dragon fruit area-wide IPM:

- Total area of dragon fruit 2000 ha
- Farmer name: Dinh Van Moi ; Crop age: 3 year old; Area under crop: 1.4 ha
- SOFRI Protein baits in every alternate rows; Twice sprayed at fruiting time; First during artificial induction of flowering; Twenty days before harvesting
- Chemicals for Anthracnose, which is yet another important plant protection problem for dragon fruit: Ridomil, Score and Anthracol
- Application of herbicides Paraquat in between the rows and hand weeding within rows
- Bio-pesticide for Ants
- Farmer feels protein baits are much more helpful than ME because it catches both males and females
- Adoption of uniform technology (protein bait and sanitation as IPM strategies) throughout the vast area with help of cooperative society; 3 cooperatives and 1 group
- Group training from SOFRI and Provincial Plant Protection Sub Department; Duration: 2-7 days, but no season-long FFS ; Practices GAP (Good Agricultural Practices); Traders buy the produce
- Currently crop is in flowering stage hence not possible to calculate the percent damage

4.4.8. Visit to Facilities for Producing Protein Baits

Participants were divided into three groups for the visit to facilities producing protein baits situated inside the Foster Beer Company. Protein baits are derived from "*spent yeast*" after yeast has been used 5-6 times for beer production. "*Spent yeast"* is composed of alcohol, liquid and yeast. To produce protein bait, the mixture is first treated in a *Yeast Heating Tank* or *Evaporating Tank* where it is boiled at 120^{O}C for six hours until 40% of the liquid has evaporated. The mixture is next treated in a *Proteinizing Tank* where it is kept for 24 hours and papain enzyme is added to break down the complex proteins into a solution of amino acids. Preservatives are finally added to the resulting protein baits which are then bottled for sale.

The equipment for producing protein baits was provided by Australia under an earlier ACIAR-supported project. The local government provided funds for the construction of facilities such as tanks and fixtures. The production of protein baits is part of the Social Corporate Responsibility programme of Foster's Vietnam Limited originally but now bought over by Asia Pacific Breweries Limited. The factory produces about 50,000 liters/year of protein baits marketed by the Can Tho Pesticide Company in Vietnam as SOFRI Protein 10DD.

4.5 Design of Area-wide Best-Bait Management Strategies for Fruit Fly

The session on designing area-wide management strategies was facilitated by **Dr. Prabhat Kumar** and **Ms. Alma Linda Abubakar** and chaired by **Dr. Vijay Shanmugam** on 13 December 2010. The delegates from China PR and the Philippines acted as host team for the day.

The session was aimed to provide guidelines to participants in designing a community-wide fruit fly management programme. **Dr. Vijay Shanmugam**, FAO Consultant, introduced a protocol on *Technical Requirements for Area-wide Management of Fruit Flies*. The guidelines include the following points:

4.5.1. Protocol for area-wide IPM program

4.5.1.1. Handling of ME and CUE traps for fruit fly population monitoring

1) The BCRL ME and CUE blocks contain 1 gram of ME each but do not contain any insecticide.
2) Before using in bottle traps, add 3 – 5 drops of malathion insecticide to each block and let it absorb into the block. Use the pure undiluted insecticide, i.e. do not dilute with water. Do not worry about the strong smell of the Malathion as adult fruit flies are not affected by this odor. Always use gloves and other recommended safety precautions when handling insecticides.
3) Prepare the bottle traps and hang 1 ME or CUE block in each bottle trap. Number each trap with a water-proof permanent marker pen.
4) Hang the traps at about eye level in the shade within a host tree at a density of approximately 1 trap per hectare. Thus if you have 6 hectares in your project site, you must use 6 traps.
5) Collect, identify and count the trapped flies weekly. It is suggested that only bottles containing dead flies should be gently removed. After collection of flies, it should be screwed back without disturbing the ME/CUE blocks.
6) Start trapping 4 weeks before fruit set/pollination and continue this for the rest of the year.
7) Cross-contamination between ME and CUE is a common problem caused by handling. Avoid this by having different persons handling the ME and CUE traps.
8) If same person is handling both ME & CUE, it is suggested to wash hands using ethyl alcohol (50-70% strength) and then with soap and water.

9) Replace ME blocks in the traps monthly and the CUE every 2 months.
10) Collect the old blocks and bury them in the soil at a depth of more than 50 cm
11) If bottle of bottle traps are cloudy, mouldy or damaged, it is recommended that you change it with a fresh one.

4.5.1.2 Sanitation

1) Fallen fruits are a major source of fruit flies in an orchard.
2) Regularly (weekly if possible) collect all fallen fruits and destroy either by burning, burying in soil at a minimum depth of 0.5 meters or converting such unwanted fruit to compost/fertilizer.
3) Some host plants that are non seasonal and bear fruits throughout the year such as star fruit (carambola) can serve as a breeding source of fruit flies. If fruits from these plants are not being harvested, they should be collected and destroyed as well. Such host trees if located close to your Fruit Fly IPM site will impact heavily on the success of your program. Thus where possible, such host trees should be cut and removed (as has been done in the area wide fruit fly control program in Thailand).
4) Similarly, wild cucurbits and discarded cucurbit plots serve as major breeding sites for melon flies; therefore they should be removed and destroyed.

4.5.1.3. Fruit Bagging

1) Bagging of young green fruit is an effective method of protecting the fruit from ovipositing flies. The bags act as a physical barrier that prevents flies from laying their eggs into the fruit.
2) A wide variety of materials (newspaper, telephone directory paper, plastic, fine cloth, etc) can be used to make the bags, which are usually about 20cm x 30 cm in size.
3) The bag should cover the fruit completely and not have any holes as fruit flies will enter through these holes and damage the fruit.

4.5.1.4. Protein Bait Spot Spray Technique

1) Protein baits are very effective because they attract and kill both male and female fruit flies especially after they emerge from the pupae in the soil and are protein hungry. This breaks the life cycle and rapidly reduces adult fly populations in fruit and vegetable farms. The bait also attracts and kills sexually mature fruit flies.
2) To prepare a protein bait solution for use in your IPM program, use the following dilutions of protein bait, pesticide and water:
   - 100 mL SOFRI Protein or PRIMA Fruit Fly Bait
   - 2 mL of Success 120 SC (Spinosad) insecticide
   - 900 mL of water

   prepare the volume of bait spray you need according to the ratios above
3) The spot spray technique consists of applying a 50mL spot of spray to the foliage of a tree and repeating this for every tree in the orchard. Thus the bait is applied to only a small spot or part of the leaves in a tree and no bait is applied to the fruits and flowers. For vegetable crops that are planted in rows, the bait may be applied as a strip to a row and repeated on every 4th row in the vegetable plot.
4) A knapsack sprayer is most suitable for application of protein baits. Calibrate your knapsack sprayer so that you know approximately how many seconds it takes to depress the trigger to apply about 50 mL of spray as different sprayers deliver different spray volumes. The spray nozzle should deliver medium to coarse droplets and not fine droplets. Power sprayers and mist blowers are not suitable for use with protein bait sprays.
5) Apply a spot of about 50mL of the bait to the underside of the foliage of your fruit tree where possible as this will help to preserve the spray deposit on the leaves in case it rains. The bait can also be applied to the upper side of the leaves.
6) Do not apply baits in a rainy weather or in when it is about-to-rain. In such cases, apply your bait spray next day. If it rains within 2-hrs of bait spray, repeat your bait spray next day.
7) In this manner apply a spot of bait to each tree in the orchard until all trees the trees have been treated. For vegetable crops planted in rows, apply the bait as a continuous strip to alternate rows in the plot.

