Case Studies

Part 2

PAKISTAN

Case Study 1: Managing CLCuV through changing the planting time of cotton

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Background

Cotton is one of the most important fiber and cash crop of Pakistan which earns 60% foreign exchange for the country. The Cotton Leaf Curl Virus (CLCuV) disease is a major threat in reduction of cotton yield. By the early 1990s, CLCuV had become the major limitation to cotton production in Pakistan. The very characteristic symptoms include leaf curling, darkened veins, vein swelling and enations that frequently develop into cup-shaped, leaf-like structures on the undersides of leaves.

Intervention rationale and objectives

The disease is either managed through the development of resistant varieties or different standardized cultural practices. Key objective of the study was:

- To develop the capacity of FFS farmers in managing CLCuV disease in cotton growing areas of Pakistan
- To transfer indigenous knowledge on CLCuV management practices to neighbouring farmers

Process and methodologies

In Pakistan, Farmer Field School (FFS) farmers in three districts of Punjab i.e. Bahawalpur, Khanewal and Vehari are managing the CLCuV at their farms through changing the planting time of cotton. FFS farmers experimented to test the hypothesis of managing the CLCuV through early sowing of cotton by comparing it to mid and late sowing. Since last three years, they are comparing their early, mid and late sown cotton crop by counting the disease incidence %.

Results and outcomes

Data on CLCuV incidence was recorded on four cotton varieties (MNH 886, CIM 573, CIM 598 and BH 172) from April to November for early (April), mid (May) and late (June) sowing dates. The detail of data is as under:

District	2012	2013	2014
Bahawalpur			
Planting time	April, May & June	April, May & June	April, May & June
Results	Less disease incidence in April and May sowing	Less disease incidence in April and May sowing	Less disease incidence in early sowing as compared to late sowing
Khanewal			
Planting time	March, April & May	March, April & May	March, April, May & June
Results	Less disease incidence in early sowing than late	Less disease incidence in early than late	0% in early and 20% in mid & late sowing
Vehari			
Planting time	Last Week April	May	April, May & June
Results	Less disease incidence in late April sowing especially within two months period sowing	Less disease incidence in late May sowing	Less disease incidence in early sowing as compared to late sowing

FFS farmers are observing their cotton crop for CLCuV

The results showed that:

- Less disease incidence in April and May planting especially within two months period as compared to June sowing.
- CLCuV affected BH 172 and CIM598 cotton varieties especially in mid and late sowing.
- Early sowing (April to mid May) resulted in reduction of CLCuV due to its vector (low whitefly population) in cotton crop

Lessons learned:

- It is simple and highly economical method without adding of any extra efforts
- Early sowing of cotton crop is preventive measure to avoid CLCuV

- Neighbouring/ fellow farmers are practicing the same method to reduce the disease incidence of CLCuV
- FFS farmers in Sindh, Pakistan adopting same practice in their farms

Case Study 2: Managing CLCuV through Nitrogen and Micronutrients

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Background

Cotton, an important commercial crop, is extensively cultivated in Pakistan. It is infected by several pests and pathogens inducing different diseases. Among them CLCuV is the most important, causing enormous losses to the crop. Cotton yield in Pakistan is severely hampering by CLCuV during last 20 years.

Intervention rationale and objectives

Farmers are managing the disease by use different cultural practices and nutrients as foliar spray. In Pakistan, Farmer Field School (FFS) farmers in three districts of Punjab i.e. Bahawalpur, Khanewal and Vehari are managing the CLCuV at their farms through applying urea and micronutrients as foliar spray.

Process and methodologies

FFS farmers experimented to test the hypothesis of managing the CLCuV by applying foliar spray of urea and micronutrients. Best dose of Urea (2%) with micronutrient solution was applied with five days interval on cotton crop in different FFS at District Bahawalpur, Khanewal and Vehari in minimum one acre area after CLCuV symptoms were visible. Since last three years, they are practicing this method.

FFS farmer spraying 2% urea with micronutrients on cotton

Results and outcomes

The results showed 40 to 100% recovery of CLCuV. The detail is as under:

Districts	2012	2013	2014
Bahawalpur	1-3% urea along with micronutrients (Zinc, Manganese and Boron)	2% urea along with micronutrients (Zinc, Manganese and Boron)	2 % Urea with micronutrients (Zinc, Manganese and Boron)
	40-70% crop recovery	40-74% crop recovery	100% crop recovery Improved plant vigor Reduced boll shedding
Khanewal	1-2% urea along with micronutrients (Zinc, Manganese and Boron)	2% urea along with micronutrients (Zinc, Manganese and Boron)	2 % Urea with micronutrients (Zinc, Manganese and Boron)
	45-70% crop recovery	45-70% crop recovery	90-100% crop recovery Improved plant vigor Reduced boll /fruit shedding
Vehari	1-3% urea along with micronutrients (Zinc, Manganese and Boron)	2% urea along with micronutrients (Zinc, Manganese and Boron)	% Urea with micronutrients (Zinc, Manganese and Boron)
	45-70% crop recovery	45-70% crop recovery	80-90% crop recovery Improved plant vigor Reduced boll /fruit shedding

