Case Studies

Part 1

BANGLADESH

Case Study1: Adoption of Integrated Pest Management (IPM) Practices and Empowerment of IPM-FFS Farmers

1. Background

Intensive cropping to increase rice production in Bangladesh has resulted in the high chemical inputs. This has produced negative impact on human health, soil and environment. An alternative way to deal with pest problem that reduces pesticides inputs is known as Integrated Pest Management (IPM). On the other hand, application of pesticides to combat pest-damage increases the direct risk of environmental pollution, increases selection pressure for insecticide resistance both in target and non-target pests and often reduces the abundance of beneficial, thereby contributing secondary pest outbreaks. It is imperative to develop environment friendly, economically sustain and socially acceptable program for our country to cut down the expenditure on chemical pesticide.

2. Intervention rationale and objectives

Enhancing environmental literacy is one of the goals of IPM-FFS (Integrated Pest Management-Farmer Field School). IPM-FFS encourages farmers not to spray unless pest thresholds reach a damaging level. This is an informal learning approach where "classroom" is the farmers' own field, and "content" to be learned comprises interrelated components of that field. The Farmer Field School (FFS) approach is a tool developed to improve farmers' livelihoods through adoption of IPM practice and empowerment. IMP-FFSs are season-long, field-based groups of 25 farmers, who meet regularly (once a week) to learn together through discovery and experience. FFSs ensure a convergence between local and scientific knowledge and aim to make farmers better decision-makers.

Even though FFS are applied for a variety of objectives: to grow a healthy crop, to observe the field regularly, to conserve on natural enemies and to make farmers (IPM) experts on crop production. The Farmer Field School (FFS) approach is a form of adult education, aimed at building farmers' decision making capacity through discovery learning. It is an innovative tool to facilitate interactive learning. This case study was conducted to analyze the implementation on the FFS approach of IPM 2nd phase project during July 2010 to June 2013. The main objectives of this study:

1) to compare IPM knowledge of IPM-FFS farmers between before and after joining the FFS
2) to identify adoption practices in IPM-FFS farmers
3) to find out the empowerment areas of FFS farmers.

3. Process and methodologies used

Case study was carried out on IPM-FFS in rice of IPM 2nd phase project in Valuka Upazila (sub-district) under Mymensingh district. Data collection method was Purposive/Recall Method. Data were collected randomly using structure closed ended questionnaire from 10 FFS farmers out of 25 farmers of a Farmer' Field School. 10 Samples were collected. Data were collected on Socio-economic and Demographic profile, Knowledge on IPM, Adoption of IPM Practices, Decision-making process of IPM-FFS Farmers etc. Then data were analyzed with help of master table and were presented in tabular form.

4. Results and outcomes

The case study was conducted to observe the adoption of IPM practices and empowerment of IPM-FFS farmers. The results and outcomes of the present case study are presented in the following headings:

4.1 Adoption of IPM Practices

The adoption of IPM practices by the farmers was significantly higher after joining FFS compared to before joining in the FFS. The area under higher adoption (100%) was use of balanced fertilizer, synchronized crop production,

Table 1: Adoption of IPM Practices

SL No	Practices	Practice followed by the farmers			
		Before FFS		After FFS	
		No	%	No	%
1	Use of pest resistant variety	0	0	9	90
2	Use of balanced fertilizer	0	0	10	100
3	Synchronized crop production	0	0	10	100
4	Transplanting healthy seedlings & line sowing	3	30	10	100
5	Perching for insect eater bird	0	0	10	100
6	Use of bio-pesticide	0	0	9	90
7	Ails cropping	2	20	10	100
8	Surveying before using chemicals pesticides	0	0	10	100
9	Judicious application of pesticides	0	0	10	100
	Total Average	0.5	5	10	100

transplanting healthy seedlings & line sowing, perching for insect eater bird, surveying before using chemicals pesticides, ails cropping and judicial application of chemical pesticide (table1) followed by use of pest resistant variety and bio pesticide (90%). The result revealed that the adoption of IPM practices before joining in the FFS was very limited. The area under adoption was transplanting healthy seedlings & line sowing (30%) and ails cropping (20%) before joining FFS. Before joining FFS only 5% farmers adopt IPM practices, whereas after training through FFS 100% farmers adopt IPM practices in their own field.

4.2 Decision-making process

Decision-making process for empowerment of the farmers was drastically increased after joining in the FFS. The findings showed that the farmers before joining FFS had no role or passive role in decision-making areas. On the other hand, the decision-making process among the farmers was quite reversed after joining FFS. Most of the farmers had active role and few farmers had passive role in decision making process after joining FFS.

The areas under 100% farmers had active role in decision making process were use of quality seed, use of balanced fertilizer and judicial application of chemical pesticides followed by the farmers (90%) under the area of developing annual crop production plan and variety selection for cultivation(table 2). These drastic changes in decision making process might be the causes of IPM training and adoption of IPM practices in FFS.

Table 2: Decision-making process

SL no	Decision-making Area	Decision-making Scale* (N0)					
		Before FFS			After FFS		
		0	1	2	0	1	2
1	Developing Annual Crop Production Plan	10				1	9
2	Variety selection for cultivation	10				1	9
3	Use of quality seed	9	1				10
4	Use of seedling at proper age	10					10
5	Use of balanced fertilizer	10					10
6	Line transplanting of seedlings at proper age	8	2			2	8
7	Roguing of off type plant	10				3	7
8	Harvesting of rice crop at appropriate ripening stage	10				3	7
9	Analyzing the field situation before spraying	10					10
10	Using appropriate pesticides for pest management	10					10

* 0= No role, 1= passive role, 2= active role

5. Lessons learned

- Adoption of IPM practices and empowerment of IPM-FFS farmers had been increased due to positive intervention of IPM-FFS under IPM 2nd phase project of DAE.
- IPM-FFS farmers have an active role in decision making process on crop production specially in pest management.
- The bad effect of chemical pesticides on beneficial insects, human health, environment, pest resurgence and pesticide residue remained in crop had been believed by the FFS farmers after joining FFS.
- IPM-FFS approach is an effective tool for adoption of Integrated Pest Management (IPM) Practices and empowerment of IPM-FFS Farmers.

CAMBODIA

Case Study1: Story of Mr. Kuok Keuk

Mr. Kuok Keuk is 57 years old (in 2004), has 5 children and lives in Chamkar Lok village, Oprasat commune, Mongkol Borey district, Banteay Meanchey. Since 1970 he and some other farmers in the village grow vegetables on a total area of 10 hectares. Before he attended the FFS he produced vegetables using a lot of chemical fertilizers such as Urea, DAP and 16-20-00. He also used a lot of insecticides such as Folidol, DDT, Pestop, Giant, Padan, Phosdrin, Delfin and other products of which he did not know the names. He complained that his health became bad as a result of using too many highly toxic pesticides, but that he had to use them because he believed he could not get any harvest if pesticides were not applied. He mentioned that he has spent a lot of money on chemical fertilizers and pesticides on his farm and also spent a lot of money on health treatment.

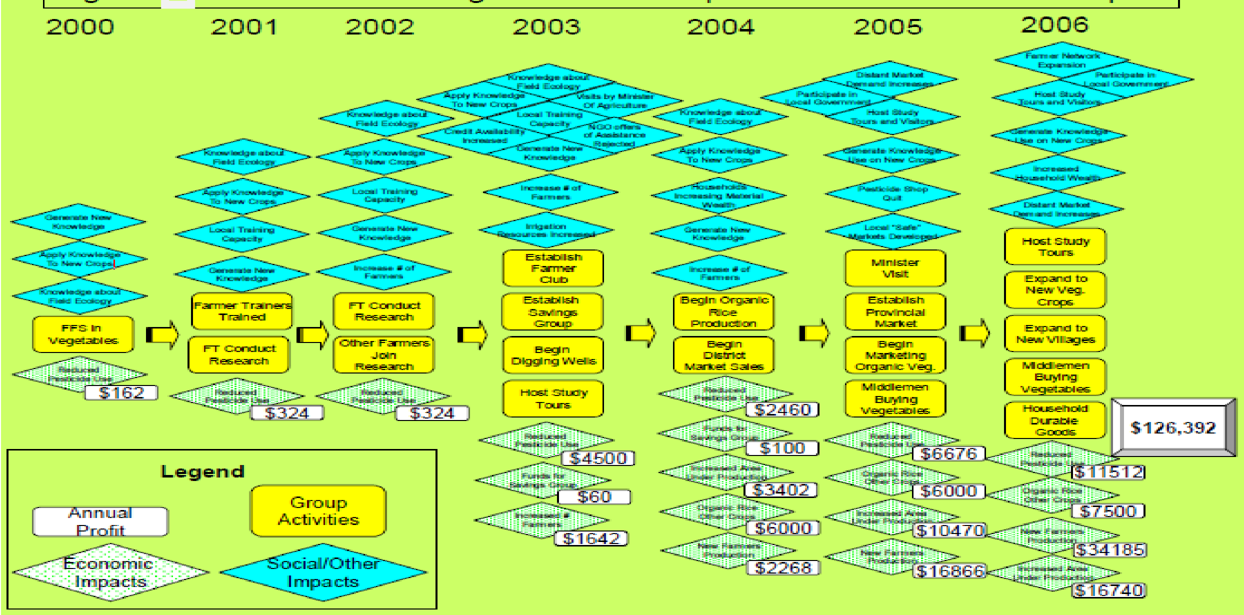
Mr. Kuok Keuk attended a Farmer Field School on vegetables in 2000 funded by FAO-IPM. He was not totally convinced of the benefits immediately after the completion of the FFS, but he kept trying what he had learned in his field. In 2001 he was selected to be trained as IPM farmer trainer. As farmer trainer he has conducted FFS together with the district trainers and at the same time he conducted many field experiments especially on using botanical and biological insecticides and mechanical control to deal with pest problems and on using organic fertilizer such as compost and cow manure. He observed that non-chemical methods could effectively control harmful insects but had little effect on natural enemies, while the organic fertilizer improved the soil fertility. He also recognized the role of beneficial animals as his friends in keeping the balance of the ecosystem. Nowadays he grows vegetables without using any chemical pesticide and uses only a limited amount of chemical fertilizers. He is in the process of converting his farm to grow organic vegetables. Neighbouring farmers have learnt from his experience and together they have formed an IPM club. Ten of the farmers grow vegetables without using any chemical pesticides, while the other 9 members reduced the application considerably. They sell their pesticide-free vegetables at the local market, but recently the Department of Agriculture, Forestry and Fisheries in Banteay Meanchey helped them to establish a market outlet in Sisophon town. He appreciated that IPM has helped him and farmers in the village to increase their income, improve their livelihood as well as health and environment conditions. Prestigiously, he was recently awarded a silver medal by Samdach Prime Minister Hun Sen as an outstanding IPM farmer growing vegetables without chemical pesticides.

Case Study 2: Chamkar Lork IPM Vegetable Club

The data in Figure 1 is Case Study from Or Prasat Commune, Mongkul Borei District, Banteay Meanchey Province from 2000-2006. By observing the colored legend denoting the impacts over time for the Chamkar Lork group the impacts are evident. The yellow boxes in the center area indicate major "events" or activities according to the farmer group. The diamond boxes in green (below) represents sources of new income while the accompanying white boxes provide the annual increase amount in profit in US$. The blue diamonds (above) represent 'non-economic' impacts. The original FFS on vegetable was facilitated in 2000 for 30 farmers on tomatoes of which only 9 farmers graduated.

The other 21 farmers were disillusioned by the FFS as they came to learn about which pesticides to use, not how to reduce their use. Only minimal gains (total of $162) were made by the nine participants from pesticide reductions. Next year the graduated farmers applied what they

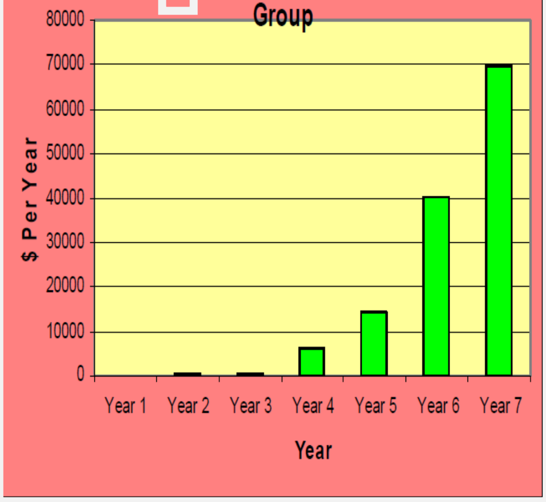
Figure 1 Chamkar Lork Village Farmers Group Evolution and Economic Impact



learned to onions, a crop with higher market value and greater pesticide use than tomatoes. In 2001, three of the graduated farmers received further training to become Farmer Trainers, providing them increased skills to carry out their own research to generate data and solutions. Farmers conducted experiments in 2001 and 2002 in order to find ways to further reduce pesticide inputs in onions by 50% in 2002 and by 80% in 2003.