8) The total volume of protein bait applied per hectare of crop area is only about 10-20 litres to be effective. The bait spray will be less effective if applied at a volume of less than 10 litres per hectare, so make sure that you apply a spray volume of not less than 10 litres per hectare of your crop.
9) Because adult flies are active and feed soon after sunrise, start your bait application in the early morning and try to complete it before 9 or 10am before its gets too hot.
10) The spot sprays give the best results when they are applied beginning at about 1 week after fruit set or pollination and then weekly until harvest. The number of bait sprays applied will vary depending on the crop and the time it takes from fruit set to harvest.

Additional information on the guidelines was provided. ME and CUE lures are used for monitoring and suppression. In the first year of the project, ME and CUE will be introduced for Fruit Fly monitoring rather than as a management strategy. The use of modified traps is encouraged in consideration of costs. The use of 1.5 liter sized bottle with standard opening is recommended. The opening should be 3x3x3. There are many sources of male lures in the market and the purity of these lures varies. Less pure lures have less attractancy. Contamination between ME and CUE should be avoided. Use alcohol first to wash hands and equipment before washing hands with water and soap after handling lures. If the traps are contaminated on the outside, the flies will not enter the traps so readily. The traps should be hung in host trees within the crop at the rate of one trap per ha Fly populations should be monitored continuously to understand seasonality, weather functions, etc. Monitoring should be done in both IPM and control sites.

Questions and Answers:

Mr. Anisur Rahman Ansari, Senior Scientist, NARC, Nepal inquired about the need to add more insecticide to ME and CUE lures. *Response* from **Dr. Vijay Shanmugam**, FAO Consultant: *Use pure insecticide. Try to use concentrations of 50% or 80%. Use 5-10 drops. If the block is saturated, there is no need to use more. Insecticides are only added to new blocks.*

Ms. Arunee Chareonsaksiri, Agriculturist, DoAE Nakorn Nayok Province inquired about the amount of ME and CUE to use. *Response* from **Dr. Vijay Shanmugam**, FAO Consultant: *The blocks already have ME and CUE. For purposes of standardization, used impregnated blocks.*

Ms. Arunee Chareonsaksiri, Agriculturist, DoAE Nakorn Nayok Province inquired if the use of CUE lures in fruit gardens was needed. *Response* from **Dr. Prabhat Kumar**, Project Coordinator, AIT: *Use ME lures for fruits and use CUE lures for vegetables.*

Ms. Arunee Chareonsaksiri, Agriculturist, DoAE Nakorn Nayok Province asked why the lures had to be installed before flowering. *Response* from **Dr. Vijay Shanmugam**, FAO Consultant: *To establish the population (baseline) of fruit flies before flowering.*

Ms. Arunee Chareonsaksiri, Agriculturist, DoAE Nakorn Nayok Province inquired whether or not the lures affect other insects. *Response* from **Dr. Vijay Shanmugam**, FAO Consultant: *ME and CUE lures are very specific and do not affect other insects except lacewings which are attracted to ME*

Dr. Nguyen Van Hoa, Deputy Director, SOFRI asked about the area that activities under the project should cover. **Dr. Prabhat Kumar**, Project Coordinator, AIT: *For the first season, start with 5-6 ha. This will be easy to manage. When implementors have gained confidence, then the area can be expanded.*

Mr. Jan Willem Ketelaar, CTA, Regional IPM Programme inquired about alternatives to Malathion. *Response* from **Dr. Vijay Shanmugam,** FAO Consultant: *The experiments conducted earlier in the training showed that when softer pesticide products are used, the flies remain in the traps for a long time and can fly out. Malathion kills flies immediately when they pick up the pesticide on their feet. The rapid kill makes flies fall in the trap that is important for accurate counting.*

Mr. Anisur Rahman Ansari, Senior Scientist, NARC, Nepal inquired about the use of dichlorvos (DDBP) as a substitute for malathion. *Response* from **Dr. Vijay Shanmugam**, FAO Consultant: *Dichlorvos is very strong and provides rapid knock down so that flies get knocked down too rapidly and fall outside the trap.. Chlorpyriphos can also be used but are slightly repellent to flies. Malathion does not repel flies.*

Mr. Anisur Rahman Ansari, Senior Scientist, NARC, Nepal explained that it is difficult to get malathion in Nepal. *Response* from **Dr. Vijay Shanmugam**, FAO Consultant: *Use chlorpyriphos, not dichlorvos.*

Mr. Xie Yiling, Section Chief, PPS Guangxi asked if the effectiveness of the traps are affected by the flies that die in the bottle, i.e., trapped insects can decompose and give off odor repelling other flies. *Response* from **Dr. Vijay Shanmugam**, FAO Consultant: *Because the flies are collected once a week, it will not affect other flies in the trap. In addition, because dry traps are used, flies do not decompose and therefore there is no smell.*

Dr. Prabhat Kumar, Project Coordinator, AIT asked for more information about replications for experiment treatments, i.e., trapping of fruit flies. *Response* from **Dr. Vijay Shanmugam**, FAO Consultant: *Each trap is one replication. Each trap in both IPM and control areas are replications.*

Ms. Ludivina Dumaya, RCPC Region 12, Philippines asked if the pesticides to be used on ME and CUE lures should be in liquid form. *Response* from **Dr. Vijay Shanmugam**, FAO Consultant: *Yes, so that it is absorbed into the block. Pesticides in powder form will not be absorbed.*

Dr. Vijay Shanmugam, FAO Consultant inquired if there were concerns about malathion use. In the US, the pesticide is still accepted. It is the only organophosphate that is still allowed. It rapidly breaks down and its products are not harmful to the environment. However, a safer alternative for Malathion should be found. *Response* from **Mr. Jan Willem Ketelaar**, CTA, Regional IPM Programme: *The use of Malathion for purposes of lures may be reasonable.*

Mr. Jan Willem Ketelaar, CTA, Regional IPM Programme said that alternatives for Malathion should be considered. *Response* from **Dr. Prabhat Kumar**, Project Coordinator, AIT: *The substitute for Malathion should be a knock down pesticide*. **Dr. Vijay Shanmugam**, FAO Consultant added that it should last for two months.