Lessons learned:

- Foliar spray of 2% Urea and micronutrients is effective in reducing the incidence of CLCuV in cotton
- Profitable and easy practice of CLCuV management for farmers
- Neighbouring/ fellow farmers are practicing the same method to recover their crop from CLCuV.
- FFS farmers in Sindh, Pakistan adopting same practice in their farms

PHILIPPINES

Case Study 1: The Success of a Farmer in Organic Green Corn business through the Use of Biological Control

Name: Mr. Ernesto R. Romero

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Mr. Romero is a farmer in Nueva Ecija. He is planting crops like rice, corn and vegetables. He is very concerned about his health .He was introduced to Integrated Pest management when he met one personnel from the Bureau of Plant Industry and was able to attend some seminars for farmers in their municipal hall. In that meeting with the Bureau of Plant Industry (BPI)personnel, he first learned about biological control whom he got interested.

He asked the personnel to give him some samples of Trichogramma evenescens whom he applied on his corn plants. He observed that Trichogramma, a wasp parasitoid really works on his farm. From there on, he always ask BPI to bring him Trichogramma cards to be applied in his field.

Selling green corn became one of his business and his selling point is that he is not using chemicals unlike other planters who are using Furadan, a very strong "kill all" pesticide. So it contributes to his success in business.

But there are time especially rainy season when Trichogramma efficiency lowers. So he asked again BPI what to do. The population of cornborer is increasing during those times. So the BPI personnel gave him again another biological control agent, the earwig. Earwig is a general predator. He combined both Trichogramma and earwig in his corn plantation. Now his corn business is thriving and still his seeling point is his corn is organic.

At present , he is now an avid fan of biological control and he is using all available biocon agents in his farm be it on vegetable, rice or corn.

He became an outstanding farmer of Nueva Ecija in 1995, Most Outstanding Member of Seednet, an association of seed growers and awarded as Farmer Scientist of Region 3.

Case Study 2: Success Story of Valencia Bukidnon, Rice Farmers Group

Author: Mr. Audy Maagad

They were two groups of Farmer Field School graduates in Bukidnon Province. Thirty two of them are males while thirty nine are females. The aimed to increase their rice productivity, reduce the cost of production and increase their farm income. So they participated in a pilot program of FAO in collaboration with the Philippine Department of Agriculture.

The following field management were followed by them:

Field Management

1. Thorough land preparation
2. Use of best performing and high quality rice seed variety in their area
3. 20 x 20 cm distance of planting
4. 1-2 seedlings per hill
5. Soil analysis
6. IPM based on biological control
7. Water management (AWD)
8. SRI method
9. Nutrient manager

Harvest management

1. Planting of vegetables like legumes in bunds
2. Organic fertilizer
3. Rice-culture
4. Aquatic biodiversity

In order to have a comparison, they gather data from other farmers which they called farmers practice. There are many management practices which are not present in those listed above. Like they do not do soil analysis. They do not plant also other crops on the bunds. They also use chemicals for pests management.

The result of Valencia, Bukidnon FFS group compared against the regular Farmers Practice are the following:

Cost of Production

Farmers Practice	Valencia Farmers Practice	Diffrence	Savings (%)
Php 14,380.00	Php 12,400.00	Php 1,980.00	14

Net Income: increased by 58%

Added Income:

Rice (FP)	Rice (Valencia Farmers)	Add'l Income from Vegetables and /ducks	Gross Income of Valencia Farmers
Php 98,040.00	Php 126,920.00	Php 18,000	Php 144,480.00

Return of Investment(%)

Farmers Practice	Valencia Farmers Practice	Difference
5.82	10.65	4.83

So the Valencia Farmers have succeeded in increasing their income in a monocrop area by incorporating other farming considerations like planting additional crops on bunds and raising ducks. By not using inorganic pesticide also, they were able to catch again their endemic fish and other aquatic organism which also can supply protein in their diet. The presence of aquatic organism which were not present before means improving the biodiversity in the area which will help in the resiliency of the environment in coping with changing agro-climatic conditions. Also, all farmers in the Valencia group are healthy because they have healthy environment and good source of health food.

The major lesson we learned from here is healthy environment and biodiversity will contribute to good crop production leading to healthy life.

SRI LANKA

Case Study 1: FFS to combat rice field rats in Kahapathwala

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Introduction

Kahapathwala is an isolated village, located in Kurunegala district, where almost all families have small piece of land to cultivate rice for their consumption only. The size of the village is about 50 ha occupied around 160 farm families with land holding of around 0.25 – 0.5 ha per family. Almost 75% of farmers are part time farmers who attended in rice field activities in need based or in weekends. Farm women or parents of the family looked after the cultivation after crop establishment.

This is a 100% rain fed area without proper irrigation facilities and run off and seepage from nearby mountains directed to rice fields. Therefore they cultivate rice in only one season (rainy season October to February). Some farmers cultivate vegetables during the rest of the year with manual watering. The main problem of their rice cultivation is the crop damage due to rice field rats.