Motivated by the increased profitability as a result of successful pesticide reduction strategies the farmers began to develop irrigation resources which allowed for cultivating 4 crops per year. They also began to cultivate a greater variety of vegetable crops. More farmers became interested increasing the group membership to 30 farmers by 2006. But the highest economic impacts did not come from the group members: farmers from neighboring villages began taking advantage of the new markets for pesticide safe crops which developed as a result of the original group's work and jointly marketed their produce (Figure1)! Conclusion: If one were only to look at the economic impacts associated with pesticide reductions during the first 1-3 years following the FFS the levels of impacts would already appear significant but would not see that the most significant economic benefits are those which would begin years later. The greatest economic benefits are later 'leveraged' by the non-economic impacts which began in the first year and continue to accumulate and build over time. Unlike economic benefits which grow over time, non-economic benefits begin accumulating

Figure 2 Annual Benefits To Farmer Group



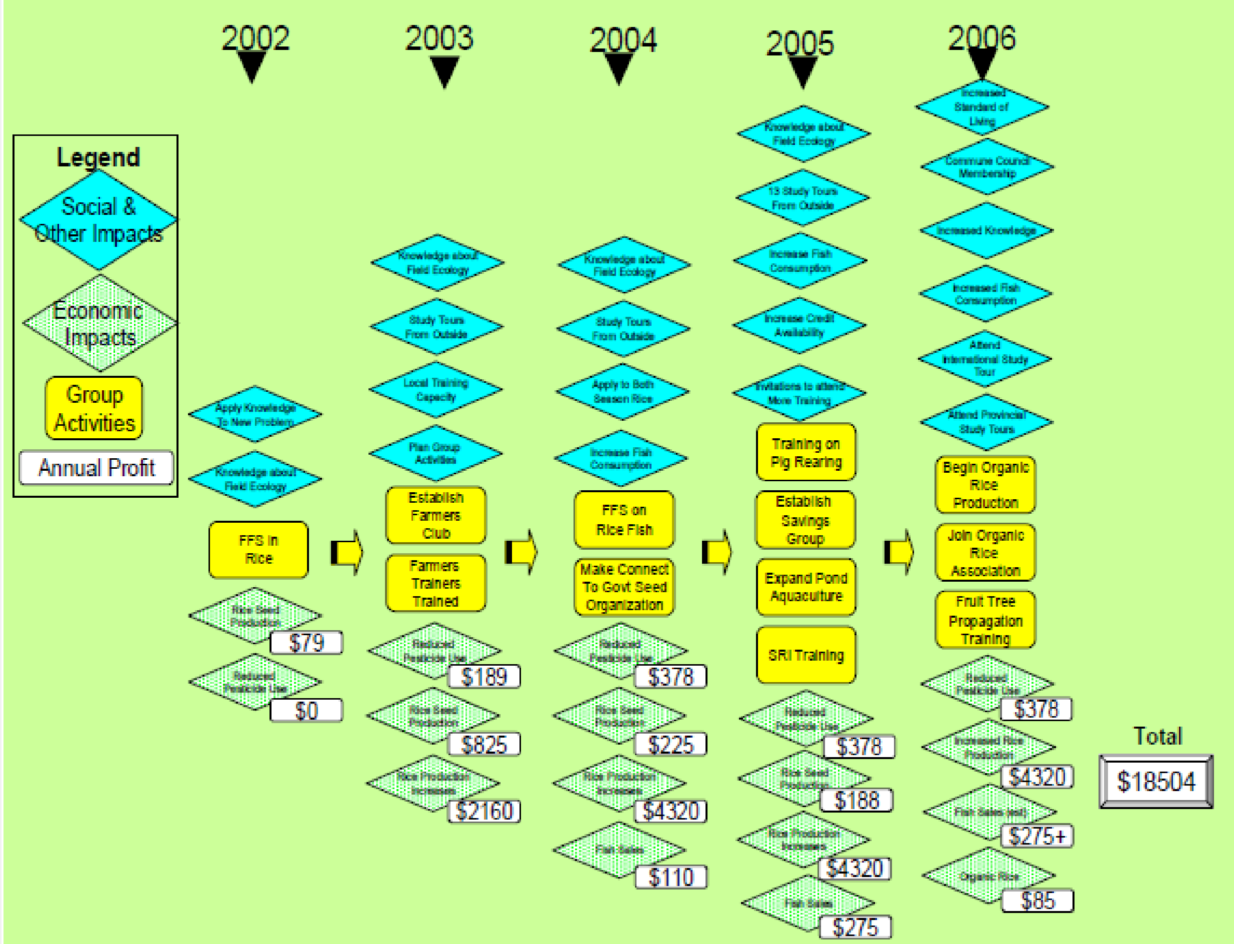
immediately and substantially after the FFS. These non-economic benefits (increased knowledge, field trials, training capacity, access to credit, group formation/strength, leverage with local government and NGOs, access to 21 markets, etc.) appear to be responsible generating future economic benefits, currently at $70,000 per year and increasing. (Kevin Kamp 2007)

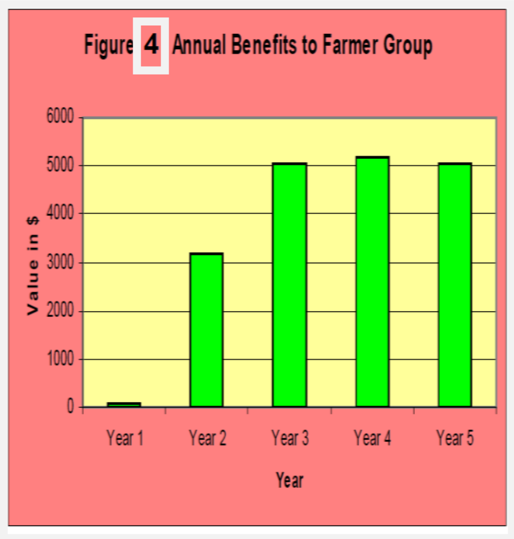
Case Study 3: Cheung Chab IPM Farmer Club

Figure 3 represents the data collected in Case Study from Kork Balaing Commune, Mongkul Borei District, Banteay Meanchey Province. It began with an FFS in rice in 2002 for 30 farmers. Much like the previous group in Or Prasat Commune, it is easy to see how the impacts have multiplied through apparent synergistic effects over time. While the impacts for the entire group in the first year were minimal ($79 for the group) the subsequent years resulted in increased economic and noneconomic impacts accruing to participating 22 farmers. Increases in financial returns over time can be easily seen in Figure 4. From an FFS with a focus on reducing pesticide use and increasing rice productivity, the farmer group members began exploring rice seed production, fish cultivation, pig rearing, fruit propagation and organic rice production. Farmers joined an organic rice farmer network and began participating in study tours to other provinces and even outside Cambodia to learn from farmers in Thailand.

From the initial impact of $79 from rice seed production, it soon increased to more than $5000

Figure 3 Cheung Chab Farmers Group Evolution and Economic Impact





per year for the group with the potential for further increases as the farmers gained greater skills,

knowledge, access to information and empowerment. It is very possible that the skills the Kork Balaing farmers have developed will be transferred to the organic rice group, which has 262 members from 24 farmer clubs which may result in additional benefits in the future. Much like the Chamkar Lork group, the financial gains increase over time. But in this case they came on a bit faster, maybe because the crop was rice, one they were very familiar with and for which mature markets already existed. (Kevin Kamp 2007)

Case Study 4: Story of Mr. Phorng Ten family

Mr. Phorng Ten, 48 years old (in 2015) as IPM farmer, and his Ms. Chhorn Som Eath, 36 years old (Tel: 855-77 528 929), has 2 children within 1 female. He was born in Kampong Chhnang province (he was orphan since child). After marriage, he has lived in Kor Kuor village, Chrey Commune, Thmor Koul district, Battambang province there no space for cultivation so his take ancient hill called "Tuol Prasat" for 9 years ago for growing vegetable crops, because of water availability year round, both dry and wet season.

Before being trained by IPM, he lived in poor condition and his health worst and worst, because growing vegetable crops follow conventional methods using a lot of chemical pesticide and got low yield. He took loan every year for growing the crop and spending in his family, because he did get enough income from farming. During that time, he faced with following problems in his vegetable production:

- Cultivation: Land preparation did not appropriately prepare and increase pest population. Variety selection unclear history and no technique for clean seed and had many seed borne diseases. He rarely got high yield and moreover, he usually got low price, because of crop selection did not match with the demand in the market.
- Insect Pest: He thought that chemical pesticide was the only way to solve these problems. He followed neighbors and pesticide seller who have no pest management background and never cultivation. So that, he usually got the very low profit and sometime he lost and crop because of pest outbreak.
- Disease: He was depend on chemical pesticide measure to cure all diseases, bud most of the time no effective, and sometime he got very yield.
- Chemical fertilizer: He doesn't know about elements in the chemical fertilizer and function of those elements for crop development. Sometime he excessively used them and made the crops stress and got low yield.
- Chemical pesticide: He thought that only chemical pesticide is the most effective measure to control pests without considering his health. He normally prayed pesticides without protective equipment any mixed 3-5 kinds of pesticide and spray every two or three day to control pests in Chinese kale, cauliflower and other crucifer crops production. He spent a lot of money on chemical pesticide and cure his health when he got poison.

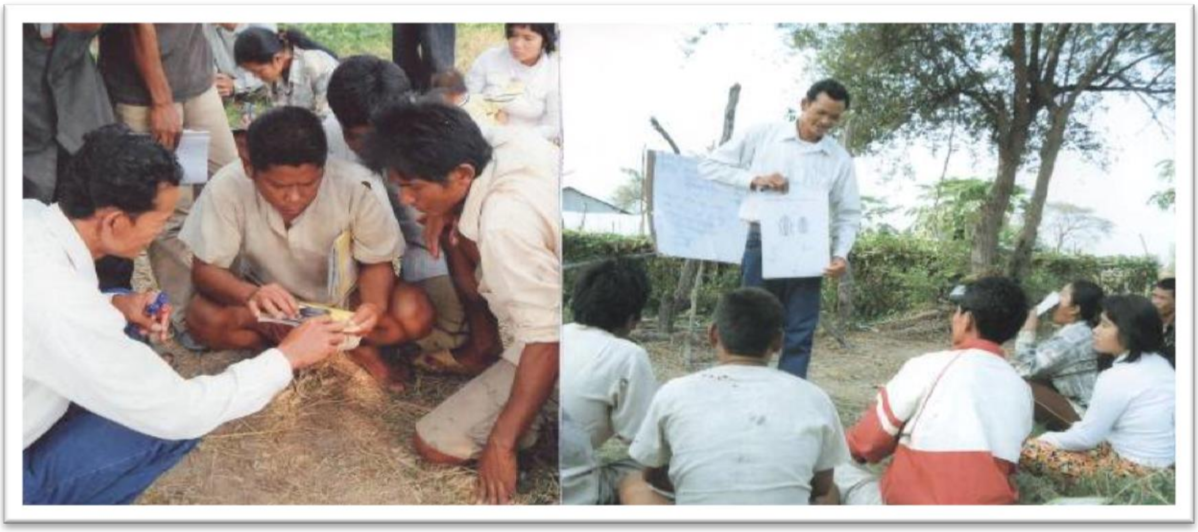
He is spraying chemical pesticide without wear protect tool. He just wear cotton scarf and T-shirt only

He is mixing chemical pesticide in the plastic tank and then stirred by hand without wear protect tool.

Health issue: He got several health problems, because he applying a lot of high hazardous pesticide with protective equipment. Although no insect in the field, he also sprayed chemical pesticide to prevent pests. He had several kinds for sickness and skin diseases until he could not spray chemical anymore and his wife spray pesticide instead of him.

Due to having a lot of problem in vegetable production at Tuol Prasat, in dry season 2010-2011, IPM Trainers conducted Farmers Training on Pesticide Risk Reduction through FFS, funded by FAO-IPM. In FFS begin process from Dec 31, 2010 to Apr 08, 2011 that has 25 participants including Mr. Phorng Ten. He studied on:

- Land preparation, soil-nutrient management and planting methods
- Seed treatment and pest management/control methods using alternative methods to chemical pesticide.
- Natural enemy and conserve them in vegetable fields
- Compost and liquid compost making as well as botanical pesticides for controlling pests.
- Field analysis through Agro-ecosystem analyses for making appropriate decision to manage and control the crop.
- Attractant trap and sticky trap.
- Hazard of chemical pesticide and health exercises on how to reduce pesticide risk.
- Economic analysis



This pictures that Mr. *Phorng Ten* participated

In wet season 2011, he continued to study in Post-FFS activities to learn deeper on crop management and pest management as well as the hazard of the chemical pesticides in order to minimize risk of pesticide and maximize yield and profit as well as health benefit. He also learned more on how to conduct research in his farms.

F

After finished study in FFS and Post-FFS activities he has applied all knowledge and skill gain from the training into his fields successfully.

- His vegetable products get high yield and higher price, because he has grown based on market demand and his produce is safe for consumers.
- Production cost expenses have been reduced especially chemical pesticide and chemical fertilizer. He has used botanical pesticide and more organic fertilizers.
- Chemical pesticide utilization reduction about 90%. His wife use soft pesticide product in case need such as Bt or Abamictin. She normally try to avoid the exposure to pesticide while using it, because she understand clearly about the hazard of chemical pesticide.

- He has applied more organic fertilizer and liquid compost. He uses more liquid fertilizer made from pineapple. In this wet season 2011, he applied liquid fertilizer made from pineapple 40cc/20 liters of water, every 4-5 days/once, and his Chinese kale grow very healthy 3 plants/2 kg that some consumers thought that his crop overuse plant stimulant. He explain his costumers very well about what he applied in the vegetable production only organic and liquid fertilizer learn from IPM Trainers and invited some consumers to visit his field. Especially, when they try to cook in restaurant showed that vegetables soft and good taste. Every trader and consumer were subscribed and bough all the produce for selling to sell in Battambang and Poi Pet.
- He produced botanical pesticide using local recipes for managing/controlling insect pests. He used Trichoderma spp for controlling soil borne diseases. He has also use attractant trap to collect the Diamond back moth and the moth of army worm. It is very effective trap, and every IPM farmers in the area apply it. Some vegetable growers in other villages also learn from him for applying in their fields.

This picture Mr.Phorng Ten and his wife set up butterfly trap in the field.

In the case study have 2 events in his household as real case:

- He stop using chemical pesticide almost 100%. When his wife went to Battambang province and met the pesticide shop owner "Long Khen" who she bought pesticide before, then owner shop asked to her on “why you never buy chemical insecticide long time". She replied, she stopped use chemical insecticide because she used attractant trap to collect moths and botanical pesticide. She has applied liquid fertilizer made from pineapple to spray in the field and crops grown healthier resistant to pests. She gave 2Kg to shop owner for cooking food. In the next day, owner of pesticide shop called and tell her about taste of vegetable, and wants her to share experiences.

Mr. Phorng Ten and his family are very happy with his vegetable production follow IPM method to get higher yield even he pay less for the input. He never get loan from the micro-finance or money lender. He could buy more vegetable fields. He get net profit from vegetable production about US$4500 per year and he can save US$ 1500 per annum after all expenses in his family. He and his wife are healthier, happy and live good environment “no smelling chemical pesticide everyday any more”.

Case study 5: Story of Mr. Nub Non

Mr. Nub Non, 39 years old (in 2015), lived in Tasey village, Ta Moeurn commune, Thmorl Koul district, Battambang province (Tel: 855-85 303 234). Besides rice cultivation, he has cultivated vegetable in order to get extra income for feeding his family. He has planted many types vegetable such as Cucumber, Swatow mustard, Chinese kale in field 1200 m2 since 1994 to present.

He applied conventional practices and follow his neighbors to solve some problems such as Stripe flea beetle, aphid, melon fly, downy mildew, curl leaf that they depend on using chemical pesticide. He used chemical pesticide cocktail 4-5 types and sprayed many times in cycle of crop. The total expense to pesticide about 1,000,000 to 1,200,000 per year. He used pesticide such as Folidol (2 liters), Diazinogn (5 liters) and other pesticides even he did not know the name of those pesticide per cropping season. He applied insecticide which read label (class Ia and Ib) to control aphid and yellow label (Class II) to control army worm, diamond back moth and flea beetle in Chinese kale, Mustard green, Swatow mustard production. He grown 6 cropping vegetable seasons and applied chemical fertilizer about US$ 300/year.

He expensed a lot of money to buy chemical fertilizer and pesticide for using in his vegetable crops production, and cause him very poor health condition such as headache, dizziness, short of breath, excessive salivation, vomiting, diarrhea and weaker and weaker. He was very worry about his health, but he had no choice. He planted 6 cropping seasons per year in the 1200 m2, and he got only 6 tones per years (crucifer crop). His net profit was only about UD$500 per year because of input cost on chemical fertilizer as well as pesticides were very high and got low yield.

Since he planted vegetable until 2005, he never learned about vegetable production from any training. In dry season in 2005, IPM trainer in Thmor Koul district conducted IPM farmer field school (FFS) on cucumber involving 23 farmers in the village (12 women) including Mr. Mr. Nub Non. The FFS was funded by FAO-IPM Programme.