Ms. Malvika Chaudhary, Senior Research Manager, BCRL India mentioned that their company was producing a dry trap that does not use insecticides. They can send some units of this trap for countries to try out. *Response* from **Dr. Prabhat Kumar**, Project Coordinator, AIT: *Comparative studies should be carried out on the new traps. It is better if the old traps are used as they have been tried and tested.* **Mr. Indmuttuvalli Prabhakara Seetharama Bhat**, Researcher, BCRL India added that trying out the new traps could be part of the study and the findings from these could be used to support the findings from the old traps.

Dr. Prabhat Kumar, Project Coordinator, AIT asked if it would be possible for BCRL to get some ideas from field experiments on a substitute for Malathion.

Mr. Jan Willem Ketelaar, CTA, Regional IPM Programme suggested that the design of traps should be discussed. *Response* from **Dr. Vijay Shanmugam**, FAO Consultant: *The design should be standardized.* **Dr. Prabhat Kumar**, Project Coordinator, AIT explained that the suggested window size should be 3x3x3 in a 1.5 liter-sized bottle. The trap should have windows on both sides.

Mr. Chhit Mak, Asst Training Coordinator, FAO IPM Cambodia asked if “old” (used) ME and CURE lure blocks could be burned. *Response* from **Dr. Vijay Shanmugam**, FAO Consultant: *Yes, they can be burned.*

4.5.2. Additional points for implementation

Additional points were raised that participants could use to design their *Area-wide Fruit Fly IPM Programme*. A summary of these points follow:

4.5.2.1 Site selection:

1) Identify one fruit and one vegetable area where fruit flies are or have long been a serious problem to farmers. This will be your IPM site.
2) Select another site about one km away where fruit fly damage is very high for your control site. This will be your non-IPM site
3) Do this for two provinces or locations, giving you two locations for fruits and two locations for vegetables in each country.

4.5.2.2. Area selection:

Suggested size is 5 ha for fruits and vegetables in each of two selected provinces

Criteria for selection of area:

1) High endemic population of fruit flies and high levels of fruit fly damage
2) Preferably a commercial crop
3) Interested farmers and communities
4) Isolated area with a similar arena of similar crop to act as control
5) Presence of IPM Trainers/Farmer Trainers

4.5.2.3. Once the area is identified:

1) Characterize the area by conducting a Participatory Rural Appraisal. Collect information on crops, season, hosts of Fruit Flies, number of farmers and farm families, market, road access and other details
2) Carry out a detailed crop baseline survey. i.e., crop calendar and one page summary of each crop
3) Mark the area using the Global Positioning System (GPS) and provide coordinates in the report
4) Mark the site of the traps

The term "area-wide" means "community-wide". The process should consider how the entire community can learn the key FFS IPM messages and apply these. It is important to consider the processes that will work best as to achieve an "area-wide" management system. Following are points to consider:

4.5.2.4. Setting up the area-wide IPM Programme

1) Identification of core groups and other farmers
2) Planning on how key knowledge from core group of FFS farmers can be disseminated to all farmers in identified area so that they equally participate in the programme
3) Determine how many sessions are needed for the training. For example if the training is on fruit crops the training could be from flowering to harvesting. If it is on vegetables the training could last the entire season
4) Determine how other key pests and constraints can be addressed

4.5.2.5 AESA and Monitoring

1) The use of 1-2-3 of AESA (percent fruit infestation; number of adult emergence or larvae/unit weight of the fruit; and fruit flies per trap per day - FTD)
2) Trap setting and servicing
3) Data sheets and formats for crops and control sites

Participants were reminded about the task that they were to carry out for the session. Using the baseline information of crops that they had brought with them, country groups were to plan curricula for the selected crops (fruits and/or vegetable). The outputs were to be presented at 3.30pm in the afternoon.

Questions and Answers:

Dr. Nguyen Van Hoa, Deputy Director, SOFRI inquired about Experts' ideas on uploading information from the traps in the GIS map and on the project website. *Response* from **Dr. Vijay Shanmugam**, FAO Consultant: *If high levels of fruit flies are obtained from trapping data and these are uploaded on the website, the data could be interpreted wrongly by a 3rd party.*

Dr. Prabhat Kumar, Project Coordinator, AIT explained that the data was intended for planning purposes and to provide information that the pest is invasive. *Response* from **Dr. Vijay Shanmugam**, FAO Consultant: *The area of 6 ha does not reflect information from a wider area.*

Dr. Prabhat Kumar, Project Coordinator, AIT clarified that the area can be defined as to provide correct information through the GIS for planning purposes and this will not be uploaded in the website if it will bring serious consequences.

Mr. Jan Willem Ketelaar, CTA, Regional IPM Programme added that for other than for evaluation purposes of the project, the information should be kept away from the website.

Dr. Nguyen Van Hoa, Deputy Director, SOFRI added that the proper way of collecting and using data should be discussed.

Dr. Prabhat Kumar, Project Coordinator, AIT advised countries without access to GPS devices to include these in their budgets.

Mr. Jan Willem Ketelaar, CTA, Regional IPM Programme requested **Dr. Prabhat Kumar** to remind participants about details of the key IPM packages for use in preparing draft curricula. Refer to section above on *Technical Requirements for Area-wide Management of Fruit Flies* .

Ice breaker

The Afternoon's Session was opened with an introduction of an Icebreaker, "*Hep-Hep-Hooray*". Participants were asked to form a circle. When the Leader pointed at the participant, he/she was supposed to say either "hep-hep" and clap or "hooray" and raise his/her hands.

4.5.2. Designing a Community-wide Fruit Fly Management Programme

Participants worked in country groups to design their *Community-wide Fruit Fly Management Programmes.* Assignments were also given for presentations on *Technical Exercises for ToT and FFS*. These were:

- Cambodia – Identification of fruit fly species
- Lao – Biopesticides
- Myanmar – Life cycle studies
- Thailand – Natural enemies
- Vietnam – Protein baits
- Bangladesh – Sanitation
- China – Artificial fruit infestation
- Indonesia – Bagging
- Nepal – Processing of FTD data
- Philippines/East Timor – Traps (CUE and ME in FFS)

The outputs were to be presented the following morning, 14 December 2010.