The leader of the farmer organization of the village invited us to help them in management of rice field rats which they struggle for last 5-6 years. When we conducted a baseline survey of the area, we came to know that around 30% - 80% of the crop yield has been damaged by rats depending on locations. The area is a valley in between two mountains which has been converted to rice fields, and therefore the surroundings provide favorable environment for rats to living and multiplication. Fields are constructed with small terraces and many bunds, due to the high slope of the land. Bunds covered with full of weeds providing favorable environment for rats.

Surroundings full of weeds

About 90% of the farmers try to manage rats only with rodenticides without success and the other farmers harvest remained part as the yield.

Knowledge of the complete rice IPM package among farmers is 0% however 60 % of them know about natural enemies like dragon flies, lady bird beetles and some birds associate in rice fields.

We conducted a FFS in 2014 Maha (rainy season) to train farmers on IPM, putting special emphasis on field rat management. Field rats became important not only because of crop damage, but also transmitting the serious human disease Leptospyrosis.

It was decided to conduct FFS to manage rice field rats first and coming season FFS for rice IPM at the meeting of farmer's organization.

Completed FFS training schedule is given below (Mainly focus to rodent management)

Session 1 –Introduction, area mapping and collection of information on locally available rat management methods.

Session 2 – Identification of rice field rats, their habitat, and calculation of their reproduction rate (practical session)

Session 3 – Learning about rat burrows (open and observe)and estimation of live rat burrows present in individual fields (Home work - Opening and destroying of rat burrows and cleaning of bunds and surroundings to reduce rat establishment.)

Field establishment of crop

Almost all farmers carryout followings.

- Cleaning of bunds and surroundings to reduce rat population buildup.
- Vegetable cultivation on bunds is encouraged, as farmers believe, when people moving on bunds rats do not like to live in bunds.
- Observation and destroying of new rat burrows, applying local methods of rat management such as broadcasting goat dong where rat damage take place, applying glidiceria branches , peaces of wiled pineapple , to field where rat damage first seen and continued weekly.

Cleaning bunds

long bean cultivation on bunds

Session 5 – Introduction of chemical control.(rodenticides) and placed rodenticides where necessary.

Results

Rat damage reduce to 80%. Farmers are so happy and organized field day to show results to farmers in close by villages. From vegetable cultivation they received additional income. They agreed rat management cannot achieve individually but as a team it is very successful. Farmer's organization agreed to conduct FFS to learn IPM and increase their yields while reducing application of pesticides.

THAILAND

Case Study 1: Cassava IPM for Pink Cassava Mealybugs control in Thailand

1. Background

Cassava is a major crop used for human consumption, animal feed and bioenergy production. Large numbers of farmers derive their livelihoods from cassava production. Cassava production in Thailand has undergone expansion and intensification in recent years, particularly driven by high demand of raw materials for bioenergy production. In Thailand, cassava is plant in approximately 1.60 million hectares in 51 provinces (from 77 provinces) in 2014, it is also destined for the export market. Thailand is a biggest exporter and China is the largest importer of dried cassava and starch. Presently, China and Thailand are using cassava mostly for animal feed and industrial purposes while some other countries are using it principally as food, although there is interest in possible diversification.

The recent incursion into Thailand by the exotic pest pink cassava mealybug (Phenacoccus manihoti) and its rapid spread the infestation of many provinces in 2008 caused extensive cassava crop damage and losses. The pink cassava mealy bug, P. manihoti, is an invasive insect pest in Thailand. How and when the pink cassava mealybug first arrived is unknown, but the first report of an outbreak was in 2008 in Kamphaeng Phet, a province located in the north of the Central Region. the pink cassava mealybug is by far the most serious pest in native environment of South America, P. manihoti is kept under control by natural enemies. However when P. manihoti was accidentally introduced to Africa in 1973, the natural enemies were absent and the rapid spread of the pest resulted in very high losses to the cassava crop. A natural parasite of the pink cassava mealybug in South America, Anagyrus lopezi, was identified, imported to Africa, mass reared and released. By the end of the 1980s, the pest was being kept under control by A. lopezi.

2. Objectives

1) To combat the CM by developing pest-spread prevention strategies and ecological pest management approaches for mealybug management.

2) To reduce cassava crop damage and losses from pink cassava mealybug.

3.Activities done

<u>Survey</u>

Since the pink cassava mealybug was first found in Thailand in 2008 and caused serious damage later, many activities were done to combat the pink cassava mealybug. According to the results of a survey of mealybugs on cassava in Thailand, there are at least 4 species present: the striped

mealybug, Ferrisia virgata; the jackbeardsley mealybug, *Pseudococcus jackbeardsley;* the Madeira mealybug, *Phenacoccus madeirensis* and the highly-invasive pink cassava mealybug, *Phenacoccus manihoti*. The first 3 species are common insect and do not cause serious damage, only P. *manihoti* causes serious losses to cassava production.