He learned on how to grow healthy vegetable crops, pests management, hazard of chemical pesticide and crop manage through discussing, practicing and analyzing the field situation (Agro-ecosystem analysis) for making appropriate decision to manage/control crop as well as pests in the FFS. He clearly understand on technical cultivation and other substance relation in vegetable agro-eco system and pest management.

After the FFS, he continued participate in post-FFS activity, and he learned deeper on vegetable crop ecology, pests management /control methods and the risk of pesticide application. After finished training, He has applied IPM methods for improving his vegetable crop productions, income and his health through applying more organic fertilizers (compost) mixing with rice straw, siam weed, ash, manure and other waste around the house to basal in his farm. Moreover, he always produces botanical pesticide for using in vegetable production in order to solve the problem when he encounters. He knows very well about pest and natural enemies, and has conserved the natural enemies in the field. He has reduced the chemical pesticide application around 80%, and only used soft pesticide in case of needed.

During the cucumber cultivation in wet season 2005, he faced problem with aphid, and he took frying oil 2 spoons with one spoon of detergent mixed 10 liters of water, and spray on aphid effective control this pest. Otherwise, he applied biology approach such as catch nest of ant put on cucumber plantation to control aphid.

He has also applied IPM methods in other vegetable production such as Green mustard, Cabbage and Pakchoi. He faced many problems with pest insect such as stripe flea beetle, diamond back moth, army worm. He just applied botanical insecticide to control pest insect.

The botanical insecticide including: Yam 2 kg, Boraphed 2 kg, Neem for 2 kg and Malaysian spurge tree 2 kg cut into small pieces and soak in 10 liters of water, stir every day and keep for 5-7 days possible to use.

Mr. Nub Non confirmed that he stop worry on pest insect in vegetable cultivation, because of his fields have a lot of natural enemies and he has alternative methods to manage/control the insect pests. He has applied the knowledge from IPM training to grow the crop healthier, get higher yield, more profit and he is healthier. After the IPM Training, he normally got 30 Tone per years with in 1200 m2 which he can grow 6 cropping season per year, and his annual profit 20,000,000 Riel – 25,000,000 Riel (US$ 5,000 – 6250 per year).

He was marriage 6 years with no child. After he applied IPM methods (reducing chemical pesticide) one year and his health is improved, and then he got one son. He said that without IPM he already dead with pesticide, because he sprayed every day. Now, His family is very pleasure with good health, no smelling chemical pesticide, fitness and have no sickness like before.

Nowadays, he is able to use sprinkler for irrigating the vegetable field to save labor and time, resistant climate change and reduce heat, reduce pest insects in the soil. He confirmed that, he will to stop use chemical pesticide on his vegetable cultivation to improve human health (both producer and customer) and contribute to improve environment.

Furthermore, he always share the successful experiences with neighbors for improving their vegetable crop production, pest management and health. He thanks to the National IPM program, Provincial IPM Programme and IPM Trainers who train him and help him to his crop production, living standard and health as well as make him happy always with the result from crops production.

CHINA

Case Study 1: Where is the Road to sustainable Pesticide Risk Reduction Practice?

-Shanglin FFS follow-up activity: Raising ducks in the paddy field

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Since the China/FAO Pesticide Risk Reduction Program was implemented in Guangxi Province in China in 2008, 13 PRR and IPM FFS has been carried out in Nanning City. A great number of farmers were trained who had intensified pesticide risk conscious. However, how many farmers could adopt IPM technology and PRR theory sustainably after FFS without swinging back to the old treadmill is always a concern and challenge when considering the long-term impact of FFS.

The villagers in Gaoqiu Village of Shanglin County have found a way for sustaining FFS practices, namely, raising ducks in the rice field.

Background Information

Shanglin County is called the "back yard garden of Nanning City". Gaoqiu Village in Shanglin County is to the northeast of Nanning City. Its Lofty Mountains range like a screen locating at the East of the village. A stream issued from North to South irrigates the paddy field of the village. There are only 72 households in the village with the population of 380 people, the crops grown include rice, sugarcane, vegetables etc.

Fig.1 The facilitator Xu shenggang (Nanning plant protection station) teaches farmers to use AESA in rice field

However, in this beautiful village, it is identified that farmers knew little about rational use of pesticides even they endeavored to build and maintain the village environment. Abuse and overuse of pesticides were rampant in the village. In this regard, it was determined that an IPM and PRR FFS was to be conducted there to help the farmers to adopt IPM practices and protect the environment.

Implementation of FFS

On March 24, 2009, a rice IPM and PRR FFS was carried out in Gaoqiu Village and achieved great success. In total, 12 FFS meetings were implemented, involving 37 farmers and 3 facilitators. The content of the meeting include AESA, special topics, field experiments, and group dynamics. The awareness of pesticide risk increased and farmers also grasped the proper way to manage pest.

To what degree the behaviors of the farmers have been changed?

The behaviors of the farmers have been changed after FFS. However, it was found in a follow-up post training survey that farmers gradually went back to their old ways when they applied pesticides. Through discussing with farmers, it was found that the reason why they did not practice IPM methods was they were not sure about the effects of the IPM technology and worried about the output. After a while after the FFS, farmers threw wasted pesticide and packages to the field, even canals and streams. What could be done to change the phenomenon?

Breeding Ducks in Paddy Field-Learning from Failure

In order to change the behaviors of the farmers, many ways were brainstormed such as planting organic rice, building cooperatives, developing leisure agriculture and rural tourism. However, the conditions were not so mature. For example, the organic rice planning plans, because of the complex application procedures, rigorous management mechanism, regular certification requirement and limited paddy field, was voted down by the village committee.

It was known that a “Yongsu Agriculture Pioneer Plan” program funded by Hongkong Kadoorie Farmland Fund was to do research on planting method to reduce greenhouse gas emission through breeding ducks in paddy filed. The initiative was raised in Gaoqiu Village to ask for villagers’ interest. Some villagers expressed their interests. The program was initiated in the second half of the year 2010 with the participation of 5 farmer households, monitoring and testing the emission of CH_4 and CO_2 from the field. Although great efforts were made, the results were not good. Farmers did not follow paddy-duck production model. Ducks were not put in the paddy field during the whole process so that pests and weeds were not eradicated very well. Farmers still depended on pesticide mostly. The problem was not solved as expected.

In 2011, the failure of breeding ducks in paddy field were discussed. Farmers admitted honestly that there was not an effect constraint mechanism to manage ducks breeding and pesticide usage. In order to put off their doubts, it was decided that a comparative test was conducted. Technology and financial support were provided to motivate their enthusiasm. This time there were 3 farmer households joining in our program, while 2 other neighboring farmer households adopted the traditional way as a comparison. Ms.Huang Airong, the farmer who joined the paddy-duck model test got the benefits brought by the method. She had confidence in rice and ducks production without pesticides. Once in a villagers gathering, she shared her experience with other villagers: no pesticide were used from the period of planting to harvest; rice plant-hopper and weeds were much less than those using pesticides; the rice applied organic fertilizer were more delicious than those using chemical fertilizers; ducks bred in paddy field were more tasty than those fed by additives and could be sold at a higher price. Her introduction raised great interests in the villagers.

Breeding Ducks in Paddy Field-Further Development

After the above gathering, a young man named Wen Chaohui who had secondary education bravely spoke out his idea. He always paid attention to ecological protection and food health. He hoped to cooperate with the village: no fertilizer or pesticide will be used in the paddy rice and technical support will be provided. In March, 2012, he in association with other 8 farmer households connect their paddy field, in total of 11mu, to breed ducks. They used sheep manure as organic fertilizer. After around 10 days after paddy transplanting，they released ducks of right age into the paddy fields. They used cooked corn to feed ducks. The ducks lived in the paddy field day and night until the paddy bloomed. Because of these ducks, weeds and pest decreased significantly (see Annex I). The rice and ducks tasted more delicious and were sold out at the price of 16RMB/kg and 26RMB/kg respectively. All these gave villagers the confidence in ecological planting and breeding.

Fig.2 Field experiment and extension of raising Ducks in paddy field

In March 2012, Mr.Wen Chaohui and his villager partners set up Shanglin County Old Farmers Ecological Planting and Breeding Cooperative. They put their products on the internet by using the platform of County Agriculture Information Website. In addition, they invited County TV Station to promote ecological planting and breeding model to neighboring villages. In the second half year 2012, their products were ordered out through the internet before they started second season of rice-duck production. However, there were doubts from journalists and customers: since you did not have certificate from relevant agencies, how could you guarantee that no chemical products were used during rice-duck production? Actually, they adopted a kind of emotional certificate, customers could come to the field whenever they like to know the whole process of planting and breeding. More importantly, the idea of environment protection is what the young man and his villager partners are seeking for. Now more and more villagers begin to decrease the usage of fertilizers and pesticides. Gaoqiu Village becomes more and more beautiful under ecological framing and the programme called Beautiful Guangxi, Clean Rural and Urban Areas which was promoted by Gunagxi Government.

Lessons learnt and experiences for success

There are lessons learnt from the case, these fails gave villagers more experiences to explore ways for success.

- Improper duck releasing density and timing.

The weeds were abundant and mature and the number of insect pest increase significantly when the ducks were still young and the number was not enough to control pest.

- Pesticides application during rice-duck programme

The pesticides applied by households that did not participate in the rice-duck programme poisoned the ducks released.

There are also successful experiences that could be shared:

- Successful implementation of FFS

Through FFS, farmers changed the wrong perception that pesticides and chemical fertilizers must be used during rice tillering stage to increase yield and income. The key for FFS is AESA, which could lead farmers to ecological planting and breeding.

- Integration of social resources

It could be seen from the case study that the farmers in Gaoqiu Village might have returned to pesticide abuse and overuse if there had no rice-duck programme. Introducing new technologies and programmes were good ways to restrict framers to abuse and overuse pesticides, for instance, introducing IPM, developing agriculture produce in together with agri-enterprises, producing quality produce for export.

- There are farmer leaders in the village

It could be seen that farmer leaders like Ms.Huang Airong and Mr.Wen Chaohui played important role in the success for the case. It is important to have village leaders to participate in the programmes so that they could influence others, which is more effective than only completing tasks.

- Promotion and demonstration

It is important to promote and demonstrate to framers and consumers so that more and more people will participate in the programme.

- Attention from the society

Ecological agriculture is not a simple agricultural production and marketing but a traditional culture. Breading ducks in the paddy field is a traditional culture with long history. Villagers, citizens and government officials could participate in the action to pay more attention and support ecological agriculture for better environment protection, food safety and human health.

Annex

Table 1 Pest Comparison between Paddy-Duck Field and Normal Field

	Weeds（plant /m^2）	Rice Plant hopper（per hundreds plants）	rice sheath blight（%）
Paddy-Duck Field	1	76	0.03
FP	15	876	12.6

Table 2 Inputs and Output comparison Unit：Yuan/mu

	Pesticide	Fertilizer	Organic Fertilizer	Ducks	Feed	Seine	Total
Paddy-Duck Field	0	0	190	90	20	50	350
FP	110	120	0	0	0	0	230

Table 3 Output and Net Income Comparison

	Output kilogram/mu	Rice yuan/mu	Duck yuan/mu	Total Income yuan/mu	Net Income yuan/mu
Paddy-Duck Field	265	4240	1300	5540	5190
FP	432	3024	0	3024	2794

Case Study 2: Using Insects to Manage Insect Pests: Farmers Changed from Incomprehension, disbelief to Proactive Selection.

Case Study on Technologies Extension from FFS in Xiaofengying Village, Kangzhuang Township, Yanqing County

Background Information

Yanqing County, locates to the Northwest of Beijing Downtown, is more than 70 kms away from the City. It is an important ecological conservation area. The yearly average temperature is 4-6℃, lower than the downtown of Beijing City. It is very suitable for vegetable production in summer and is considered as northern vegetable garden. Kangzhuang Township is the core vegetable production area, vegetable industry has developed since 80's last century to meet the market needs and improve farmers' income. From 2007, protected agriculture on the production of colored capsicum and tomato etc have been developed in Kangzhuang Township. For now, the township has become a summer vegetable supply base in Beijing City, supplying vegetables to Southern part of China like Guangzhou City and Shenzhen City.

Vegetable production depend a lot on chemical pesticides, arousing quality safety concerns. It is needed to develop alternatives. Protected vegetable production is a direction for local vegetable production, mainly focused on vegetables like cucumber, tomato, colored capsicum, eggplant etc. Thrip is one of the commonly seen insect pests, farmers do not know the life cycle and occurrence, they overuse chemical pesticides like imidaclopridbeta cypermethrin and Abamectin, in an unscientific manner, resulting in pesticide resistance to thrips and arousing safety concerns on vegetable production. In this regard, it is a burning issue to explore and extent IPM technologies

Built Farmer Field School, explored and extended IPM technologies

In April 2008, Yanqing Plant Protection Station set up FFS based on Northern Vegetable Garden in Kangzhuang Township, endeavoring to strengthen the farmers' understanding on IPM and safeguard agriculture produce safety and farmers' income increase.

FFS was conducted yearly targeting different crops since 2008 based on Northern Vegetable Garden Cooperative in Kangzhuang Township. The participants consisted of farmers from 5 villages namely Xiaofengying, Dongguanfang, Xiaobeifang, Dongguanfang, Xiaobeibao and Xihongsi and Xisangyuan. 30 FFS participants mainly were decision makers of the families and vegetable growers. There were 26 female participants, accounting for 86.7% of the total. The average age of the participants was 47, in which 11 aged 50-60, 11 aged 40-49, 4 aged below 4. In terms of educational background, 24 FFS participants graduated from junior high school, 5 participants graduated from senior high school and only 1 was a graduate of primary school. There were 12 to 18 meetings for one season of FFS. The training curriculum included Agro-eco System Analysis, group dynamics, insect zoo, role play, demonstrative experiment, Ballot Box Test(BBT), study tour, field experiment and field demonstration.

In the FFS, IPM plot and Farmer Practice plot (FP) were set. IPM plot is not only a demonstrative and model field but also a place for observation, learning and practice for the participants. FP plot is a control and verification for IPM plot, it also could be used to identify problems in the production.

Study tours were organized in each FFS. On July 28,2011, FFS participants visited Guangjitun vegetable production base and Chanliying vegetable production base in Yanqing County. Agriculture extensionists Mr. Han Yongmao and farmer facilitator Ms.Ma Chunhua guided the participants to understand new varieties of colored capsicum. Mr. Han Yongmao introduced the production, marketing and management of the base. Afterwards, the participants also visited Chanliying Village where farmers do not have much production experiences. It was found that the placement of the insects prevention door curtain did not meet the quality standard, some even had no insects prevention door curtain, which led to poor insect pest control effect. In addition, it was also found that rain flooding resulted from poor drainage, stickiness of the soil and thin tilling layer easily led to the death of the seedlings.

The participants learnt a lot from the study tour. The farmers have learnt the controlling effect of insect pests prevention door curtain, physical and biological pest management methods like applying predatory mites and yellow sticky traps, applying slurry for controlling capsicum sunburn. The participants also learnt that plant diseased debris should not be placed randomly and colored capsicum should be planted at east -west direction. After the discussion, the participants reached the consensus that they had learnt new cultivation technologies and identified shortages in their own production. They suggested that more study tours were to organized so that they could get to know new knowledge and technologies more directly and quickly.