4.6. Training curriculum and materials development

This session was aimed at reviewing the development of draft training curricula and other extension materials developed during the course of the training. The session was chaired by **Ms. Dada C. Morales-Abubakar** and **Dr. Ho Van Chien** acted as rapportuer**.** Delegates from Vietnam and Bangladesh acted as host team for the day.

4.6.1. FFS curricula for area-wide FF IPM

The draft curricula for the area-wide IPM programme for the selected crops were presented by the countries. Considering that most of the AFF project countries have little to no prior experiences of dealing with FF and required consultation with the national agencies, the submission of the curricula at a later date was suggested. The deadline of 30 December was suggested to provide more time for revision, consultation and finalization of the curricula. It was suggested that each AFF project country should attach the final FFS curricula to their Country Strategy Papers.

4.6.2. Session guides development

A number of session guides on each of the technical topics needed to assist farmers for making informed decision and implementation of area-wide IPM strategies were developed by the participating countries. As per the assignment given the preceding day, each country presented the session guides for critiques and comments for finalization.

Cambodia presented a session guide on 'identification of the fruit fly species (3 species, *B. dorsalis, B. correcta* and *B. cucurbitae*).

Dr. Prabhat Kumar commented that there should be a pictorial guide detailing the differences between the species. He further added that at farmer's level using the 'wings' is an easy way to tell the differences. He mentioned that currently there are two species (*B. dorsalis* and *B. cucurbitae*) described on the project's website and soon *B. correcta* would be added, too.

Laos presented a session guide on introducing biopesticides for management of FF**. Dr. Vijay** inquired whether at this stage when biopesticides are in experimental stage they should be integrated in IPM. **Dr. Prabhat Kumar** informed that as a part of the AFF project, the partner BCRL is undertaking a series of laboratory tests and later field experiments planned in India, Vietnam and in Nepal to establish efficacies and possible use of biocontrol agents. Until such time, the project should not focus much on biopesticides and remain focused on tested IPM strategies.

Myanmar presented a session guide on the life cycle studies for FF. **I**t was suggested that at farmer's level, focus of the study should be to work on visible stages (larval, pupal and adult). Observing the egg stage inside fruits would require microscopes which may not be a tenable option at FFS level training.

Vietnam presented a session guide on protein bait application studies at FFS/TOT. It is suggested that this session should be designed in the FFS/TOT well in advance of commencement of spray in IPM fields so that farmers and trainers understand the mode of action, limitations, and do's and do not's of using protein baits.

Thailand presented a session guide on natural enemies of the FF utilizing a cage experiment**.** It was suggested that for such studies the pre insect-zoo weighing of fruits are essential as to establish the number of parasitoids/unit weight of the fruit.

Philippines presented a session guide on the use of CUE and ME as trapping tools for pest monitoring purposes. It was suggested that different groups of farmers should handle the ME and CUE as to minimize any chance of mixing the two lures. Other pertinent points on designing local traps, etc. were also discussed.

China presented their session guide on artificial infestation of fruits by fruit fly. Process of oviposition and possibly egg laying would be an important part that farmers can learn from this exercise. Dr. Vijay suggested that, if available, star fruits are good for use for such studies.

Indonesia presented a session guide on fruit bagging. It was suggested that through simple experimentation with farmers group, efficiency of various local and suggested materials, cost and product quality could be easily evaluated at FFS. A good designed study would help farmers to understand the process and help them in selecting locally available best material for bagging. Similarly a different set of studies could also be carried out to help farmers understand the correct fruit development stage for bagging.

Bangladesh presented a session guide on sanitation. As a follow-up discussion several methods of sanitation and disposal of infested fruits were suggested.

Nepal presented their session guides on calculating and using FTD techniques. Purpose, method and finally evaluating the data were discussed.

4.7. Evaluations, wrap-up and closing ceremony

4.7.1. Evaluation of participants' Knowledge and Skills Development

An evaluation of the workshop participants was carried out to assess the increase in knowledge and skills on the various applied tropics covered during the workshop (see Annex 7 for test questions). Majority of the participants scored over 80% score in the tests indicating overall success of the workshop in meeting its objectives (see table below for more details).

Sl	Area (Skill and Knowledge on Fruit Flies)	Average scores	Remarks
1.	Diagnostics	>90%	3 AFF project species were well understood and majority of participants were able to identify and distinguish. It was also agreed that project would provide high resolution pictures of the wings and other visible marks to the trainers to be able to identify correctly
2.	Damage symptoms and nature	>90%	Similarly most of them were able to understand the nature of damage
3.	Life cycle, Biology and Ecology	>85	For some it was difficult to relate the various life cycle stages compare to others. Partly due to the fact that it was first opportunity. Therefore, more supportive reinforcement trainings are needed in this area.
4	Monitoring skills	>75%	More practice and experiences are needed as follow-up training
5	Management	>75%	Concepts are understood but practical experiences have yet to be acquired through field practice
6	Integration of management strategies and area-wide IPM concept	>70%	Require more follow-up trainings to strengthen ability to design and integrate area-wide management strategies

4.7.2. Evaluation of the workshop by participants

The *Itemized Response Technique* was used to evaluate the training. Participants were asked to answer three questions: 1) what went well; 2) what needs improvement; and 3) how can it be improved.

On the *Technical Aspect*, participants gave positive feedback on the expertise and facilitation skills of Resource Persons - especially **Dr. Vijay Shanmugam** - and learning about identification of fruit fly species as well the various management strategies (bagging, protein baits, sanitation, and biopesticides). The practical exercises were appreciated for having provided knowledge to participants through hands-on learning. One participant mentioned that the lectures and practical exercises were useful for future work on implementing FFS on IPM for Fruit Fly. The field visits were considered helpful in providing first hand information on real situation that farmers are confronted with. Ice breakers were evaluated as having contributed positively to the training. On the other hand, participants indicated the need for more hands-on and detailed procedures for management strategies such as how to prepare and use protein baits. This was noted as something that could be improved as to allow participants to be able to demonstrate the process to other trainers and farmers in their own countries. Some participants felt that knowledge on life cycle of fruit flies was not completely gained because they were not able to see the egg stage, whereas others saw the egg stages too. There were suggestions that life cycle insect zoos be prepared prior to the training as to allow participants to see the whole life cycle of fruit flies. One participant mentioned the need for practical exercises on insect box collection. The need for written instructions for home work was also mentioned as an area for improvement. Six participants specifically mentioned the need for a longer duration of the training course. On designing the curriculum, one participant mentioned that it would have been easier to integrate the project within the framework of FFS if the project sites that were visited were within FFS areas or where FFS graduates were participating.

On the *Organizational Aspect*, feedback was generally positive with participants indicating that the training venue, schedule, accommodations, food, transportation and interactions between participants-participants and participants-facilitators were good. However, three participants commented that there was a lack of equipment/materials (e.g., cutter, light).