IPM implementation to control pink cassava mealybug

To combat the pink cassava mealybug, *Anagyrus lopezi* was introduced to Thailand

from the International Institute of Tropical Agriculture)IITA (Benin for biological control of the pink cassava mealybug in 2009. Rearing and releasing the parasitoid: A.*lopezi* and local predatory lacewings: *Plesiochrysa ramburi* and others related environment friendly technologies. It is proved that by using the introduced wasps for the exotic mealybug and local predators together with ecological pest management with the training efforts of field extension workers and farmers has proved highly effective in dealing with the cassava pests problem.

Technology and knowledge transfer

The Regional Training Course on Cassava Mealybug and its Management is being conducted as an activity of the regional FAO project to provide necessary knowledge for GMS partner countries on developing pest-spread prevention strategies and ecological pest management approaches for mealybug management, including facilitating the introduction of natural biocontrol options to prevent further spread of the pest not only across each country but also beyond to other GMS partner countries

4. Process and methodologies used

Since 2009 the cassava pest control were conducted under the collaboration by many stake holders DOAE,DOA, KU and TTDI with the help and supported by international organization as FAO and CIAT. The management of cassava mealybug by biological control : rearing and releasing *A. lopezi* parasitoid and *P. ramburi* local predator together with other technology in IPM which has proven very effective in Thailand. Since Integrated pest Management) IPM (play importance roll to control pest efficiently, economically and sustainability, the control methods of pink cassava mealybugs which are recommended by the collaboration of KU DOAE and DOA are:

- -Cultural control : we recommend to do sanitation in the infested field before planting by plough and dry the soil at least 2 weeks, and planting with clean material
- -Chemical control: Soak the cutting stalk in Chemical solution before planting.
- -Biological control : by rearing releasing parasitoid : *A lopezi* , predator : *Plesiochrysa ramburi* and other exist Natural enemies
- -Mechanical control : cut the damaged shoot and burn.
- -Legal control :Inhibitted on transportation of the mealybug contaminated stalk which avoid the contamination to the other area.

The IPM recommendation were introduced to farmer through Community Pest Management Center (CPMC). The CPMC were established since 2008, the major objectives are transferring the knowledge and technical know-how to the farmers, support farmers in the controlling of their major plant pests by themselves and supervise farmers to rear natural enemies and microorganisms used for biological control. The responsibilities of CPMC are weekly do field monitoring, report pest situation weekly, transferring technology by FFS, all activities were done by farmers.

5. Results and outcomes

To date, institutions in Thailand in particular DoA, DoAE and TTDI have gained immense experience and possess the expertise to effectively combat the PCM, by the cooperation: 1) More than 40,000,000 pairs of *A. lopezi* and 50 million of green lacewings of

P. *ramburi* were produced and released during July 2010-August 2014. 2) Number of areas of infestation observed around 300,000 hectare in May 2009 was reduced to 10.88 hectare in October .20133) Since 2013 to now, the infested areas are fluctuated from 10 -200 ha. never more than 1000 ha. Finally, the pink cassava mealybug are under control now.

6.Lessons learned

1) The collaboration of all stake holder together with farmers participation lead to the succession and sustainable intensified of cassava production through effective management on cassava pest control.

2) The sharing of technological knowledge are necessary to the neighbouring and other GMS countries to avoid movements of cassava planting materials there exists a real risk that the PCM will soon spread to pose serious threat to the cassava production and the related industry throughout the GMS. If nothing is done at regional level, the GMS countries will face additional pressures pertaining to alleviating rural poverty and improving food security.

Conclusion

This strategy are already implemented to the farmer practice through the Farmer Field School approach. All activities are conducted through community pest management center (CPMC). After some years of the project, the result shown that the risk by losses dued to PCM outbreak is declined give more sustainable results.

Case Study 2: Vegetable IPM for (DBM) control , North of Thailand

1.Background

Diamondback moth (DBM), Plutella xylostella, poses a major constraint to crucifer vegetable production in the highlands, North of Thailand. Such those cased, there are 2,400 hactare of cabbage fields in Tub-berg village, Lomkao district, Petchabun province, in with at lease 2-3 cabbage crops are grown throughout the year. The farmer always use pesticides to control pests, especially Diamond Back Moth (DBM), Plutella xylostella which a huge amount of pesticides were used. Heavy reliance on chemical control resulted in frequent DBM resurgence, human health hazards, environmental pollution, and threat to the export market.

Since Oct. 2004, the FAO (The FAO Inter-country Programme to Strengthen IPM Training and Sustain IPM Practices Among Vegetable Farmers in South and Southeast Asia) and DOAE undertook collaborative work on DBM classical biological control in highland cabbage production in Phetchabun Province. This collaborative work with a particular technical support role by the DOAE-Pest Management Division. To overcome DBM problems, biological control was explored, with initial surveys to determine the parasitoid diversity and abundance. These were conducted on

crucifer crops above 1000 m altitude in Chiangmai and Phetchabun highlands in October 2004. The survey of DBM and its indigenous natural enemies together with an analysis of weather data has been implemented continuously even since. Findings revealed no DBM egg parasitoid but presence of larval (Cotesia plutellae, Macromalon orientale) and pupal (Diadromus collaris) parasitoids, with average overall combined parasitism of 42.3% which were insufficient to suppress DBM populations. Since the DBM parasitoid Diadegma semiclausum was not found, the Thai Government proceeded in 2005 to introduce it from the Cameron Highlands in Malaysia

A Brassica IPM strategy with an integral biological control component, most notably the release of parasitoid (Diadegma semiclausum) to control Diamond Back Moth, was introduced to the farmers for implementation in their brassica crops in Tub-berg village, Lomkao district, Petchabun province starting in October 2004.