Using insects to manage insect pests: farmers changed from Incomprehension, disbelief to Proactive Selection

Biological control is one of the important technologies in FFS. The FFS participants were doubtful when FFS facilitator Ms. Gu Peiyun started to explain control method of Applying Insect to Control Insect Pests, some participants said “so many pesticides have been applied with little usage, it is incredible that a couple of insects could solve the problems”; “It is impossible, pesticides are the most effective ones”. But the participants changed their perceptions after consecutive 2 weeks of insect zoo study.

When Ms. Gu Peiyun was conducting AESA, a cabbage caterpillar parasitized by *Cotesia spp*. was identified. The whole cabbage was removed and planted in a flower pot covered with insect net for observation of the changes. After one week, the participants observed that the caterpillar did not move with silken cocoons on it’s body, but the color of the caterpillar did not change too much. The facilitator said that the caterpillar could not damage cabbage any more but some of the participants did not agree. They thought that the insect pests would continue to damage the cabbage as long as it was still alive, pesticides were still needed. So the facilitator marked the damages made by the caterpillar. After another week, when the participants observed the insect zoo again, they found that the caterpillar was still there with milky white cocoons along the sides of the caterpillar. There were no new wounds and the old ones did not expand. Till then, did the participants believe that using insects to manage insect pests is true, it is so convenient placing insects to kill insect pets, and the insect pests could be killed even with no pesticides. In FFS, farmer science is also an important training method in addition to insect zoo. The facilitator designed farmer experiments based on production needs and encouraged and guided the participants to participate in the experiment. For instance, the comparative experiment on the control effect of yellow sticky board trap and insect pests prevention door curtain, comparative experiment on methods for colored capsicum sunburn management, predatory mites control colored capsicum thrip, study and demonstration on real time monitoring and warning of 2 diseases of cucumber. These studies helped the participants to understand the advantages and disadvantages of different technologies intuitively, which contributed to faster and better learning for application. In which, the experiment of applying predatory mites to control thrip on colored capsicum is a good example. The crop selected was capsicum names Caijiaohuangguiren, the experimental field was organic vegetable production base, the duration was Aug.11-28, 2011 (harvest time for colored capsicum). After the base population of thrip was surveyed, Amblyseius barkeri（50/㎡was release to the field on August 11 for the first time and on August 25 for the second time. Field survey was conducted 3 days and 10 days after the first release and 3 days after the second release respectively. Control plot was set up with no Amblyseius barkeri release. 5-point-sampling-method was applied, 10 flowers were selected at each point and insect population on the sampled flowers were recorded, insects reduced rate and control effect were calculated. The results show that control effect was the best on 14 days after the first release and 3 days after the second release, reaching 95.8% and 97.8% respectively. It was also shown that the control effect would have been much better if the predatory mites had been released at the early stage of thrip occurrence.

Fig.1The facilitator was facilitating investigation methods

Fig.2 The participants were releasing predatory mites

Fig.3The participants observing egg cards of predatory mites

Fig.4The participant was surveying thrip’spopulation

Built predatory mites mass rearing plant and provided natural enemies nationwide

FFS participate Mr. Zhao Yuzhong learnt that predatory mites could control thrip with good effect. He also learnt that predatory mites are extensively applied in other countries. He boldly raise the plan of building a predatory mites mass-rearing plant to supply the products to organic production base. Under the support of Beijing PPS, Mr. Zhao Yuzhong successfully built predatory mass-rearing plant with an area of 100 m^2 .During the process, precise moisture control during rearing process puzzled Mr.Zhao Yuzhong. With the help of Beijing PPS, the plant introduced automatic temperature and moisture control system to provide conditions for mass rearing. Mr. Zhao Yuzhong also led his team to develop automatic packing line, enhancing commercial conversion rate of predatory mites. Since the plant was operational two years ago, 14.6 billion predatory mites were produced to control pest mites like two-spotted spider mites, covering 200,000 ha. The products were sold to 7 provinces/cities including Beijing, Hebei, Tianjin, Hainan and Xinjiang. Based on FFS, he collaborated with Beijing PPS and research institutes like China Agricultural University to produce combined natural enemies to control insects. Based on ecosystem principle, through natural enemy release, it provided better conditions for organic vegetable production. Till now, the green vegetable garden base in Yanqing County with no pesticides spray has reached 50%, it is estimated that it could reach 80% till 2016。

Experiences gained

- Season-long participatory training is the most effective model in extending IPM

It is hard for farmers with relatively low educational level to receive IPM because farmers tend to attribute poor control effect to the technologies or products itself instead of the unscientific or unstandardized practices. Through season-long participatory training, the farmers understood how Amblyseius barkeri predated spider mites and the macro effect of IPM plot. They developed deep understanding on release timing, releasing number and matching management measures.

- It is vitally important to identify and cultivate leading farmers

In FFS, the facilitator found that Mr. Zhao Yuzhong liked to receive new ideas and practice experiments; in addition, he also had great impact on others. The facilitator gave him more opportunities for sharing his experiences with other participants. Eventually, he guided the participants to set up cooperative and build mass rearing plant, becoming a well-known technologies leader.

- Combination of professional technologies and participatory training tools is a powerful technologies extension method

FFS is an educational method with farmers as the center, field as the classroom and practice as a method. It applies participatory, interactive and heuristic training methods . The primary goal of FFS is to improve farmers' technologies adoption rate through training activities and cultivate farmers' scientific conscious and research capacity so that farmers could better understand and master related technologies and apply to agriculture production through observation and participation in activities like group dynamics and experiments etc.

Case Study 3: Successful Area Wide Control Program for Chinese Citrus Fly *(B.minax)* Control

Introduction

Ecoman Biotech, with the support of National Agricultural Technology Extension and Service Center (NATESC) and local government, has implemented Area Wide Control Program (AWCP) for Chinese citrus fly *(Bactrocera minax)* at Shuang Yankou village in Dianjun District, Yichang City, Hubei Province, China.

The local control methods were inefficient in controlling Chinese citrus flies leading to wide spread infestation with an average fruit damage rate of 30-40% in some infested areas.

We have specially designed our Great® fruit fly bait (GFFB) product based on the biological behaviors of fruit flies. By mass baiting with GFFB through our Area wide control program, we have drastically reduced the fruit damage rate to less than 1%. Our innovative AWCP methodology involves proper training, organization, systematic planning, technical support and involvement of the local government bodies.

Our successful AWCP results with reduced fruit damage rate, convinced the farmers to adapt our method of control over other local practices. The effect of our AWCP not only helped local farmers to restore the confidence in growing citrus, but also provided an effective solution for the control of other disease and pest in the whole district.

Chinese citrus fly *(B.minax)* is a pest that made a severe impact on the citrus industry. It greatly affected the citrus growing area which is surrounded by the Yangtze River, in the middle of China.
From the year 2008 to 2011, there was a sharp decline in citrus production due to Chinese citrus fly *(B.minax)*. The inferior quality citrus produced made it unsalable as the prices plummeted, which had a negative impact on the citrus industry in the region. As a result, the citrus farmers started to migrate to cities looking for alternative sources of income for their livelihood.

In the year of 2011, we began to promote our AWCP using Great® Fruit Fly Bait (GFFB) across the country in cooperation with the National Agricultural Technology Extension and Service Center (NATESC). In the year 2011-2012, AWCP using GFFB was conducted in the citrus crops in the areas surrounded by Yangtze River. We achieved great success through years of exploration by conducting numerous AWCPs. This paper selects Shuang Yankou village as a classic example of an experimental demonstration in this region to describe our technology and method of control.

In point spraying GFFB we only need to spray 60 points per acre, making it extremely easy to cover large areas when compared to other conventional methods.

Background Information

Located in the Citrus Industrial Zone i.e. the area surrounded by the Yangtze River, Shuang Yankou is a village in Dianjun District, Yichang City, Hubei province (Figure 1). It has 534 citrus-planting farmers and a total citrus acreage of 346 acres. From the year 2008 to 2011, the average fruit damage rate due to Chinese citrus fly reached 30%-40% for 3 consecutive years making it the worst hit village in Dianjun District. Vendors were not willing to buy citrus produced in this village, which in turn badly affected the farmers' source of income. The money invested on the crop exceeded the returns fetched from it, making it difficult for poor farmers to keep investing.

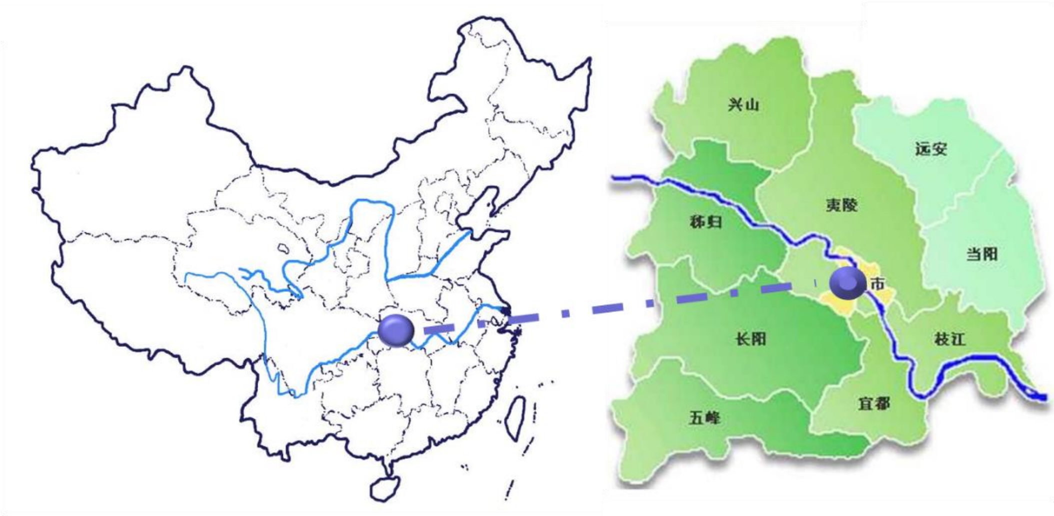

Fig.1.
Location and enlarged view of Shuang Yankou Village shown in blue dots

Wang Yumei was a 52 year old lady farmer who owned 2 acres of citrus crops. (Fig.2) While her husband and son were working in the city as migrant worker, she stayed at home taking care of her grandchildren. Her plot was situated at the border of Shuang Yankou village, close to the mountains. The damage rate due to Chinese citrus fly was more serious i.e. more than 60% in her plot. Due to the heavy presence of maggots in her citrus, none of the traders agreed to buy them. With the situations getting worse for three consecutive years (2008-2011) due to the increasing losses in her citrus plots, she started losing hope for things getting any better. And finally decided to go to the city looking for jobs after April, 2012.

Fig.2 Wang Yumei picking citrus fruits infested by Chinese citrus fly

Implementation of AWCP for Chinese citrus fly

I. The District Government's support

On 12th March, 2012, after several long-term communications with our company, government of Dianjun District held a meeting for the control of Chinese citrus fly in their area (Fig.3). They agreed to support us in conducting an AWCP using GFFB and selected Shuang Yankou village as the trial area. They also partially funded the control program.

Fig.3 Ecoman's officials meeting with Govt. Official, Dianjun District

II. Meeting with the village representative

On 13th March, 2012, the village representatives of Shuang Yankou village held a meeting, where they unanimously agreed to support an AWCP for Chinese citrus fly. (Figure 4). Wang Yumei came to know about our trial and decided to give this a final try just for 1 season, before moving to the city looking for alternate options for her livelihood.

Fig.4 Shuang Yankou village representatives meeting

III. Training to farmers and Sprayer team

On 18th May, 2012, experts from Ecoman trained the villagers and sprayer team (Figure 5). The training helped the sprayer team learn the effective method of GFFB application and also understand our systematic and integrative AWCP approach for fruit fly control. It made the farmers understand the Chinese citrus fly control method and mobilized them to participate actively in supervising the work of the sprayer team for better control.

Fig.5 Ecoman experts training Shuang Yankou farmers (left) & Sprayer team (right)

IV. Monitoring

From May-July 2012, the experts from Ecoman and the local government technical staff together monitored Chinese citrus fly's population density, emergence time, peak feeding time and stage of the fly by studying the pupae from the soil, hanging bait trap and point-spraying (Figure 6), which helped them accurately determine the start and end time of GFFB application for Chinese citrus fly control.

A Checking Pupae	
B Hanging traps with bait	

C Point-spraying	

Fig.6 Monitoring Chinese citrus fly

V. Mass Baiting with GFFB

From June-July 2012, we start applying GFFB by point spray method as per the schedule in Table 1 with the help of the Sprayer team (Fig.7). To ensure that each sprayer operated in accordance with the standard, the organizers trained each operator once again before spraying. The farmers supervised the work of the sprayer team to ensure proper application in the whole trial area.

Table 1 Spraying schedule of GFFB in ShuangYankou Village

First	Second	Third	Fourth
June 13th	June 20th	July 2nd	July 10th

Fig.7 - AWCP in Shuang Yankou Village

On June 13th 2012, Sun Jinsong, Chief agronomist, Yichang city, led a team to conduct a spraying test in Wang Yumei's citrus orchard (Figure 8). Wang Yumei participated actively in the test. There were 2 spraying points in her plot. 31 Chinese fruit flies were found dead after 40 minutes of the 1st spray, 23 of the them being female and 8 male. The results of the spraying and killing experiment gave Wang Yumei more confidence on our control method.

Fig.8- Sun Jinsong, Chief Agronomist, Yichang City with his team in Wang Yumei's citrus orchard (left) & results of flies killed (right)

VI. Fruit damage rate in the citrus orchard

This survey was divided into 2 parts -

a) Fruit damage rate when the fruit is hard and green (Green fruit damage rate)

b) Fruit damage rate when the fruit is ripened. (Fruit damage rate)

On 25th July 2012, Dianjun District government and Ecoman formed a team and recorded the observations of the green fruit damage rate (Figure 9 & Figure 10). We randomly checked fruits from the 10 different sites. Each site was surveyed by 2 people. Each person randomly picked 500 fruits from 5 trees. As shown in Table 2, data was recorded for 10000 fruits from 10 different sites (1000 from each site), of which 3 sites had a total of 39 damaged fruits and the green fruit damage rate was 0.39%.