There were also comments that the training venue was far from the hotel, the food was monotonous, participants were given a lot of homework and very little free time.

Suggestions for improvement included allowing participants to indicate their food preferences, not keeping participants from 0730hrs to 1900hrs, involving participants in developing the design of experiments and better time management as to be able to meet the programme of activities as scheduled. As to improve scheduling of activities, one participant suggested that activities be switched around so that experiments/field visits are conducted in the afternoon and classroom sessions in the morning. Three participants commented that the local organizer should prepare materials and the agenda for field work better. Also in connection with the field visits, a suggestion was made on making more translators available if interviews are to be carried out with farmers. One participant commented that computers should be made available for participants who did not have their own laptops. Two participants had mentioned that no handouts were provided to supplement the sessions so that sometimes participants could not catch up with the presentations and missed important points especially because some Facilitators speak fast and participants could not follow the discussions. There was a suggestion to provide a CD of the training when this is completed.

4.7.3. Closing ceremony

The closing ceremony was organized at the SOFRI meeting hall at 1700 hrs on 14th December 2010. The ceremony was presided by **Dr. Hguyen Minh Chau, Dr. Vijay Shanmugam, *Dr Nguyen Van Hoa*, Dr. Prabhat Kumar** and **Mr. Jan Willem Ketelaar.**

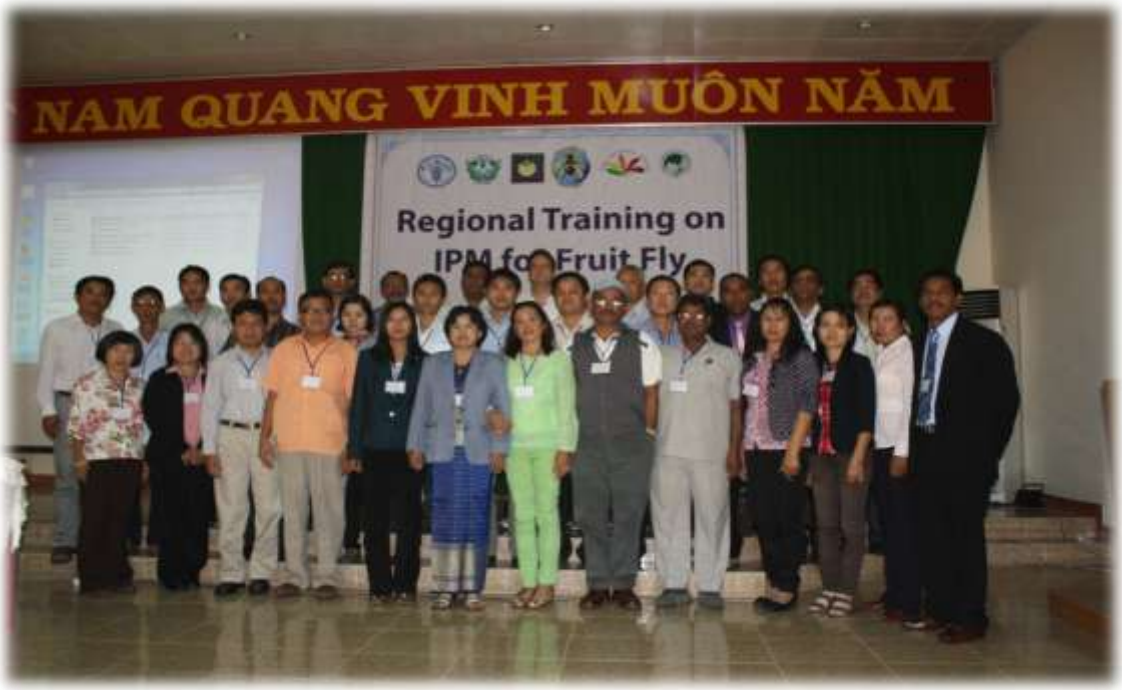
The ceremony began with a summary of the workshop by the Project Coordinator **Dr. Prabhat Kumar** who provided a synthesis of the workshop. He further highlighted the importance of each session, e.g., country presentation, importance of identification of fruit fly, study on life cycle, ecology and biology, management options like protein baits, bagging, and lures. He stressed that it is a new challenge for the IPM folks in the region to utilize and expand these knowledge to develop scientifically robust and socially beneficial FF IPM FFS for the smallholder/commercial fruit and vegetable producing farmers in the region for collective prosperity.

The project would soon be implemented. In the past six months, all the basic preparations have been completed, which by no means a small task is given the size of money and time available for the purpose.

The partnership of FAO and BCRL was also acknowledged. Finally he acknowledged the excellent support from **Dr. Vijay Shanmugam** and all individual scientists and support staffs including the Director and Deputy Director **Dr. Hguyen Minh Chau, *and Dr Nguyen Van Hoa* respectively,** from SOFRI for their excellent cooperation in the organization of the workshop. Before closing his remarks he assured all countries of full cooperation and support from AIT, Bangkok, Thailand in meeting the challenges of food, social and income security through sustainable agriculture technologies and extension.

Mr. Jan Willem Ketelaar spoke of cooperation and support from FAO-IPM for successful implementation of the project. **Dr. Hguyen Minh Chau** officially closed the workshop with good wishes to the participants in implementing area-wide FF IPM projects in the region. The distribution of certificates was followed by the closing of the training.

Annexes



Annex 1: List of Participants from AFF Project and other Asian Countries

Country	Name	Designation/ Organization	Email Address
Bangladesh	1. Mr. Muhammad Ashraful Islam	Master Trainer, DANIDA ICM Programme, DoAE, Bangladesh	kbd_ashraf@yahoo.com
Cambodia	2. Mr. Chhit Mak	Training Coordinator, FAO IPM	mak.faoipm@online.com.kh
	3. Mr. Hor Sophal	Provincial Coordinator , Kandal Province	faoipm.lira@online.com.kh
	4. Ms. Ly Yan	District Trainer Team Leader, Battambang province	faoipm.lira@online.com.kh
China	5. Mr. Xie Yiling	Section Chief, PPS Guangxi	gxfz@vip.163.com,
	6. Ms. Shan Lihua	Chuxiong city plant protection plant and examines the station	yncbfz@163.com
Indonesia	7. Mr. Cahyana Widyastama	Field Indonesia	wcahyana@yahoo.com
	8. Mr. Arief Lukman Hakim	Field Indonesia	arieflh@uni-bonn.de
Laos	9. Mr. Somkhit Sengsay	PPC IPM Intern	deang_deng007@yahoo.com
	10. Mr. Khanxay Somchanda	PPC IPM staff	khbombay2004@yahoo.com
	11. Mr. Phoukaothong Sykaisone	PPC IPM staff	ipmlaos@laotel.com
Myanmar	12. Ms. Kaythi Wai	Deputy Supervisor, MAS	ppmas.moai@mptmail.com
	13. Ms. Thin Thazin	Executive Member, MFVPEA	thinthazin.012@gamil.com
Nepal	14. Mr. Soorya Kanta Sapkota	Plant Protection Officer, Regional Plant Protection Lab, Biratnagar	c/o Arjun.Thapa@fao.org
	15. Mr. Anisur Rahman Ansari,	Senior Scientist, NARC	c/o Arjun.Thapa@fao.org
Philippines	16. Ms. Ludivina Dumaya	RCPC Region 12	ldumaya@yahoo.com
	17. Mr. Damaso P. Callo	Officer, Crop Protection, Bureau of Plant Industry	damesjr@yahoo.com