Intervention rationale and objectives

1.To improve environmental conditions to provide favorable conditions for effective DBM biological control by Diadegma semiclausum.

2. Strengthen IPM Training and Sustain IPM Practices to reduced pesticide used and introduce biological control to control DBM.

Activities

1.Survey done in 2004 to document natural biological control revealed the presence of the parasitoids Cotesia plutellae, Macromalon orientale and Diadromus collaris. These, having a combined overall parasitism rate of 42.3%, were insufficient to suppress DBM populations. Since the major DBM parasitoid Diadegma semiclausum was not found, the Thai Government proceeded to introduce it from the Cameron Highlands in Malaysia.

Diadegma semiclausum parasitizing the DBM lava the DS pupa and farmer releasing parasitoid

2.In 2005, parasitoid Diadegma semiclausum were reared and released in FFS fields. Patches of crucifers were planted during off-season periods to provide year-round food for DBM, the latter as host for the parasitoids. In this field site, farmers participated in two rounds of consecutive IPM-FFS.

3.The mass production and field introductions of the parasitoids at sites where farmers have.

4. Monitoring and Evaluation activities had also be undertaken as to determine establishment of the parasitoid and evaluate their capacity to regulate DBM populations.

Process and methodologies used

The extension activities that have been done :

1. Training on Diadegma semiclausum rearing for the staff of DOAE Provincial Agricultural extension officer, the research assistants and farmers.
2. The refresher course for IPM trainers to increase facilitation skills of
2. IPM trainers and design the M&E systems for quality control of IPM farmer education.
3. The training course for IPM- FFS
4. The Evaluation and Planning Workshop
5. Survey, Mass Rearing and field introduction of parasitoids and M&E for parasitoid establishment and effectiveness assessment:
6. Production of advocacy and adapted training materials,the short version of Brassica IPM Ecological Field Guide and IPM-GAP curriculum.

Results and outcomes

The results indicate that DBM larvae are actively being parasitized by the introduced parasitoid, *Diadegma semiclausum*. The results from the monitoring also confirmed that the parasitoids were established in Tubberg village, Lomkao district, Petchabun province because they can survive on the stubble brassica residues after harvesting into the new growing season. The parasitoids were also found in non-released fields indicating progressive spread of the parasitoids area-wide.

After participation and aided by high levels of biological control from parasitoids, farmers reduced pesticide use from 18-20 times to less than two times per crop. Subsequently, more parasitoid

releases took place area-wide (400 ha) in joint efforts with up-scaling of IPM-FFS training to 100 farmers.

Rearing *Diadegma semiclausum* in the laboratory

Continuous surveys done until 2010 consistently confirmed the spread and establishment of the parasitoid over 800 ha with satisfactory parasitism rates (80%) in fields where farmers practice IPM. Farmers now can produce higher quality crucifers with no concern of unacceptable pesticide residues, and have gained access to more domestic and international markets. That D. semiclausum can readily establish area-wide in intensively-sprayed crucifers in Phetchabun clearly illustrates the importance of coupling IPM-FFS training with parasitoid releases where crops are sprayed heavily.

Since Thailand have promoted the qualified agricultural products available for marketting reason through GAP, the GAP rule were introduced to the cabbage planting in Tubberg district. The result followed, the cabbages were produced with IPM production technology were finally get certified by Q-GAP label and end up in the high end market.

Lessons learned

The success of pest control through IPM will be most effective if farmer have selected the right methods which based on the situation and ecological basis. Eventhough the parasitoid, Diadegma semiclausum are most effected to control DBM, the others method were still necessary to practice to support and provide good condition for the parasitoid such as keep the cabbage field after harvesting ,the Ds have to live longer in the leftover cabbages.The other pest like Pieris sp., flea beetles may cause a lot of pesticides used which need to provide another control methods to control them. Because of those reasons, monitoring, rearing, releasing activities may need to be done continuously.

TIMOR LESTE

Case Study 1: Beyond the Control of Diamond back Moth Plutella xylostella in Timor Leste

a case study from Maubisse sub district, district Ainaro, Timor Leste, April 2010

Department of Plant Protection National Directorate of agriculture and Horticulture Ministry of Agriculture and Fisheries Timor Leste

Background

Timor Leste situated in the eastern half of Timor Island and it is located between Australian and Indonesia. About 85 % of population from 1,4 million rely on agriculture as a main source of income. Rice and maize are the major staple food, moreover, beans, potato, sweet potato, cassava and vegetable is also being cultivated by the farmers. Most of Timorese farmers is subsistence farmers with small landholding and produce for own consumption. The total area of Timor Leste is 14.000 Km^2 which include high land and low land.