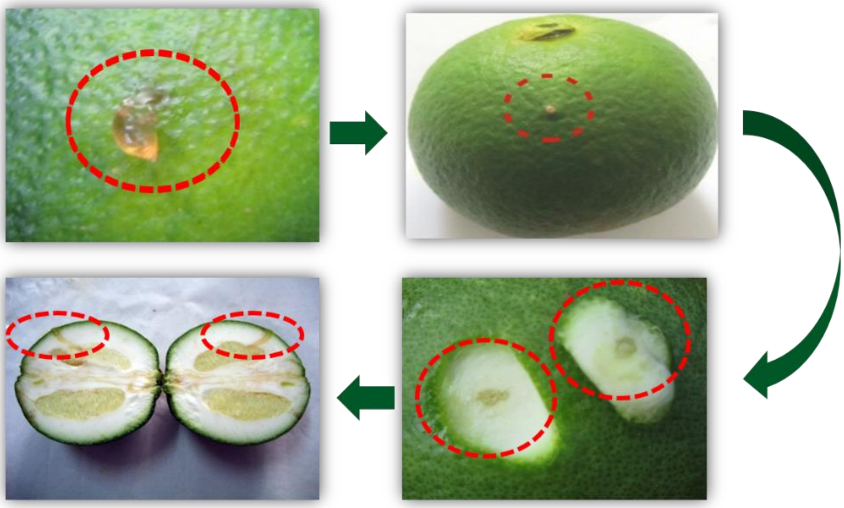

Fig.9 Symptoms / Signs of green fruit damage rate

Table 2 Green fruit damage rate in Shuang Yankou Village

Site	No. of sample fruits	No. of damaged fruits	Fruit damage rate (in %)
1	1000	0	0
2	1000	4	0.4
3	1000	0	0
4	1000	18	1.8
5	1000	0	0

6	1000	0	0
7	1000	6	0.6
8	1000	0	0
9	1000	11	1.1
10	1000	0	0
Total	**10000**	**39**	**0.39%**

Fig.10. District government official examining the fruit damage rate at Shuang Yankou Village

In September 2012, a team of agricultural experts from provincial, city and county levels examined the fruit damage rate of Chinese citrus fly (Figure 11). Results are as below (Refer Table 3)

No. of Sites	Sample size of fruits (in kgs)	Fruits damaged (in kgs)	Fruit damage rate (in %)
10	**2500**	**8.4**	**0.34%**

Fig.11 Team of Agricultural experts from provincial, city and county levels examined the fruit damage rate

The investigation showed that till 29th September 2012, Wang Yumei harvested 11000 kg of citrus fruits and earned around 4516 USD. (Table 4) Our successful trial prevented her and many other farmers from migrating to cities looking for alternative options of income for their livelihood.

Table 4. Comparison in productivity & revenues before and after trial in Wang Yumei's citrus orchard

	Productivity (in kgs)	**Revenues (in USD)**
Before trial	1000	323
After trial	11000	4516
Difference	**10000**	**4193**

Our AWCP for Chinese citrus fly at the citrus orchards of Shuang Yankou village, for just one season, drastically reduced the fruit damage rate and increased harvest by more than 3 tonnes which is equivalent to an increased revenue of 968-1129 USD.

Factors influencing the effect of AWCP

We have conducted numerous successful AWCPs in the Citrus Industrial Zone i.e. the area surrounded by the Yangtze River. With years of experience, we have classified the important factors influencing AWCP as below:

i) Good Technology

A good technology is the base for an effective trial. Point-spraying of GFFB saves labor and time. It is highly cost effective when compared to the conventional methods. It is an environment friendly solution leaving no residues on the crops.

ii) Systematic Organization and Right Usage

It plays a crucial role in a successful AWCP. Few organizers of the demonstration did not understand the importance of organizing the end users, providing them the right training explaining the right method/time/point of application. They even ignored the importance of monitoring the results of the trial. This resulted in an unorganized and uncoordinated action from the end users leading to high fruit damage rate.

The mode of selling GFFB through distributor channel did not fetch great results. The reason being lack of proper guidance and training on the product usage and organization to the end users also leads to poor results.

iii) Support from the Government

Government initiated promotional campaigns to create awareness, a dedicated team of officials for organizing and financial support to share farmers' burden- are the key aspects we look at, as support from the Government. Government involvement plays a key role in reaching to the masses and winning their confidence.

iv) Active participation of the farmers

The battle against the most economically significant pest - Chinese citrus fly can only be won with the combined support from all the end users. Since, it is always a challenge to organize farmers owning small fragments of land, it is important that they perform unified action to fight the common problem. It is also important for them to supervise/monitor the action of the sprayer team to ensure better control. Personal grudges if any with the sprayer team should not affect the spraying activity in the trial area leading to poor results.

v) Various marketing activities for farmers

Farmers are always inclined to adhere to old habits of pest control. There is also an inhibition to try something new. In order to persuade them to support and participate in our AWCP, we need to use various promotional channels for making it easy for them to understand. It includes educative videos, posters, leaflets, text messages and other technical service training sessions (Fig.12).

Fig.12 Various promotional channels for farmers

vi) Monitoring

Scientific monitoring can help us accurately determine the start and end time of GFFB application for Chinese citrus fly control. The right time of application is extremely important for effective control of the fruit damage rate.

Latest developments

- From 2012- 2014, the coverage area of AWCP for Chinese citrus fly in Dianjun District increased from 10% to 95%.
- Through our AWCP the average fruit damage rate in the region was below 0.3%, hence protecting the citrus industry.
- Many farmers like Wang Yumei in Shuang Yankou village recorded good yields from their citrus orchards and earned enough for a living. They no longer migrated to cities looking for jobs.
- Our AWCP model has set an example for many cooperative organizations, who have started to provide specialized AWCP services to farmers by their team of experts. They provide comprehensive solution for pest prevention and control to the farmers.

Case Study 4: Self-Financed FFS for Value Chain Development
-A Case from Rongan County, Guangxi Zhuang Autonomous Region

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In 2008, the Plant Protection Station in the Bureau of Agriculture of Rongan County, Guangxi Province sent two extension workers to attend season-long Training of Trainers (TOT) course on Pesticide Risk Reduction (PRR) and Integrated Pest Management (IPM) held in Tianyang County, Guangxi Province. The TOT was organized by FAO/China PRR Programme. The objective of the TOT was to train the first batch of IPM trainers to pilot FFS. Upon graduation in 2008, and with seed funding from FAO, the two graduates started to conduct season-long FFS on kumquat. Even FAO stopped financing FFS, the FFS did not stop, FFS farmers have been empowered to become farmer facilitators, and they continued FFS by themselves, using FFS as an important method to train cooperative members and perform cooperatives functions.

Main activities conducted to establish self-financed FFS

- Assisting farmers to set up cooperatives in the course of or at the end of FFS. In Rongan County, at least four Kumquat Cooperatives were set up assisted by facilitators. Based on cooperatives, follow- up activities were easy to be conducted and value chain was easy to be developed.
- Obtaining multi-channel support from multi-departments to carry out various agricultural programmes and to improve farmer facilitators' abilities. FFS participants improved their communication, organizational and management skills through implementing different projects. At the same time, self-confidence was built and improved in the process.
- Assisting farmer leaders to facilitate and carry out FFS. The TOT facilitators assisted two capable FFS participants identified to conduct FFS in cooperatives or in other FFS.
- Endeavoring to green food certification, brand and market development. The kumquat products were certified and a famous local brand was developed, broadening the marketing channels. Their kumquat are now sold to Shanghai, Zhejiang Province and exported to Southeast Asian counties.

Fig.1 Two Farmer facilitators were facilitating IPM on kumquat pest control in Rongan FFS

The efforts taken by the farmers and facilitators were rewarding, cooperative members reduced pesticide risks, improved yield and net income of the products. As per survey conducted, IPM has been adopted by FFS farmers, in average, after training, pesticides use has been cut by 40%, the application has been reduced by 5 times. Alternatives were applied. No pesticides residues were tested exceeding the limit restrictions. Comparing FFS graduates and non-FFS graduates, the inputs on pesticides were reduced by 105RMB, saving 34% of the costs. The yield and net income of the kumquat farmers has been increased by 40% and 105.3% respectively. In addition, the demonstration and effects of the Kumquat Cooperative attracted more members, driving the development of neighboring farmers.

Fig.2 Rongan Kumquat brand registered and the JIEFANG Daily report that the hometown of kumquat links Shanghai market

- **Experiences and lessons learned**
- Because the workload of the staff of PPS is heavy, expansion of FFS facilitated by extension workers has constrains. Cultivating farmer facilitators in the FFS implementation process and encouraging farmer leaders to become farmer facilitator are important. Farmer facilitators enrich the extension stakeholders, more farmers could benefit from participating in FFS.
- FFS conducted by farmer facilitators is closer to farmers and field practices, motivating farmers to participate, communicate and to share indigenous knowledge.
- It is important that the stakeholders work in synergy to support FFS so that FFS funding resources and support could be broadened.
- It is important to embed FFS follow-up activities into other programmes, for instance, new socialist countryside building Programme to sustain follow-up practices.

DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA

Case Study 1: Trichogramma Production and Application in the DPR Korea

Maize is the main crop in the field and corn borer, *Chilo suppressalis* is the insect pest damaged seriously to maize in DPRK. Corn borer develops two generation every year. First generation is early to mid of June and second generation is end of July to early of August.

Trichogramma is the main biological agent to control corn borer.

The stock Trichogramma is collected from the egg mass of corn borer disinfected by Trichogramma in the untreated fields to use in mass rearing next year.

For the mass rearing of Trichogramma, *Sitotroga*, alternative host of Trichogramma is reared massively by using the maize or barely. The eggs of Sitotroga are collected and disinfected by Trichogramma before release to maize field.

In first generation of Corn borer, eggs of Trichogramma are released three times at intervals of 5 days and two times at intervals of 5days in second generation.

The Trichogramma production facilities of all Province and County Plant Protection Substation produces Trichogramma every years and the County Farm Management board and Province Rural Committee supply the all materials for Trichogramma mass rearing.

From 2004 to 2009 CABI, Swiss implemented support project for Trichogramma production in county production facilities which focused to renovation of facility and quality control of Trichogramma products.

By Trichogramma mass production corn borer could be controlled effectively without using the chemical pesticide and maize harvest is increased by 10%

Case Study 2: Development and Application of Entomopathogenic Nematode in the DPR Korea

The underground pests such as grub, cutworm and wireworm are the main insect pests in the maize and vegetable fields. The chemical pesticides such as Poxim and Chlorocorid were used to control the damage from these pests.

The Central Plant Protection Station (CPPS) and AAS developed and applied successively entomopathogenic nematode (EPN) to control the underground pest in the field by CABI support project from 2011. Researchers of Plant Protection Institute, AAS and experts of CPPS found out local EPNs in the soil which was identified it Steinernematidae carpocapsae by using the PCR analysis.

EPNs are produced by in vivo method using the Tenebrio and in vitro method using sponge media with pork kidney and soybean oil. EPN products are dissolved into water and dispersed to seedbed of maize one day before transplanting to field. In case of direct planting, seeds of maize are coated by clay with EPN and applied to maize field.

The underground pests are managed effectively by using the EPN from EPN production facilities of counties and provinces to reduce the seed amount and increase the harvest in the fields.

LAO PEOPLE'S DEMOCRATIC REPUBLIC

Case Study 1: Integrated Pest Management of Fruit fly in Lao PDR

Introduction

The National IPM Programme implemented the FAO project "Area-wide Fruit fly Integrated Pest Management in southeast Asia"funded by AIT for the period of 2010-2014. Purpose of the project was to strengthen support systems and enhance knowledge on *Bactrocera* fruit flyecology, biology and management among smallholder farmers. Capacity building activities focused on training of fruit and vegetable crops by sustainably practicing integrated pest management with minimal use of toxic synthetic pesticides.

Fruit flies are considered one of the most serious pests of fruits and vegetables in the world as well as in Lao PDR because they attack a wide range of crops such as mango, guava, jujube, bitter gourd, cantaloupe, water melon, cucumber and others. There were no significant research and development activities have been carried out so far in Lao PDR related to management of the fruit flies. Although there is a lack of data, fruit flies are known to attack fruits and vegetables in Lao PDR throughout the year and cause substantial yield loss. Up to 2010, there was no information on the occurrence of fruit flies (FF) and estimate of yield loss due to fruit fly damage in the country and no recommendations from Plant Protection/Extension Service on fruit fly management.

With funding from FAO, in 2011, the National IPM Project conducted baseline survey on fruit fly in some selected districts of Vientiane Capital and Province, 148 farmers were interviewed and traps (with ME & Cue Lure) were set-up before survey e.g. during February September 2011. The survey results showed that population of *B.cururbitae* was found highest followed by *B. dorsalis& B. correcta* as well as few other species such as *B. Dacus*& other unknown species and up to 50% of fruits were infested/damaged.

Following two Training of Trainers courses, 3 pilot FFS work in cucurbit crops, 3 FFSs on FF-IPM on jujube were implemented in Vientiane Capital and Vientiane province in 2012 &2013 followed by 3 post FFSs on FF-IPM in jujube. 127 farmers (including 30 women) participated in the FFSs. Graduated farmers found that the innovative IPM fruit fly management practice was effective and increased income by 50-70% compared to previous years.

1. **Intervention rationale/objectives**

To enhance knowledge on fruit fly ecology and management among smallholder farmers to be able to grow healthy and safe fruit by sustainably practicing integrated pest management and improved income the farmers.

2. **Activities**

Main activities include structure learning exercise, set up traps in IPM & Non-IPM village (1 trap/ha), AESA, identification of 3 important species of fruit fly, insect zoo/life cycle & biology of fruit fly, monitoring & evaluation of fruit fly population/FTD, fruit fly baits (ME, Cue Lure & protein bait) &demo on use & effectiveness of protein bait, fruit wrapping& field sanitation, percentage of infested fruit, harvest & post harvest technologies, participatory economic analysis & mapping.