Thailand	18. Ms. Charuphan Hongsawat	Environmental Officer , Samutsakhon Provincial Administration	jeeraracute@hotmail.com
	19. Ms. Watchreeporn Orankanok	Director, Irradiation for Agricultural Development	watchreeporn@yahoo.com
	20. Ms. Arunee Chareonsaksiri	Agriculturist, DoAE Nakorn Nayok Province,	arunee2554@gmail.com
Timor Leste	21. Mr. Severino Sousa Costa	Head of Pest Section, Department of Plant Protection	severinosc@hotmail.com
	22. Mr. Serafin Rodolfo	Assistant Technical Department Crop Division	serafin_rodolfo@yahoo.com
Vietnam	23. Mr. Do Van Van	Southern Region Plant Protection Centre	ppdsouth@hcm.fpt.vn
	24. Mr. Nguyen Duy Khanh,	Northern Central Region Plant Protection Centre	
	25. Ms. Luu Thi Hong Hanh,	Forest Pest Management Division	
	26. Mr. Nguyen Van Hoa	Deputy Director, Southern Horticultural Research Institute (SOFRI)	hoavn2003@gmail.com
	27. Mr. Le Quoc Dien	Head, Training Center. SOFRI	dien72@hotmail.com
	28. Mr. Ho Van Chien	Director, South Regional Plant Protection Center	hvchien@vnn.vn
	29. Mr. Tran Van Hieu	Programme Assistant, FAO IPM Programme	tvhieuipm@vnn.vn
	30. Ms. Truong Thi Ngoc Diem	International Cooperation Department , (SOFRI)	ngocdiem281277@yahoo.com
Regional	**31.** Ms. Malvika Chaudhary	Senior Research Manager, Bio-Control Research Laboratory	malvika.chaudhary@pcil.in
	32. Mr. Prabhakara Seetharama Bhat	Researcher, Bio-Control Research Laboratory	prabhakara.ms@pcil.in
	33. Mr. Prabhat Kumar	Senior Research Specialist, AIT	pkipm@ait.ac.th
	34. Mr. Vijay Shanmugam	Consultant Entomologist	vijayseg77@gmail.com
	35. Mr. Jan W. Ketelaar	CTA, FAO Regional IPM Programme, FAO	Johannes.Ketelaar@fao.org
	36. Ms. Alma Linda Abubakar	Programme Officer, IPM Programme, FAO	Almalinda.Abubakar@fao.org

Annex 2: Schedule of the Regional Training

Date		Training Activities	Remarks
Mon 6 Dec		Arrival at Tien Giang	
Tue 7 Dec	Am 8:30-10:00	Opening Ceremonies • *Project Overview* • *Overview of FAO's IPM Programme in Asia* • *General Overview of Fruit Flies in Asia – species, life cycle, biology, crop losses and current management strategies*	**Dr. Prabhat Kumar, AIT** **Mr. Jan Willem Ketelaar, FAO-RAP** **Dr. Vijay Shanmugam**
	10:00-10:30	Tea break	
	10:30-12:30	*Block I: Country Presentations:* *Block I-a: GMS Country Presentations:* • Cambodia • Lao PDR • Myanmar • Thailand • Vietnam	**Chair: Mr. Jan W. Ketelaar**
	pm	***Block II-a: Fruit Fly Species Diagnosis, Biology and Ecology***	
		Laboratory work on identification of fruit fly species Practical work on setting up life cycle insect zoos (including inoculating "clean" fruits) and other studies to explore fruit fly ecology and biology, including host preferences and roosting behavior	**Dr. Vijay Shanmugam and Dr. Watchreeporn Orankanok, DoAE** **Dr. Prabhat Kumar, AIT**
		Welcome party hosted by FAO-IPM	
Rapportuer for the Day: Dr Prabhat Kumar ; Host Team: Cambodia and Bangladesh			
Wed 8 Dec	am	***Block II-b: Damage Symptoms Recognition and Assessment***	
		Collection of samples of fruit fly infested fruits and vegetables. Village walk and interaction with farm communities Processing of observations on occurrences, infestation and management practices	**2 groups: Sapodilla orchards** **One group to village not employing fruit fly IPM practices** **One group to village employing fruit fly IPM practices** **Guidelines for village walk to be provided**
	pm	*Block I-b: Other Country Presentations:* • Bangladesh • China • Indonesia • Nepal • Philippines • Timor Leste	**Chair: Mr. Jan W. Ketelaar**
Rapportuer for the Day: Dr Vijay Shanmugam ; Host Team: Laos and Indonesia			

Thu 9 Dec	am	***Block II-c: Management Options for Fruit Fly***	
		Practical work on collecting information from protein baits and different traps Processing information from field work to monitor fruit fly populations – including modifying the Agro Ecosystem Analysis as a tool for management decision making	Baits and traps previously established for learning purpose of participants: Participants to work in 2 groups: One group to collect information from Star apple and Sapodilla orchards One group to collect information from Cucumber and Bitter gourd fields **Dr. Prabhat Kumar, AIT**
		1 Traps and their use in fruit fly IPM (Methyl Eugenol and Cue-lure) Practical work on preparation of different traps Developing technical exercises to introduce traps and their use in fruit fly IPM in FFS (Home work to be submitted for review next day in English)	**Dr. Malvika Chaudhary and Mr. Prabhakara M.S, BCRL** **Chair: Dr. Vijay Shanmugam**
	pm	*2 Protein baits and their use in fruit fly IPM* Practical work on preparation of protein baits Dissections on adult fruit flies to show the difference between mature (protein fed) and newly emerged immature flies Checking and re-setting insect zoos; collecting information on life cycle experiments Developing technical exercises to introduce protein baits and their use in fruit fly IPM in FFS (Home work to be submitted for review next day in English)	**Dr. Nguyen Van Hoa, SOFRI** **Practical work to be carried out within SOFRI premises** **Dr. Ho Van Chien, SRPPC** **Chair: Dr. Vijay Shanmugam**
Rapportuer for the Day: Dr Malvika Chaudhary *Host Team: Vietnam and Philippines*			
Fri 10 Dec	am	*3 Sanitation measures as a fruit fly control strategy* Practical work on implementing sanitation measures *4 Bagging and its use in fruit fly IPM* Practical work on bagging (using bags of different materials – newspaper, cloth, plastic, etc.)	**Mr. Le Quoc Dien, SOFRI** **2 groups: Star apple orchards** **Compare fruits from gardens where bagging is practiced and where it is not (using different kinds of bags)**
	pm	Checking and re-setting insect zoos; collecting information on life cycle experiments Practical work on collecting information from protein baits and different traps Processing information from field work to monitor fruit fly populations for management decision making Developing technical exercises to introduce sanitation measures and bagging and their use in fruit fly IPM in FFS Take-home work: Designing Farmer Field Studies on Fruit Fly IPM	**Dr. Ho Van Chien** **Dr. Nguyen Van Hoa** **Practical work to be carried out within SOFRI premises** **Dr. Ho Van Chien** **Chair: Dr. Vijay Shanmugam**
Rapportuer for the Day: Dr Nguyen Van Hoa ; Host Team: Thailand and Nepal			