Cabbage is the main vegetable crop for people who live in the hilly areas of Timor Leste. For example Ainaro, Aileu and Ermera District.Meanwhile, at other district, cabbage also being grown, but the quantity are small. While cabbage is the main crops, there are also other crops such as potato, sweet potato, beans, and other vegetable crops. During growing season, cabbage is mainly attacked by diamond back moth *Plutella xylostella* and this pest becomes a serious threat for cabbage growers.

Farmer often relies on cultural control method such as sanitation and intercropping, however, the productivity of the cabbage declined. To respond to this issue, the introduction of chemical control becomes first priority to the cabbage growers.

Objectives

The objectives of the this study is to find a suitable solution on how to control *Plutella xylostella* Diamond Back Moth using less cost method of control and to minimize cost of production.

Activities

The activities include field survey, setting up of demonstration plot, and observation of plot until harvesting of the cabbage.

Process and Methodology used

The process and methodology used in this activity is setting up demonstration plot and after that application of integrated management in order to minimize the damage of Diamond Back Moth on cabbage. There are three types of management strategies which are used such as chemical control, biological control and cultural control (sanitation). The application of chemical at weekly base, and about 6-7 chemical spray until the cabbage is harvested. While the sanitation process also at the same level with chemical application. Observation for damage percentage and number of Diamond Back Moth larvae is done before the application of treatment.

Result and outcomes

At the harvesting time, we count the cabbage's weight, calculated the percentage of damage and compare different treatments. The result show that chemical control using of inorganic insecticides has less weight compare to biological insecticides, and control or use of sanitation only also provide same weight, but the damage percentage is high on control.

Figure 1. Farmer with his demonstration plot

Lesson learned

Most of the farmer is interesting in using of biological insecticides such as Bt, and it provides better quality of cabbage and gain more weight in a short period. Moreover, the method of application is not difficult and there is no environmental damage.

Some photos

References

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Case Study 2: Increasing potato production through IPM strategies

(a case study from Hatubuilico sub district, District Ainaro, Timor Leste, December 2010)

Department of Plant Protection National Directorate of Agriculture and Horticulture Ministry of Agriculture and Fisheries Timor Leste

Timor Leste situated in the eastern half of Timor Island and it is located between Australian and Indonesia. About 85 % of population from 1,4 million rely on agriculture as a main source of income. Rice and maize are the major staple food, moreover, beans, potato, sweet potato, cassava and vegetable is also being cultivated by the farmers. Most of Timorese farmers is subsistence farmers with small landholding and produce for own consumption. The total area of Timor Leste is 14.000 Km^2 which include high land and low land.

Figure 1. Map of Timor Leste

Potato is also one of important source of income for people who live in the hilly areas of Timor Leste such as Ainaro and Aileu districts. Potato has been cultivated during Portuguese occupation until today, and the production is not increase due to attack of late blight of potato. This fungus attack during growing season when the condition is favorable for disease development, and at the early January, the fungus is more due to high rainfall rate.

The objectives of the this study is to find a suitable solution on how to control *Phytopthora infestans* Late Blight of Potato using different fungicides with different dosage.

The activities include field survey, setting up of demonstration plot, and observation of plot until harvesting of the cabbage.

Figure 2: disease observation and spraying of fungicides

Process and Methodology used

The process and methodology used in this activity is setting up demonstration plot and after that application of integrated management (spray different fungicides) in order to minimize the damage of late blight fungus on Potato. There are three types of fungicides which are used such as Ridomuil MZ, Daconil and Choloratanil. The application of chemical at weekly base, and about 6-7 chemical spray until the Potato is harvested. Observations for damage percentage and insect pest damage at the field condition. At the harvesting, counting the number of tubers per plant.

Result and outcomes

At the harvesting time, we count the number of tuber per plant and weight them in order to compare different fungicides treatment. The highest number of tuber found on fungicides Daconil, however, Dithane and Ridomil has low number of tubers. On the other hand, the weight of potato tuber is more on Dithane than other two chemicals.

Figure 3. Farmer happy face at harvesting

Lesson learned

Most of the farmer is interesting in using of Daconil to control late blight of potato, moreover, other fungicides such as Ridomil and Dithane also can be used if require. Farmer also learned on how to make proper observation of diseases outbreak and when they have to take a control measure.