4. Process and methodologies used

- Baseline survey and selected target village for organizing farmers field school.
- Selected 15 to 30 farmers who were interested to join the farmer field school in the Ban Cheng village, Thoulakham district, Vientiane Province.
- Organized farmers field school 15 weeks by the refer to FFS curriculum for IPM fruit fly
- The farmers will meet together one time in the morning per week.
- In the farmers field school were divide 2 plots for field studies (IPM &FP plots)

5. Result and outcome

Figure 1: Population monitoring of fruit fly on Jujube in 2013

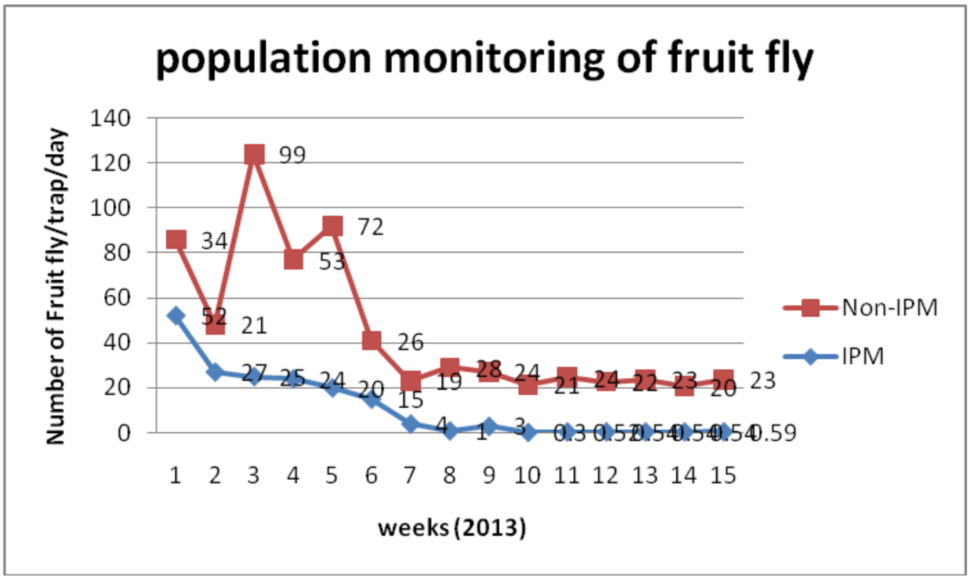

Figure 2: Percentage of damage of fruit fly on jujube in 2013

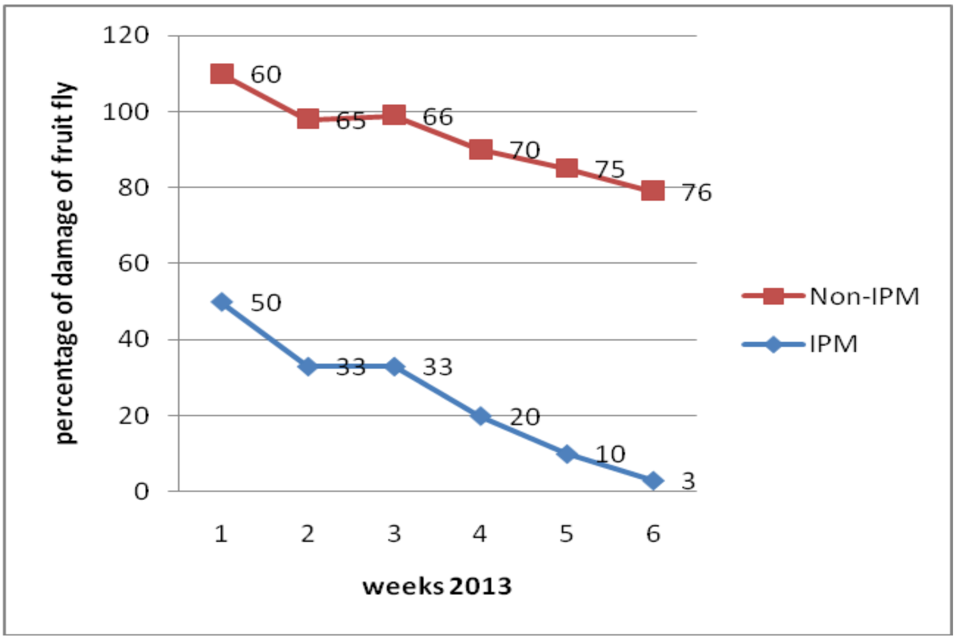

Table 1: Jujube yield and cost benefit analysis in 2013

Name of village	IPM Plot				FP Plot			
Cheng village	Yield(kg/ha)	Cost/ha(kip)	Income/ha(kip)	Profit/ha(kip)	Yield(kg/ha	Cost/ha(kip)	Income/ha(kip)	Profit/ha(kip)
	750	336.000	1,875,000	1,539,000	360	380,000	900,000	500,000

Figure 3: Population monitoring of fruit fly on Jujube in 2014

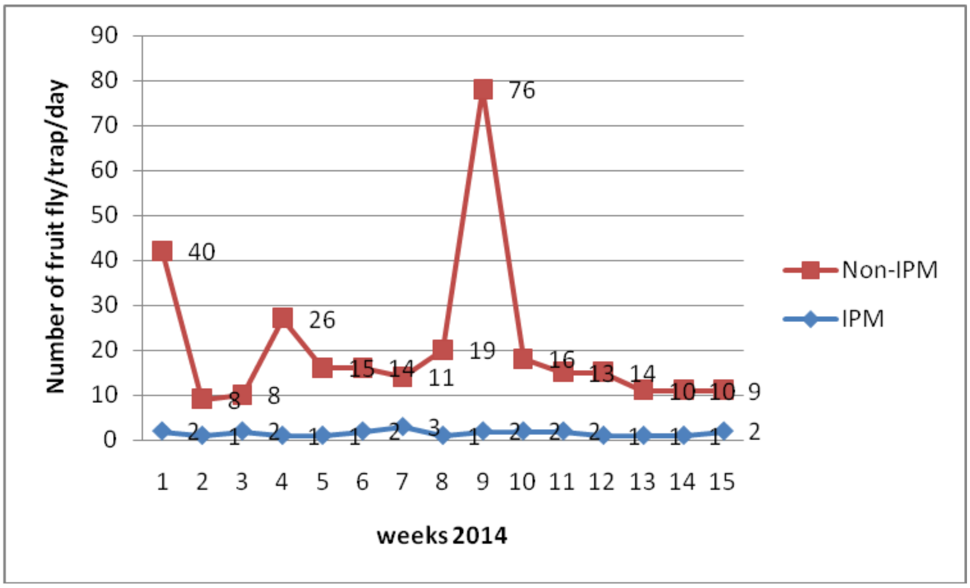

Figure 4: Percentage of damage of fruit fly on jujube in 2014

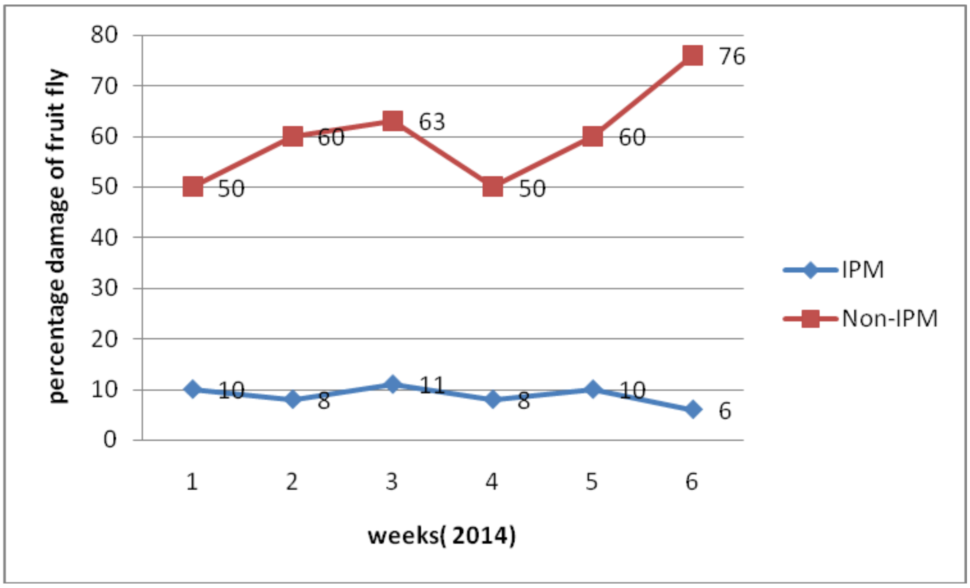

Table 2: Jujube yield and cost benefit analysis in 2014

Name of village	**IPM Plot**				**FP Plot**			
Cheng village	**Yield(kg/ha)**	**Cost/ha(kip)**	**Income/ha(kip)**	**Profit/ha(kip)**	**Yield(kg/ha**	**Cost/ha (kip)**	**Income/ha(kip)**	**Profit /ha(kip)**
	13,560	**2,403,000**	**27,120,000**	**24,717,000**	**7,140**	**1,513,500**	**14,280,000**	**12,766,500**

6. Lesson learn

In conclusion, the FFSs on Jujube were organized by IPM Trainer in Vientiane Capital and province. Farmers showed their interests in the IPM strategies to manage and control fruit fly that they have never realize about that. Due to limited field experience, technical knowledge and field problems countered due to extreme to hot weather condition, some trainers were not able to make timely informed decision resulting in rather low quality FFS. However, farmers still have learnt some techniques on pest management and crop production. It provided good lessons learn for IPM trainers for Jujube fruit fly management for implementing the more successful in the next season.

MALAYSIA

Case Study 1: IPM PRACTICE ON RICE BY FARMERS COMMITTEE

Muhamad Zulhisham Jusoh, Agriculture Oficer, Plant Biosecurity Division, Department of Agriculture, Ministry of Agriculture and Agro-based Industry, Malaysia

Rice, the Malaysian staple diet, is cultivated on 673,745 hectares producing annually 2.5 million tons of paddy grain valued at RM2.2 billion. However, this quantity is sufficient to meet only 70% of the country's need and the balance imported from countries abroad. Efforts are being undertaken to increase the productivity of existing rice-field and opening up new areas for rice planting to cope with the growing demand for the produce.

Pest and diseases threats are major challenges faced by rice growers. They debilitate plant growth and where the virulent rice-blast disease, the marauding insect pest brown plant-hopper, together with the voracious golden apple snail mollusks and the seemingly innocuous weedy-rice can inflict heavy yield losses and, in certain instances, wipe out the rice crop entirely. In addition of that, the crop losses caused by rats are also the serious issued which the rice growing facing every session. The estimated losses cause by rats between 5-10% of total annual rice production. As, such, effective rice field pest management is essential to reduce yield losses and prevent more serious damage to the crop. Several controlling methods had been implemented to tackle the problem under integrated pest management concept.

Integrated pest management (IPM) approach is the answer to tackle a pest attack. IPM implementation can also reduce the use of pesticide and avoid an environmental problem in the area. Nowadays, global needs the food to be free of chemical as well as good quality product. The main objectives in IPM is to train rice growers the concept of pest management using

Farmers invovled in training activities

combination of all suitable techniques to be practiced in his or her field. Other objectives of IPM are to control and maintain biological diversity in paddy field and to keep pest below threshold levels that can cause unacceptable crop losses.

Understanding how a crop grows and develops, and its place in the cropping system, is essential for successful pest management program. The knowledge of interaction between pest and crop management practices affecting crop growth and development, helps to draw an effective pest management plan. Furthermore several external factors also affect crop and make it more susceptible to pest attack or provide conditions for pest development. By knowing those factors, their effects and prevention or treatment, a successful pest management program are much easier to be developed.

Effective implementation of IPM on rice focused on 4 activities which are training, pest surveillance, illegal pesticide campaign plus pesticides application technique and traditional pest management practices. Farmers will be guided by technical extension together experts personal from DOA.

Training activities apply is face-to-face approach. Agriculture agent will meets farmer groups weekly or biweekly during the whole cropping seasons to share and discuss their observation and plan out activities for the following weeks. By this system, IPM activities were easily organized, implemented and blended into rice cropping system. Farmers will take action and make their own decision based on knowledge gained through the training. The training sessions include both theoretical and practical of pest surveillance, control and management of pest and disease, pesticides application techniques, safe use of pesticides, timing spray and selective use of pesticides in managing paddy pest.

Pest surveillance in this area is still within the Department of Agriculture responsibility. For this particular program a surveillance brigade are establish. This brigade will conduct pest survey

Surveillance bridget

for 6-7 round per season. The information will be used to predict and help in making decisions on the populations of the pest with consideration presence the natural enemies. If the pest population exceed Economic Trash holds Level (ETL), growers will be advice to take action to control the pest. Currently 12 pest surveillance centers carry out surveillance on the major rice granary areas, involving 240,152 ha of paddy area.

The third activity is to educate farmers regarding adverse effects of illegal pesticide for health and environment and proper techniques of pesticides application techniques. These activities aimed to reduce the use of banned and dangerous pesticide in agriculture industry especially in rice plantation. Normally farmers choose to use these type of chemical because of its effectiveness and immediate result on killing pest also their least cost. Farmers are also willing that their health at strake even though the several effect of these illegal pesticide has been inform. Many campaign has been done to acknowledge farmers the effect of illegal pesticide used on health and environment. At the same time, these campaign has also improve their skill in proper pesticides application techniques, an important part in IPM programmes. These learning process will be in theory and practical guide by technical officer from Biosecurity DOA.

The last activities is to educate farmers with traditional pest management practices in examples the used of biological agent to control pest or use of beneficial plant to attract more predatory population into their environment. Besides these, the used of IPM tools namely light traps, netting, pheromone traps, swapping net, and others will also be in the programmes. These practices are very important in implementation of IPM in paddy field.

In 2013, the Department of Agriculture Malaysia with the cooperation of Integrated Agriculture Development Area (IADA) had launched an IPM project in 540 hectares at Selangor main granary area. The main objective of these programmes is to give knowledge to the farmers to manage their own crop in the right manner via IPM principles. During this programmes, farmers will learn a combination of control pest methodology and also the pesticide application technique. These IPM programmes includes all activities from the beginning till the end of the planting season. The participant were selected by state agriculture office involving 40 farmers from 64 hectares planting areas. A committee was formed to discuss and plan for the overall IPM activities for the whole season. Under this programs, 2 groups of farmers were established which is one for surveillance brigade and the others is for pest control brigade. These 2 brigades are headed by agriculture officer from Biosecurity as a supervisor and mentor. Farmers selected for these program must attend a series of theory and hands on training for the rest of planting season. They will be able to recognize pest and predator-prey and also the symptom of paddy disease. They will be tough on recording pest which found of filed to the surveillance form in order to evaluate their ETL and finally to make a decision depending on the calculated ETL. They will also send the report to the committee for further action. The control brigade will only put into action when control operation is requested. They are provide with a personal protective equipment for the control operation.

In this program, farmer are introduce a methodology of destroying paddy straw by using decompose agent or burning to control pest and disease during land preparation. Farmers also be introduced the technology for control golden apple snails (GAS) by using a combination of IPM technique such as physical method (mutual assistance among farmers to collect and destroy eggs and adult), biological agent such as used of duck, biopestcide, and chemical control. Department of Agriculture support farmers these GAS control by providing duck to selected farmers (4 farmers involved in this programmes). Farmers which involved in these programmes are very happy and as they gain extra income from the selling duck eggs. According to the participant, their income from selling duck eggs is about RM70 to RM150 per day. Duck will be released to the field in the morning and evening when at the age of 1 month. 100 ducks will control GAS in 5-6 hectare planting areas. This is an effective way of suppressing GAS population in the rice field. Other IPM tools such as light traps, swapping net, T-stick for barn owl, pheromone traps to control stem borer and netting to trap migratory insect are also being introduced. Combination of all these technique has successful reduce pest incident in the area. The effectiveness and outcome of the project will be discussed in the committee head by DOA.

During these project, lot of benefit obtained by besides the raise of income. Farmers involved has increase in knowledge on pest and disease for rice. Their cultural practice and pest management has since changed after the implementation of the IPM. They know and can decide when to take action by using pesticide for control pest and disease. Before these programmes, farmers practice calendar spray which is not the best solution for controlling pest. Instead, pest population is higher before implementation of these programmes. After farmers change to IPM methods, predator population in these area increase based on their surveillance data. These also help to control the incident of pest outbreak. Surveillance data shows that insect pest population is lower than before and outbreak for diseases is very much under controlled. Farmers production increase about 3 to 3.5 tons per hectares after they practice IPM which is 12.33 tone per hectares against 9.9 tone per hectares before IPM project. Farmers involved in ducks programmes has also get extra income from selling duck eggs. These programs has avoided the use of illegal pesticide for control pest and the pesticide usage is reduced. Farmers whom are not involved in the program has shown interest to join and to try out IPM in their planting area. Department of Agriculture has always encourage and guide farmers to practice IPM in their areas.