Sat 11 Dec	am	*5 Conservation and augmentation of natural enemies of fruit flies (*discussions to take off from insect zoo results) *6 Biopesticides and their use in fruit fly IPM*	**Dr Prabhat Kumar** **Dr. Malvika Chaudhary and Mr. Prabhakara M.S, BCRL**
	pm	*7 Sterile Male Technology for fruit fly management* Practical work on collecting information from different traps Processing information from field work to monitor fruit fly populations for management decision making Checking and re-setting insect zoos; collecting information on life cycle experiments Developing technical exercises to introduce biopesticides and their use in fruit fly IPM in FFS Visit to SOFRI VHT facilities Take-home work: Designing Farmer Field Studies on Fruit Fly IPM (cont.)	**Dr. Watchreeporn Orankanok** **Dr. Ho Van Chien** **Practical work to be carried out within SOFRI premises** **Dr. Prabhat Kumar** **Dr. Ho Van Chien** **Dr. Nguyen Van Hoa** **Chair: Dr. Vijay Shanmugam**
Rapporteur for the Day: Mr. Le Quoc Dien *Host Team: Myanmar and Timor Leste*			
Sun 12 Dec	am	Visit to area-wide Fruit Fly management programmes: Define area-wide management and how FFS farmer training can be applied in area-wide management of fruit fly	**2 groups:** **One group to visit Dragon Fruit fields** **One group to visit Barbados cherry fields**
	pm	Visit to facilities for producing protein baits	**Briefing will be done in one group after which participants will be divided into three groups for touring the facilities.**
Mon 13 Dec	am	***Block III: Design of Area-wide Best-bet Management Strategies for Fruit Fly***	
		From FFS to area-wide management: Discussions and designing a community-wide fruit fly management programme (A pre-requisite is the summary of baseline information and crop calendars from the key areas where implementation will take place.)	**Dr. Prabhat Kumar**
	pm	Designing a community-wide fruit fly management programme (cont. and also refer to Farmer Field Studies designed in earlier sessions as well as how to monitor populations of fruit fly) Presentations on community-wide fruit fly management programme	**Chair: Dr. Vijay Shanmugam**
Rapportuer for the Day: Ms Alma Linda Abubakar Host Team: China and Philippines			

		Block IV: Training Curriculum and Materials Development	
Tue 14 Dec	am	Presentation of exercises and curriculum for ToT/FFS	Chair: Ms. Dada C. Morales-Abubakar
	pm	Report out on results of observations from monitoring tools and insect zoo observations on life cycles, parasitization and parasitism levels Evaluation and course wrap up Closing ceremony Farewell party by Director SOFRI	Including insect zoos on parasitization and parasitism levels previously established for learning purpose of participants Dr. Prabhat Kumar and Dr. Ho Van Chien
Rapportuer for the Day: Dr. Ho Van Chien *Host Team: Vietnam and Bangladesh*			
Wed 15 Dec	**am**	**Departure of participants**	

Annex 3: Output of the Sapota field visit

IPM group	Non IPM group
a) Farmers practice • Only pesticides & traps with pesticide (pre IPM) • Know the key ff species • Use trap with Pesticides • YST • Monitoring using ME; if population more than FTD > 10 – use protein baits • 30 farmers in one group • 50-90% damage pre IPM, down to 10% after adapting IPM b.) Fruit damage • 23 fruit Damage based on external symptoms – dissection confirmed 9/100 (9%) • Fruits collected from tree	a.) Farmers practice • 3 ha; 10 yrs old • FF, F borer, Mealy bug • He knows FF • Used chemical baits, ME traps, pesticide; 2 times per month spray • Rainy season peak population • 50% loss • Cypermehtin & Fipronil • No other control • Export to China & aware about bad effects of chemicals b.) Fruit damage • 43 fruit Damage based on external symptoms – dissection confirmed 4/100 (4%) • Fruits collected from ground

Additional notes:

- Both groups of participants learnt how to recognize fruit fly oviposition marks on sapota fruits which manifested as white latex oozing from the stings. Farmers practicing IPM used these symptoms to collect and destroy such fruit to prevent fruit fly breeding in their orchards (sanitation). Non-IPM farmers did not practice such sanitation.
- IPM farmers only needed 2 rounds of spot protein bait spot sprays to control fruit flies whereas non-IPM farmers applied methamidophos cover sprays twice per month with up to 20 applications per year to control fruit flies in their orchards. They also experienced many health problems such as eye and skin irritation when using insecticide cover sprays.
- In the laboratory the damage recorded on sapota from IPM farms was 9 % and non IPM farms were 4 %. However, the fruit collection between the 2 groups was not standardized as some collected fallen fruit as well as fruit from the trees. Participants clearly understood the many advantages of IPM over non-IPM based sapota production.
- For the purpose of establishing the percent infestation, fruits should be collected randomly either from tree or from ground; They should be collected from more than one site from same location
- Once in a month/ Continuous fruiting – once month. Seasonal fruits two times towards the end of the season; Calculating percent infestation and also number of FF adults/larvae per unit weight are one of the important monitoring methods that could be easily adapted in the FFS/TOT for accessing efficacy of IPM along with adult traps by ME/CUE on weekly basis.