VIETNAM

Case study 1: Save & Grow practices utilizing integrated rice-fish-aquat biodiversity increases gross income by 210%-550%

The Regional Rice Initiative (RRI), a pilot of the Strategic Objective 2 "Sustainable Management of Agriculture, Forestry and Fisheries" of the Food and Agriculture Organization of the United Nations, is designed to focus on the importance of goods and services produced by and available from rice ecosystems, and to identify and locally test sustainable rice production practices to enhance resilience and increase efficiencies in rice production to improve food security. In 2013, pilot activities under the first phase of the project were carried out in Indonesia and the Philippines. At the start of the second phase of the Regional Rice Initiative, Vietnam participated in the workshop on "Experiences and Results Sharing on pilot Save and Grow Farmers Field Schools (FFS) for Sustainable Rice Intensification" held in Bali, Indonesia from 3-5 April 2014

Vietnam is one of the countries supported by the Swedish-funded FAO Asia Regional Integrated Pest Management (IPM)/Pesticide Risk Reduction Programme. The Programme maintains a well-established network of government and civil society organizations committed to empowerment of rural communities and improving smallholders farmers' knowledge and skills on ecologically sound agricultural production and protection. The RRI pilot project activities in Indonesia and the Philippines built on the capacities of this network of government and civil society organizations (CSO) partners of the FAO Asia Regional IPM/Pesticide Risk Reduction Programme. In response to the interest of other countries and as a way to expand the utilization of experiences gained from RRI-1, pilot Save and Grow activities to be supported under the Swedish-funded programme were implemented in Vietnam in 2014.

With support from the regional CSO The Field Alliance/Thai Education Foundation and the local CSO, Center of Initiatives on Community Empowerment and Rural Development (ICERD) training on aquatic (including rice-fish) and agrobiodiversity and pesticide impact assessment were carried out for communities. Initial surveys carried out by ICERD showed that farmers in selected sites in Bac Giang and Quang Binh provinces in northern Vietnam practice rearing fish in ponds close to rice fields. Some farmers reportedly released fish from the ponds into the rice fields after harvesting. Pesticide use - about 5-7 applications per crop, not including herbicides - was the key reason. As part of the process of community education on pesticide risk reduction, the FAO-supported National IPM Programme assisted the formulation of Community Action Plans and trained farmers in FFS to reduce pesticide risk, including the use of biological control options for pest management. Among other agreements, various stakeholders in the commune - including local government, people's organizations (Farmers'

Union, Women's Union, Youth Union, etc.) and farmers agreed to improve the rice ecosystem as to integrate rice-fish-aquatic biodiversity in the production system.

A total of 105 farmers (55 women) from Bac Giang and Quang Binh applied rice intensification practices learned from FFS to an area of 34 hectares. Rice fields adjacent to each other were selected for the Save and Grow study plots. Following good principles and practices of Save and Grow, rice farmers applied efficient management, growing healthy, well-yielding crops with fewer and more sustainable production inputs. Farmers explored making optimal use of multiple goods and services of paddy-based farming systems - including conservation and management of aquatic biodiversity (including both captured and cultured fish species) - in combination with improved agronomic practices such as wider plant spacing/reduced seeding rates, improved water management, and reduced chemical pesticides through the application of ecologically sound IPM. This included the use of biological control agents such as Metarhizium anisopliae as an alternative to chemicals for the management of the brown planthopper and natural biological control provided by ecosystem services.

Table 1 summarizes the differences between yields and benefits farmers obtained if the farmers only grew rice and when aquatic biodiversity was integrated in the production system

Table 1: Yields and benefits from rice only and integrated rice-aquatic biodiversity production systems

Parameters	Total Bac Giang	Total Quang Binh	Average
A. Rice yields (kg/ha)	6,120	5,417	5,768.5
B. Gross income from rice production only (US$/ha)	2,215	1,569	1,892
C. Yields of fish and other aquatic organisms (kg/ha)	7,913	1,860	4,886
D. Gross income from fish and other aquatic organisms (US$/ha)	9,981	1,738	5,860
E. Gross income from rice, fish and other aquatic organisms [B + D] (US$/ha)	12,196	3,307	7,751
F. Input costs (US$/ha)	4,547	1,402	2,975
G. Profits [E - F] (US$ /ha)	7,649	1,905	4,776
H. Difference in gross income between rice production only and integrated rice-fish-aquatic biodiversity production (% increased)	551%	211%	381%

Exchange rate: US$1:VND21,405

The average gross income from integrated rice-fish-aquatic production is US$7,751 compared to US$1,892 obtained from producing only rice. Utilization of integrated rice-fish-aquatic biodiversity production practices resulted in average gross income ranging from 211%-551% compared with producing rice only. Farmers' experience and the aquatic biodiversity species and numbers - especially fish - accounted for the big difference in benefits. Informed management decision making based on agro-ecosystem analysis, the use of ecosystem services such as natural pest control to avoid unnecessary use of chemical pesticides and the use of biological control agents also contributed to effective and sustainable pest management. The fish provided additional services by eating insect pests found at the stem and base of rice plants and those that fall into the water. The value of these ecosystem services are not reflected in this case study

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Figure 1: Yields from rice only and integrated rice- aquatic biodiversity production systems (kg/ha)