The conclusion, these IPM project which is IPM in many ways complies with the ecological criteria and may be considered a sustainable approach to rice production, however, rice food security is dependent on the initiatives carried out to boost rice output. However, there is also an unpredictable factor in IPM implementation such as constant changing of weather conditions especially in the tropical climate often affects the success rate of the IPM programmes.

Human emotional and behavior also be a major factors in IPM practices successes. If 1 or 2 farmers in the committee cannot except the methodology and technology used in IPM programmes, it will affect all the areas of the programmes. Therefore, these issue need to tackle and settle in better way to get cooperation from all involved in these programmes. The experiences will gained from these programmes from time to time and these will improve the IPM implementation in rice field by farmers.

MYANMAR

Case Study 1: Rice IPM in the Greater Mekong Subregions

1. Background

In order to meet the food needs and expectations of a global human population, that is projected to increase to 9 billion by around 2050, crop production will have to increase by some 70–100% during the 21st century. In South East Asia, 618 million people (11.7%) currently live in 3.3% of the World's land area. Attempting to address this global issue, a number of recent, high profile, multiauthor, scientific and policy papers have identified the need for a holistic approach to a broad range of issues, including soil conservation, water availability and the need for sustainable and improved pest and disease management practices. With changes to market policy, rural development, low producer prices and increased costs of agricultural inputs, food production in the ASEAN countries can barely keep up with increasing demand: especially in the cities. Contamination of food with residues of pesticides, together with their impact on the environment in the rural areas, is a matter of increasing concern in this region and elsewhere.

In Southeast Asia, food supply is commonly based on smallholder structures, especially for important staple foods such as rice or soya. Furthermore, many cash and export crops such as oil palm, cocoa, or tropical fruits are grown by small farmers: often then supplying the processors of large plantations. The various technologies of the

'Green Revolution', including high-responding varieties tied to inputs of chemical pesticides and fertilizers, brought about increases in yield per hectare for many crops, but due to low and even declining producer prices, did not always increase income for rural families. This increased dependence of farmers on expensive chemical inputs, which sometimes was compounded by pesticide resistance and pest resurgence caused by the impact of broad-spectrum insecticides on natural enemies.

Rice is stable food for Asian countries and chemical insecticides have been used intensively to boost rice production. In recent years, Yellow Stem Borer, YSB (Scirpophaga incertulas) is very serious in some rice growing regions of Myanmar and reduce the yield evidently. Moreover, misuse and overuse of chemical pesticides leads to increase resistance to some insect pests, resurgence of secondary pests and residues on food. In Myanmar, most of the farmers rely on chemical insecticides. To reduce pesticides use and to produce safer foods for consumers, Integrated Pest Management (IPM) has become prominent in these days. Agricultural extension services, aided by international programmes and often supported by the Food and Agriculture Organization of the United Nations (FAO), GIZ, IRRI, EuropeAid, promoted IPM from the 1990s onwards. The (FAO) currently defines IPM as “an ecosystem approach to crop production and protection that combines different management strategies and practices to grow healthy crops and minimize the use of pesticides. FAO promotes IPM as the preferred approach to crop protection and regards it as a pillar of both sustainable intensification of crop production and pesticide risk reduction. As such, IPM is being mainstreamed in FAO activities involving crop production and protection.” IPM involves using the best combination of cultural, biological and chemical measures for particular circumstances, including plant biotechnology as appropriate.

Europeaid funded Greater Mekong Subregions (GMS) and provided technical assistance by CABI and IPP-CAAS (Institute of Plant Protection-Chinese Academy of Agricultural Sciences) to promote rice production by applying rice IPM. The project commenced in 2011 and egg masses of yellow stem borer in seriously damaging rice growing regions such as Yangon, Ayeyerwaddy, Bago and Mandalay.

2. Intervention rationale and objectives

IPM is a preventive strategy of crop protection that uses biocontrol as a main pillar and integrates various other methods. Specifically acting synthetic pesticides can be used as a last option. IPM is cost effective and prioritizes human and environmental safety. IPM also considers farmers’ local knowledge and practices, and the need for an appropriate level of education.

In Myanmar, rice IPM has been implemented with the aid of EuropeAid. The objectives of the rice IPM are:

- To reduce rice stem borer population
- To study *Trichogramma* and its distribution according to rice growing areas
- To examine the parasitisim of *Trichogramma* on laboratory and rice field
- To transfer technology and knowledge on stem borer controlled by *Trichogramma*

3. Activities

Four regions where rice is growing have been selected, namely, Yangon, Sagaing, Mandalay and Nay Pyi Taw. In Yangon region, Taik Kyee Township was selected to implement Trichogramma-based rice IPM. Trichogramma have been released in one selected field from that township and compared the situation of yellow stem borer eggs. Last year, one Trichogramma rearing facility (TRF) has been constructed in Yangon and now has been trying to rear Trichogramma. In this year, IPM knowledge and strategies have been disseminated to the farmers from selected regions. Two more TRFs have been renovating in Sagaing and Mandalay Regions. One more TRF will be renovated soon.

New *Trichogramma* Rearing Facility (TRF) in Yangon (7.3 m x 19.1 m)

Renovated *Trichogramma* Rearing Facility (TRF) in Mandalay

Renovated *Trichogramma* Rearing Facility (TRF) in Sagaing

5. **Process and methodologies used**

4.1 *Trichogramma* strain used

Trichogramma cards, which has prepared by exposing eggs of the factitious host *S. cerealella* glued to paper cards to female wasps of the *Trichogramma* strains for parasitization at a wasp to egg ratio of 0.1 for 43 h, were brought from China.

Small scale *Corcyra* (host for *Trichogramma*) rearing

Field Inspection in *Trichogramma* released paddy field

4.2 Field release design

The *Trichogramma* cards were released at 10-m distance, which resulted in nine release points in each plot of 900 m^2 (30 by 30 m). The distance between neighboring plots was 5 m. The plots were arranged as a completely randomized design. Within 7 d before the experiment, no insecticides were applied to the plots. In each plot, four rice hills each showing one

Yellow Stem Borer (YSB) egg mass were applied at southeast, southwest, northeast, and northwest direction at 7 m from the center release point in a plot. Ten randomly collected rice hills with YSB egg masses were labeled for easy recollection.

Development of *Trichogramma* on the cards was regulated at controlled temperature for timing of release. The *Trichogramma* cards were released by hanging on the topmost rice leaf blades in the afternoon in the field when initial wasp emergence (~ 5%) was observed. After

48-h exposure in the field, all the rice hills with YSB egg masses were recollected in the morning of 22 August.

Equal size of paddy fields (each = 10 ha) was selected for the experiment. Parasitized *Trichogramma japonicum* egg cards were brought from China. Each wasp card contained about 1000 parasitized eggs. Just before emerging from parasitized eggs, those cards were released at the rate of 100000 wasps/ha. Three days after releasing wasp cards, egg masses of yellow stem borer were collected and brought to the laboratory and kept at 28 ċ. The number of larvae emerged from yellow stem borer egg masses were counted and recorded every day. Four days after collecting from field, the emerged number of wasps from YSB egg masses were counted and sexed under microscope and recorded.**4.3 Data Collection**

The hills recollected from the field plots were potted and placed in cages (50 by 40 by 40 cm) at 24 ± 3 ċ and 75 ± 10% RH in the insectary. Seven days after field exposure to T*richogramma* wasps, the egg masses on the rice hills were collected, checked for the total number of eggs, number of eggs already hatched, and number of eggs turning black (i.e., parasitized), and then put singly into glass tubes with moist filter paper (25 ± 1ċ and 70 ± 5% RH). The tubes were checked daily for wasp emergence until 16 d after field exposure. Parasitism and wasp emergence rates were calculated.

5. Results and outcomes

In *Trichogramma* released field, the parasitism rate on YSB egg masses was higher when compared to non-released field. Less number of chemical pesticides applications was observed than non-released *Trichogramma* field. Less number of Lepidopterous species (e.g YSB and rice leaf rollers) were also found in *Trichogramma* released fields than non-released fields. Moreover, more population of natural enemies (e.g spiders, rove beetles, green plant bug) was found in the *Trichogramma* field plots than farmer’s practices field.

6. Lessons Learned

IPM is a globally accepted method to control pests. Biocontrol-based IPM can reduce the use of pesticide application, but it takes time and rather difficult to convince farmers. Moreover, it takes time to discuss with farmers not to use chemical pesticides. Biological control is one of the control measures to reduce chemical pesticides. It is very important to rear the host of *Trichogramma* (*Corcyra* eggs) so that the required *Trichogramma* can be reared commercially. As the released *Trichogramma* is potential to control YSB, more repeated release is necessary to get profitable result. The distance between TRF and implementation (transportation) should also be considered before releasing *Trichogramma*. Weather conditions such as extreme temperatures, heavy rain and strong wind should also be considered before releasing *Tricho*-cards as these conditions may disturb the parasitism of the released *Tricho*-cards. Timing is very important for successful releasing *Trichogramma*. It is important to coincide the presence of eggs of YSB in the field when releasing *Trichogramma*. More funds will be required and capacity building should be improved. Participation of farmers is critically important for successful rice IPM. Coordination and cooperation of stakeholders are also important.

Case Studies 2: Intra-regional transfer of biologically-based plant protection technology to improve livelihoods of smallholder maize farmers in the Greater Mekong Subregion

1. Background

Maize is one of the most important crops for animal's feed and human consumption. In Myanmar, maize has grown mostly in Shan state and Sagaing Region. Asian Corn Borer (ACB) (*Ostrinia furnacalis*) is one of the major insect pests in these regions which reduce the yield of maize. In order to minimize and indiscriminate injudicious use of chemical pesticides, Integrated Pest Management (IPM) has been enshrined as cardinal principle of plant protection in the overall crop protection. IPM is an eco-friendly approach for managing pest problems encompassing available methods and techniques of pest control such as cultural, mechanical, biological and chemical in a compatible and scientific manner. IPM technology manages the pest population in such a manner that economic loss is avoided and adverse side effects of chemical pesticides are minimized. IPM approach has been globally accepted for achieving sustainability in agriculture. It has become relevant due to a number of advantages like safety to environment, pesticide-free food commodities, low input based crop production system etc.

Maize IPM project was started in 2012 in Myanmar. This project is funded by EuropeAid and technically assisted by CABI (Switzerlands and China) and Institute of Plant Protection, Chinese Academy of Agricultural Sciences (IPP-CAAS), Beijing, China. Its main purpose is to promote livelihood of people who grow maize in GMS, especially China, Myanmar and Laos.

2. Objectives

- To improve the livelihoods of maize growers in Mekong Subregion by facilitating the transfer of knowledge on a biologically-based plant protection technology
- To outcome the mass production of the parasitic wasps, *Trichogramma ostriniae* to
- reduce the lepidopterous pests on maize, including Asian corn borer and apply this wasp extensively in field
- To develop economically and environmentally sustainable agriculture
- To facilitate the transfer of knowledge on a biologically-based plant protection technology
- Economically and environmentally sustainable, locally-adapted production technology transferred and biologically-based plant protection agents
- Knowledge and skills of production personnel, extension workers and smallholder farmers enhanced for the successful implementation of the BCAs
- Sustainable grassroots organisations nurtured to become key village-level providers of BCAs, agricultural inputs

3. Activities

Experimental **s**ites were selected where maize is grown commercially. Major maize growing areas are Shan state (156223 ha) and Sagaing Region (71382 ha). There are four experiment sites in Shan State as maize has been grown in these sites Regular field visits were made. Farmers were surveyed for their inputs (fertilizer, pesticides etc) and knowledge of pest control for maize. Knowledge of maize IPM was disseminated to regional plant protection staff, agricultural extension staff and farmers. Technical booklets, leaflets and other training materials were provided to farmers. Annual working plan workshop was held in one of the GMS member countries. Adapted TRF design was constructed to rear wasps. Application procedure of *Trichogramma* release was taught to local farmers and regional plant protection staff.

4. Process and Methodologies Used

Regular field visit to the selected maize fields to check the situation of Asian corn borers (ACB) and other pests. While visiting, farmers were shown to know how to identify pests and natural enemies of ACB. Three staff were sent to Henshui, China to be trained the production of Trichogramma in 2013. Then, pheromones traps setting and monitoring training was learnt. Practically Corcyra larvae rearing training to farmers were conducted.

And, farmers were shown how to apply Tricho-cards on maize. Before applying Tricho-cards, the maize fields were monitored. Seven acres of maize were conducted and replicated 3 times. Sixty Tricho-cards per acre (50000-60000 wasps/ac) were used for the experiment.

One control (7 ac) was used to compare with Tricho-card released field.

Inspection of Pheromones traps and TRF

Hanging the *Tricho*-cards in 40 days old maize plants

5 Results and Outcomes

IN 100 sampling maize plants, egg masses and bored symptom of ACB was not clearly different in treated and untreated fields. Wet weight of 100 cobs excluding husk in treated field was 9.49

kg and that of 100 cobs excluding husk in the untreated field was 9.02 kg. Farmers can now identify the damage symptom of ACB and handle its problems.

6. Lessons Learned

ACB is very serious injurious insect pest in Shan state all year round. If farmers can rear *Trichogramma* and release by themselves, maize production will be improved. Timing of releasing *Tricho*-cards is very important for successful ACB control. It is important to coincide the presence of ACB eggs in the maize field and the availability of *Trichogramma* to be released. Weather conditions such as extreme temperature, heavy rain, and strong wind should be focused before releasing *Tricho*-cards as they may affect the effect of the released *Trichogramma*. Participation of local authority concerned is also important for implementing larger maize IPM fields. Although chemical insecticides can be reduced when releasing *Tricho*-cards, it is impossible not to use them. Hence, it will be better if we can select the suitable strain adaptable to chemical pesticides. Livelihood of farmers will improve if they can follow biologically-based plant protection technique.

NEPAL

Case study 1: Peer pressure from fellow farmers can help reduce use of hazardous pesticides, and IPM FFS is the best approach for it.

Paras Thakur, 52, a dedicated farmer of Triveni village of Bhaluhi Bharbaliya VDC. He is also well known lead farmer to Research institutions and DADO of Bara and Parsa district. He sells healthy IPM
vegetables from his farm for about NRs. 50,000. in a season. In addition, he produces potato seed of PBS
and NL 297, 971 variety of wheat. He had received National Award on the occasion of World Food Day in 2000 for his dedication to using modern technologies in farming. He believes farming if done in scientific way can bring economic revolution in Nepal. He had received handful of training in health and agriculture, and had exposure of training both in Nepal and India. He received training in vegetable farming organized in Kathmandu and Naktajhij. He also received training on the maintenance of diesel pump set in Nepal and India. However, he was looking for practical training where not only single farmer learn but group of farmers could take advantage of the technology.

Objective: To assess the level of use of pesticide in the project site after implementation of IPM FFS.