Fly per Trap per day (FTD) = Total number of flies in all traps / no. *of traps used x no of days traps were in the field)*

Annex 4: Output of the trapping with ME and CUE

Methods and Materials

- Bottle traps baited separately with Methyl eugenol (ME) and Cue Lure (CUE) impregnated into small wooden blocks were placed in 2 locations - 1) Fruit farms and 2) Vegetable farms
- A small amount of insecticide was added to the blocks to kill attracted flies
- Traps were hung in pairs – 1 ME and 1 CUE with 3 replicates in each area

	Fruit Area				Vegetable area (all *cucurbitae)*			
	ME		CUE		ME		CUE	
	Dorsalis	*correcta*	*cucur*	*oth*	*dors*	*corr*	*cucur*	*oth*
Replication								
1	1	0	0	0	0	0	0	0
2	0	1	0	0	0	0	1	0
3	4	0	0	0	0	0	13	0
Total	5	1	0	0	0	0	14	0
FTD	1.6	0.33	0	0	0	0	4.6	0

FTD = Flies / trap / day = $\frac{\text{Total number of flies trapped}}{\text{Number of trapping days x Number of traps}}$

Additional notes:

Trapping of fruit flies is carried out in an IPM program for 2 reasons:

1) For measuring or monitoring fruit fly populations in an area
   - Usually we use dry traps baited with ME or CUE for male flies
   - Can also use wet traps with liquid lures to attract males and female flies. Commonly used wet baits are protein solutions, fruit juices/essence. But wet traps are difficult to service and need regular cleaning. Flies from wet traps decompose rapidly and are difficult to count and identify. But are useful if counts of female flies are needed.
2) As a control measure
   - Most commonly used are ME or CUE blocks (wooden or other materials) with insecticide added (malathion, fipronil, chlorpyriphos) to kill the flies
   - In area wide programs, the blocks are usually used (at 50 meter intervals) without any cover to achieve low cost. Covered blocks or blocks placed within traps can be used if they are cheap enough.

Annex 5: Output of the protein bait hands-on exercise

Materials and methods

- 200 flies per cage (two groups of participants)
- Flies age: 5 weeks old; 1 week old
- Concentration: 100 ml protein + 4 ml Regent (fipronil) 5% + 1 lit water

	Cumulative Number flies death	
Observation	*B. dorsalis* (cage 1) – 1 wk old adults (initial total no. 197)	*B. dorsalis* (cage 2)-5 week old adults (initial total no. 195)
5 minute	0	2
10 minute	0	2
15 minute	0	0
20 minute	0	116
40 minutes	94	172
60 m (total)	**121 dead 79 alive**	**All 200 dead**

Out of 30: 16 female + 14 Male 34 = 17 female+17male

Almost 1:1 ratio (male to female)

Annex 6: Output of the fruit bagging session

Crops	Age of bagging	Material suitable	Days from pollination to harvesting
		Fruits	
Guava	45 days after fruit setting	Plastic bags (small two holes to release water at the bottom)	120 days`
Star fruit	Two weeks after fruit setting	Big size news paper bags 30x20cm	60 days
Mango	30-45 days after flowering	Cotton/brown paper/ yellow paper (strong and thin paper used telephone directory paper bag	90-120 days
Marian plum	50DAP	Newspaper	75 days
Milky fruit (star apple)	45 DAP	Cotton bags	130
Jujube			
Wax apple	15 days	Plastic/ straw bag	60
Pomelo	60 days	Cotton bag	270
Banana	20 DAP	Newspaper	32
Sathon	30DAP	Newspaper	120
		Vegetables	
Bitter gourd	7 DAP	Newspaper/plastic	30days
Cucumber	-do-	-do-	Depending on the variety
Squash	-do-	Plastic	30

Annex 7: Knowledge & Skill Development Evaluation Exercise

Regional Training on IPM for Fruit Fly
Tien Giang, Vietnam, 7-14 December 2010
Knowledge & Skill Development Evaluation Exercise

Name: Country:

Total Score:

Instructions: Please fill out name and country above. Please encircle the correct answer! You will have one minute to answer each question. Good luck!

Q1: This Bactrocera fruit fly adult is identified as:

A. *B. dorsalis* B. *B. cucurbitae* C. *B. correcta*

Q2: This fruit is likely infected with

A. *B. cucurbitae* B. *B. dorsalis* C. *B. correcta*

Q3: These fruit flies can be identified as the following species:

A. *B. dorsalis* B. *B. correcta* C. mix of *B. correcta* & *dorsalis*

Q4: This fruit is likely damaged by:

A. Oriental fruit fly B. cucurbit fly C. fruit borer

Q5: Duration of the fruit fly life cycle is generally:

A. 12-14 days B. 20-25 days C. 35-40 days

Q6: The pupa of the fruit fly is normally found:

A. On leaves B. Inside fruits C. In soil

Q 7. For artificial fruit infestation study of Fruit Flies, one needs

A. Only sugar B. only water C. Sugar and water

Q8: The methyl eugenol lure attracts the male adult flies of the following species:

A. *B. dorsalis* B. *B. correcta* C. *B. cucurbitae* C. mix of *B. correcta* & *dorsalis*

Q9: The Cue Lure attracts the male adult flies of the following species:

A. *B. dorsalis* B. *B. correcta* C. *B. cucurbitae* C. mix of *B. correcta* & *dorsalis*

Q10: If you find a total of 50 adult flies in 5 traps after 2 days of setting up the traps than the FTD count is:

A. 50 B. 25 C. 10 D. 5

Q 11. The protein baits attracts

A. Only male B. only female C. both males and female

Q12: The best-bet area wide fruit fly management strategy to be employed within the context of the AIT/FAO fruit fly management project will likely be:

A. Sanitation, lures & protein baits for adult fly control B. Sanitation, protein baits and lures for monitoring only C. Sanitation, protein baits & bagging

Q13. Bagging of all fruits should be done at

A. 1 week after pollination B. 2 weeks after pollination

B. 3 weeks after pollination D. depends on fruit variety

Q 14. Which of the following stage of fruit flies are normally parasitized by parasitoids?

A. Only egg B. only larval C. only pupal D. only adults

E. Eggs and larvae

Q 15. Protein bait spray on cucurbits should be carried out on:

A. Every row plants B. Every plant C. alternate row D. Alternate

Q. 16 Protein baits spray on fruit trees in an orchard should be applied to:

A. Every second tree B. Every third tree C. Every tree

Q. 17. The recommended volume of spot spray is:

A. 100mL B. 50mLC. 25mL

Q. 18. The recommended volume of protein bait spray to be applied weekly per hectare of crop is:

A. 50-100 liters B. 25-50 liters C. 10-20 liters

Q.19. The best time to apply protein bait is

A. At night B. Early in the morning C. Late in the afternoon.

Q.20. After handling ME and CUE blocks, wash your hands with

A. Soap and water B. Oil C. Alcohol first, then soap and water

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