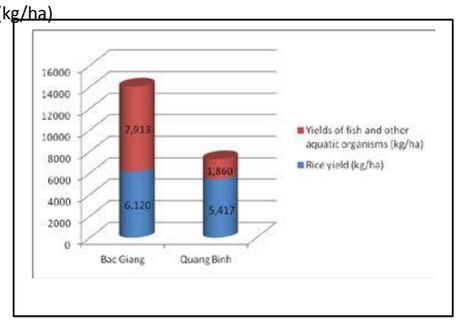
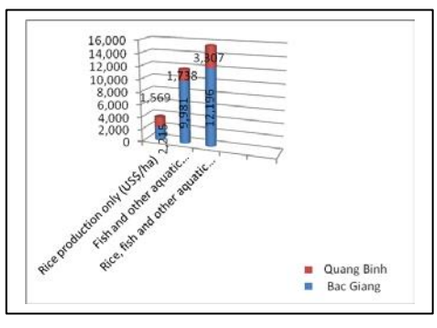


Figure 1: Gross incomes from rice only and integrated rice-aquatic biodiversity production systems (US$/ha)



The Save and Grow FFS provided opportunities for farmers and other community stakeholders to field test rice intensification practices, making optimal use of the multiple good and services of paddy-based farming systems. The Swedish-supported programme will continue efforts to strengthen community ownership in planning, management and implementation of local IPM/pesticide risk reduction programmes in support of Save and Grow FFS. The challenge now is to scale up the pilot activities to improve quality and efficiency in the rice value chain; address policy issues (e.g. implementation of national /regional rice strategies) and increase resilience and sustainability of rural communities and rice ecosystems and landscapes to address sustainable rice production intensification.

Case study 2:Using IPM, farm incomes are boosted by growing potatoes in lowland rice

Today elderly women in the northern Thai Binh province are growing potatoes using a labour-saving method and sell the farm produce to raise money to pay for their grandchildren's school! Between 2009 and 2012, incomes from growing potatoes increased by 19 to 31 percent using minimum tillage potato IPM compared with conventional potato growing methods.

In 2008, the International Year of the Potato, FAO introduced Viet Nam to the concept of minimum tillage potato growing using inte- grated pest management (IPM) in lowland rice production systems. Soon after, Oxfam Amer- ica joined FAO to support farmer field school training and field testing of this innovative po- tato growing method through Viet Nam's Na- tional IPM Programme managed by the Plant Protection Department of the Ministry of Agri- culture and Rural Development (MARD).

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Rice fields are not ploughed, or tilled, after harvesting. Instead, the paddies are drained using drainage furrows that result in raised beds. The beds are ideal for growing po- tatoes without the usual need for labour intensive ploughing, or tilling. Using mini- mum tillage potato IPM, the potato seed tu- bers are simply placed on the beds created by the drainage furrows. After adding ferti- lizer to the soil around the tubers, the beds are covered with straw left over from the re- cent rice harvest. Twice during the growing season more fertilizer and rice straw must be added to the potato beds.

Four hectares of rice produces enough straws to grow one hectare of potatoes. Using leftover rice straw for mulch has the added benefit of reducing the emission of greenhouse gases, because traditionally the rice straw was burnt

The straw mulch creates an important habitat for many of the potato's natural enemies. Also known as friends of farmers, these insects and micro-organisms are vital if the plant pest population is to be successfully regulated and in a natural organic way. Importantly, mulching with rice straw reduces the need for irrigation from 5 000 cubic metres of water to just 900 cubic metres per hectare. Using the IPM system to grow potatoes, farmers report a substantial reduction in the use of fertilizers and pesticides, and a dramatic reduction in labour. The method reduces the labour involved in land preparation, planting, irrigation, agrochemical application and harvesting by some 28 to 47 percent when compared to the conventional method of growing potatoes.

In 2009, 23 women in the IPM Farmers' Group in Thai Giang village were able to buy television sets with the extra money they made growing potatoes. From their potato-farming income in 2010, they bought gas stoves while others said they were saving the money to send their children to university.

Initially, the initiative involved one province and 25 farmers. Today, 4 000 farmers have adopted minimum tillage potato using IPM in 22 provinces; about 70 percent of those farmers are women. As

a result, minimum tillage potato IPM was recognized as a promising model and, in 2013, the ministry issued a directive calling for all potato-producing provinces in the country to apply the practice.

The potato is the fourth most important food crop in the world. The potato produces more nutritious food more quickly, on less land than any other major food crop. It has the potential to become an alternative source of carbohydrates in parts of the world where rice has long been king. In Viet Nam, the potato is an important winter-rotation food crop. It is used in food processing and has become a source of increasing income for small farmers. Favourable soil and climatic conditions – especially in the northern plains, the mountainous north and the north central and central highlands – make it possible to grow potatoes on at least 200 000 hectares of land each year.

The practice of minimum tillage potato IPM may have come at just the right time, because potato productivity from traditional growing methods has been low in recent years. Areas planted to the crop have also been declining due to a lack of quality seeds and increasing labour costs. Urbanization and the migration of rural youth to nearby cities in search of better-paid employment opportunities have left farm activities mostly to women, especially the elderly. Because conventional potato production is labour-intensive, many families shifted to planting other crops. But, now minimum tillage potato IPM may be the potato's salvation in Viet Nam, helping to conserve resources and grow more food that can improve diets and increase farm incomes for families in many provinces across Viet Nam.