In search of the continuous farmer's education, he joined a farmer field school (FFS) in 2009 where he was s Chairperson of the group. Later, he was selected to farmer's TOF raining. Now through IPM FFS and post FFS, he educates fellow farmers in his village. Few months before, he established cellar mill worth of NRs. 300,000 in his village where his two sons are engaged. He understood that how farm based training and education help farmers understand the new technologies and adopt it to their own field in a systematic way. Peer pressure from fellow farmers to optimize the use of fertilizer and reduce haphazard use of chemical fertilizers had changed the farming practices. He says "AESA is mirror of the IPM technology and Ecology is a balanced system". He was well aware of the degradation of environment .

Rationale: Progress reports of National IPM Program have shown that programe has empowered farming communities, particularly women and socially marginalized communities. The farmer groups are encouraged for advocacy and marketing of IPM IPM technology and IPM products. While discussing with farmers, they share that there is yield increment, reduction of the use of chemical pesticides, better farm managment, nursery managment, weed and pest managment and more trust in IPM technology. Talking about pesticide reduction through IPM FFS, a case study is necessary in the project site.

Methodology: Key informant interview, field observation

He still remembers that when it was difficult to breathe in the evening by the odour of pesticides that used to come from the field. Farmers in his village used to spray highly hazardous pesticide to control plant disease and insect without any care and they used to store the bottles and tank in the kitchen. Farmers used to smoke cigarettes and chew tobacco while spraying. He says that it was just like nightmare. Due to heavy use of pesticides such as thiamate, phorate, there was less population of earthworm. There was even couple of cases of pesticide poisoning, which he himself had to face police interrogation while trying to save the fellow farmers. Scenario has been now changed due to IPM FFS and post FFS activities. All farmers here grow crop using IPM technology. And there is heavy peer pressure from the IPM farmers not to use chemical pesticides. Because of this, neighboring farmers have also reduced the use of chemical pesticide and they come to seek advice from him. Therefore, he observes that after two years of IPM FFS, there is gradual increment in population of earthworm, honeybee and other useful insects in their surroundings. He is proud of being a farmer facilitator so that he can share the gift of IPM to his fellow farmers. He asks DoA/MoAD that Government should encourage adopting IPM technology all over Nepal so that peer pressure from the group will automatically discourage chemical pesticides and thereby reducing the use of chemical pesticides.

Paras Thakur working in his cauliflower field

Paras at his cellar mill of rice and other crops

Lesson learned: IPM farmer facilitators can act as good extension worker. Their involvement should be well preserved in planning process of agriculture in district. Peer pressure to fellow farmers is the key factor to adopt the IPM technology in project locations.

Case study 2: Chitra Nath Paudel

Chitra Nath Paudel, 35, is a progressive farmer and a good IPM facilitator. He hails from Hemja VDC– 2 of Kaski district. Currently, he grows vegetables, mostly: tomato, cole crops, potato and cucurbits and also runs farmer field schools.

Objective: To provide fellow farmers and field technicians a solid evidence of advantages of IPM FFS

Bygone days: When Mr. Paudel completed an I. A. from P. N. Campus Pokhara, he was looking for an income source to overcome the financial hurdles of his family. He was first reluctant to continue his ancestral profession of agriculture. He disliked the traditional way of farming. He argues that subsistence farming could not support his family. His father, a cardiac patient, needed more money every day for medical expenses when he was still living. Thus, he started commercial farming of vegetables in 2001. Though he was partly successful in his efforts, he thought of earning better than from the farm produce. So, he went to a manpower agency where he lost NRs. 60,000 in an effort to go abroad.

With no alternative, he firmly devoted himself again in growing vegetables such as cauliflower, cabbage and potato and cucurbits in his own field. Along with his own field, he grew tomato in a rented field of 30000 sqm. (6 Ropani) and was highly successful. He was awarded as the best farmer by a Local NGO in 2001. Encouraged by the award, he started tomato farming in plastic tunnels. Contrary to this, he was wits in mind when the prevalence of pests and diseases in vegetables that he grew increased uncontrollably. He bore a huge loss from pest and diseases.

Mr. Chitra Nath Paudel supervising his plastic tunnel. A pond is seen adjoining the farm.

Procedure: Interview technique (closed ended questionnaire) and field observation

IPM Entry: He joined the IPM FFS run by DADO Kaski in 2005. Because of his interest and enthusiasm, he was nominated as Secretary of the Farmer Field School.

Later he got IPM TOF to become an IPM farmer facilitator. He learned about the IPM tools and techniques of growing healthy crops by minimizing the use of pesticides. Besides identifying pests and diseases, he knows about the safe and judicious use of pesticides. He is grateful to the IPM Programme for the training and FFS. He is proud of being a farmer facilitator and is happy to share his knowledge with other farmers through the FFS. He likes to give continuity to his facilitation profession in the coming days.

Plastic tunnel for tomato farming owned by Mr.

Accomplishment: He grows Tomato himself in a large scale in 17 modified tunnel houses for which he has leased some plots. He has built a small pond nearby the tomato field. He also grows high value crops such as cauliflower, potato and cucurbits. He is fully convinced that more profit can be gained from IPM technique than the cultural practices adopted by most of the farmers in Nepal. With the investment of NRs. 85000.00 from a plastic tunnel house, he makes profit of NRs. 140,000 to NRs. 200,000 (US$ 1850—2700) every year. In addition, he runs Farmer Field Schools in the district and shares his experiences confidently with the participating farmers. He says that a successful farmer can be a good IPM facilitator and can confidently run IPM FFS.

Finally, Mr. Paudel wants to share a proven plan of growing tomato in a plastic house. He has a detailed layout plan of making a tunnel house of potato costing NRs. 36765 for which one can make a profit of NRs. 4500 in the first year. The area of one plastic tunnel is 120 sqm. (20 mX6 m) where one can grow 360 tomato plants

Lesson Learned: IPM FFS empowers farmers and develops expert farmers. Selected farmer facilitators can be well engaged as the extension workers for technology transfer to non trained farmers. In addition, they are economical and reliable source of knowledge and skills for the needy farmers. Local government bodies (DDC, VDC and Municipality) can utilize them for sustainable agriculture and thus helping farming communities. IPM techniques can be more fruitful to farmer if one practices him/herself and keeps learning attitude while adopting the techniques. There is nothing the end of techniques, more and more can be experienced through the better use of IPM techniques.

Source: case study, 2010, NIPM Program

Case study 3: Leadership by women is more sustainable than men

Mrs. Shashila Devi Khatri, 52, is the Chairperson of Deuti Bajyai IPM Group in Thakleni of Sahare VDC-2 in Surkhet District. She is a farmer, housewife and true advocate of pesticide free vegetable production. Deutibajyai IPM Group of Thakleni is famous in growing vegetables and selling it in local markets. The group is very active now and farmers of this group are jointly working for producing healthy products. This is possible because of change in leadership from male to female. She is succeeded to mobilize the farmers and lead the groups.

Rationale: IPM Programme has focused mainly the small farmers, particularly the women and disadvantaged groups. There were 50 - 99% women in IPM FFS established by National IPM Programme. As role of man is dominant over women in spheres of Nepali society, woman empowerment through FFS is necessary. NIPM Programme was strategically designed to empower women in all steps of program components. Thus, a case study of leadership of women throug IPM FFS would be more relevant.

Objective: To find out the effectiveness of women leadership in IPM FFS

Procedure: Key informant interview, field observation, group discussion

The group was first established in October 2009 with cooperation from District Agriculture development Office(DADO) Surkhet and National IPM Programme. When year long Farmer Field School(FFS) first started in the village, there were 21 female and 4 male participants. From the establishment, the chairperson has always been a male member of the group. However, the group function could not run properly in the first year. Instead of mobilizing team effort, the chairperson used to remain absent in the important FFS sessions and ordered to work in the FFS from his home.

FFS participants, particularly, females, however, could not resist the male domination and suppression from the behavior of the Chairperson. However, the FFS participant remained irregular in the FFS day. They tried their best to stop the dropouts in FFS and other irregularities in the group.

Women farmers of Deutibajai IPM group with IPM programme team

Mrs. Shashila Devi Khatri in her field

In a FFS meeting, the Chairperson of the group was forced to quit the position. With support from fellow farmers, Mrs. Shashila Khatri was selected new Chairperson of the team. When she became chairperson, few male members were not happy, either. She has better understanding of what is lacking in a team. With dedication, leadership and openness she won heart of the fellow farmers and IPM facilitators.

With her courageous effort, the group registered at DADO Surkhet and started saving-credit scheme among the group members. Because of her activeness, many farmers received training organized by IPM programme, DADO and other I/NGOs in the district. She made compulsion to have all member managed FYM and urine collection.

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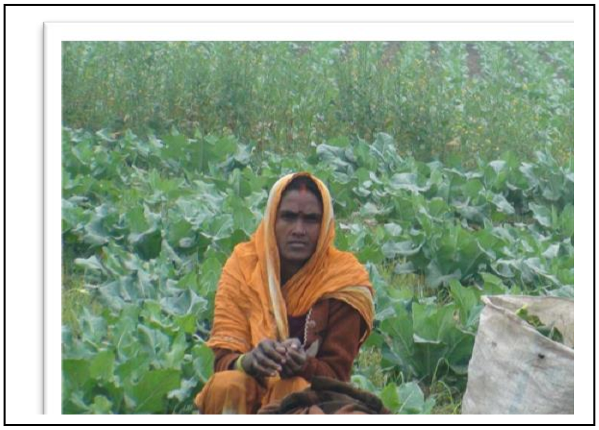
Chairperson Shahila Devi Khatri and her husband

She is determined to make her village a pesticide free area within a year. Under her leadership, now the group has produced two local IPM facilitators who regularly provide technical support to fellow farmers. She has managed uniform for all women members of the group. Moreover, she herself grows vegetables and other crops without chemical pesticide and minimum use of chemical fertilizer. She thinks that women are equally competent to men when opportunity is equally shared to both. Her husband is also participant of the IPM group. He supports her endeavor and says that success of wife also means success of both couple and family as whole.

Lesson learned: Empowerment of women can be ensured through IPM FFS. National IPM Programme has designed to provide leadership role to women in strategic way. When women in leadership position, fellow farmers, particularly women are more empowered and motivated.

Case Study4 : Spillover effect of IPM technology among fellow farmers



Mrs. Phulawati Devi Koiri, 35 is a female non participant farmer from Ward No. 3 of Bhaluhi Bharbaliya VDC. She is married with 3 children. She is living with her husband, children and father-in-law and mother-in-laws. She is literate with primary education. Her husband works in farm and occasionally goes for wage labour in Birgunj, nearby sub municipality. Her father-in-law who is 60 year old is the household head. All family members except her children work in farm and her family is the commercial vegetable grower.

Objective: To understand/know the spillover effects of IPM technology in project sites

They belong to Terai Middle caste and speak Bhojpuri. It is the main language of central Terai. Her family by profession is vegetable farming. They are small farmers with only 6 Kathhas of land. But, by renting land from other farmer they grow crop in 15 Kathhas (0.5 hectares) all the year round. All the lands are cultivable and irrigated. She grows rice, okra, cucumber, sponge gourd in rainy, vegetables, potato, spices in winter and okra and cucurbits (cucumber, bitter gourd, bottle gourd, etc.) in spring season. On average, she earns a net profit of NRs. 50,000 in a season. For education of her three children, food, medicine and other feast and festivals, the family has expenses of NRs. 15,000 in a month. Her family had less income 2/3 years before because of heavy production cost in managing pest and diseases of vegetables and other crops. In addition, the family members were suffering from unknown diseases.

Rationale: As IPM has been considered to be sustaianable approach to healthy crop production and pest management that builds social capital of farmer groups Intentionally or not, non participant of IPM FFS can be affected by programs, and the spillover effects should be taken into account, the survey of spillover effects of National IPM Programme is necessary.

Procedure: Site observation, interview technique

She had immense interest to be a part of IPM groups, both husband and wife were absent during the farmer selection process of FFS. She remembered that they were working in their field during the process. However, she remained inquisitive to knowing the IPM technologies what her neighbors were practicing. She is always in the field when her farm neighbors (who were IPM FFS participants) carry out any activities. First she copied many technologies through direct observation of the adjoining the field. She asked about some of the IPM technologies from her neighbors but her husband was reluctant to use them in her farm. Previously her family argued that IPM techniques are costly and increases cost of production and thus less or no profit at all. She did not hesitate to share that her husband was demoralized of the use of pesticide without protective measure two years before. Now, the family has a pesticide spray tank but they use it more safely.

However, with the success of IPM farmers in increasing yield and production, her family started to believe in IPM techniques. But, the use of chemical pesticides in her farm was not decreased in the first year. She herself had many health problems which she learnt from the fellow IPM farmers and facilitators that the pesticides are the main factor.

Ms Koiri works in the farm all the day long and prepares food and her children for school every day. They have two oxen, four goats and few chickens. Senior members of family take care of the livestock and poultry. Because her farm is near to the house, all family members work in the field. But her husband is often away for wage labour and selling farm produces. Because of competitive feeling and awareness on adverse effect of pesticide use, the family started adoption of the most of IPM technologies to grow vegetables and other crops. Whenever she has problems of pest and disease she recalls farmer facilitators first. There are 5 farmer facilitators in whole village. But she feels more comfortable taking advice from adjoining farm neighbors. Often time, she herself takes decision in the matter of crop production.

Ms Koiri is now able to identify quality seed, variety and manage application dose of chemical fertilizers both basal dose and top dress. She replied the crop geometry used for plantation. She can easily identify harmful and beneficial insects present in crop or field. She can tell the type of toxicity of pesticide by the color code of pesticide packs. She emphasizes on farm yard manure and compost preparation; which she prepare herself from the two cows and goats. Now she collects cattle urine for making homemade pesticides which she learnt from her neighbors. Though she does not go for selling vegetables, she does most of the field activities starting from soil preparation, nursery to harvesting. She praises herself that she is able to practice the IPM technologies in spite of her absence in IPM FFS conducted in her village. She encourages her husband to use botanical pesticides.

She, though shy, is proud of using IPM technologies for healthy crop production. She said that plant health, soil health and human health are more important than anything in life. She said that selling pesticide used vegetables meant selling poisons to the consumers. However, she shared me that she uses pesticides to protect crops from losses. However, she argued that they never got premium price for using IPM technologies. She told me that there are many non participant farmers in the VDC, both male and female, practicing IPM technologies. She claims that the use of pesticide has been reduced more than 50% in her village. She also share with me that she is more lovable in her family because of better use of technologies. She said that there are so many other IPM techniques. Finally, she thanked IPM programme and farmer facilitators who brought the IPM-FFS programs in her village. And, she wanted to be part of the IPM groups organized in the village.

Lesson learned: The spillover effects are seen in various pest management techniques and overall agronomical practices of crop production. The case study revealed that no participants of IPM FFS can also gain the knowledge over time wehne they percieve the technology is important and profitable to them in short or long run. Through the IPM FFS, the non target populations have also benefitted fromt the fruits of IPM approaches promoted by the National IPM Programme. The cluster approach of site selection and yearlong FFS is major factor for making behavioural and cultural change in crop production and pest management.

Source: Field observation survey in 2013, Mr. Buddhi Lal Chaudhary, M&E Specialist (NIPM), Rajesh Yadav (farmer facilitator) Triveni, Bara district, Nepal