



**Food and Agriculture Organization
of the United Nations**

Community Based Rice IPM Programme Development: A Facilitator's Guide

(1st Edition - 1996)

**United Nations Food and Agriculture Organization's
Inter-Country Rice Integrated Pest Management Programme
for Asia**

Manila, Philippines

**with support from the governments of
Australia, Netherlands, and Switzerland**

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Acknowledgments

IPM is not for farmers,
it's by farmers!

This book was inspired by international interest in using the Farmer Field School model of field education to promote sustainable agriculture and Integrated Pest Management (IPM) outside Asia. The Farmer Field School (FFS) model was a creation of the FAO Inter-Country IPM Programme, FAO Staff of the Indonesian National IPM Programme, and the Indonesian senior core Field Leaders I who managed the first "pilot seasons" for training about 150,000 rice farmers in Indonesia in 1988-1992. The success of the program led to replication and improvements of the FFS in the 16 participating countries of the FAO Inter-Country Programme. The Philippines' National Programme, KASAKALIKASAN (an acronym meaning Better Environment and Farming), has championed local government initiatives and a strong soil management emphasis. Vietnam's National IPM program has developed rice-fish, local IPM Clubs, and many other community activities beyond the original Indonesian work. The Republic of Korea and People's Republic of China have developed temperate versions that focus first on diseases and second on insect pests, followed by weeds, etc. The Bangladesh IPM Program is developing rice-fish. The National IPM Program in India is adapting IPM rice models to cotton, and many vegetables. Vietnam, Indonesia, and Philippines also have independently developed non-rice IPM Programs from the experience of the rice IPM FFS. Sri Lanka, Cambodia, Laos, Bhutan, Nepal, and Malaysia are also beginning FFS IPM programs. Each country has some refinements which make the FFS locally appropriate have been included in this general Facilitator's Guide.

It is important to acknowledge first that IPM has been under development for many years in all the countries under on-going national research and extension activities. In addition to these activities the FAO Inter-Country Programme for IPM in South and South-East Asia (FAO ICP), with support from the governments of Australia, Netherlands, and Switzerland as well as the Gulf Arab Fund, has been able

to push forward with two important precepts: (1) train in the field where communication is easiest and all materials (plants, insects, natural enemies, diseases, soil, etc.) are readily available, and (2) focus on farmers that are the ultimate implementers of IPM. Putting these precepts into practice has been largely due to the leadership of Dr. Peter E. Kenmore, coordinator of the FAO ICP who has been the energetic promoter of IPM throughout Asia for more than 15 years. Members of the FAO ICP including Dr. Pat Matteson, Dr. D. Russ Dilts, Dr. Kevin Gallagher, Mario Corado, Cesar Galvan, A. "Dada" Morales, Simon T., Dr. Jesus Binamira, Nugroho Winarto, Simon T., Triyanto, Dr. John Pontius, Koen den Brader, Marjon Frederix, Dr. S. Ramaswamy, Dr. W. Settle, Dr. James Mangan the tireless staff of the FAO ICP Manila office, technical and administrative back-stopping in Rome and many others have helped make IPM for farmers a field reality.

Dedicated and hard working trainers in all countries are the foundation of IPM programs and have been the core developers of national farmer trainers. The Field Leaders I, II, and III in Indonesia; Master Trainers in Philippines and Vietnam; and Senior Trainers in China, and Korea have pushed IPM methods ahead. The Ministers and Departments of Agriculture have supported programs generously, and in cooperation from the USAID, UNDP, and FAO TSS1/2 funding.

International NGOs including World Education, CIDSE, CARE, Pesticide Action Network of North America, Pesticide Action Network of Asia and Pacific, and Save the Children with numerous national NGOs have contributed to the processes documented here. Their strong emphasis on facilitation and community have been reflected in the methods in this program.

Most of all, many thousands of farmers have been involved in the formation, evolution, and conceptualization of FFS activities. Their planning, preparation, and implementation of activities have made IPM a field reality in a large part of Asia. As Dr. Salmon of Indonesia has often stated IPM is not for farmers, but by farmers!

Kevin D. Gallagher
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Note for the New Millennium:

In response to the continued interest in this Guide, it is now being made available through the internet. Since 1996, when the Guide was written, there has continued to be an expansion and evolution of the IPM Programmes managed by Governments and NGOs across Asia. In support of these programmes the FAO is now implementing Phase IV of the Intercountry Programme which is also known as “The FAO Programme for Community IPM in Asia”. The new title reflects the increased participation of farmers in the planning and management of IPM activities; having completed Field Schools like those described in this guide, many farmers are now working together to organize a wide range of scientific studies, advocacy activities, and training for other farmers.

Further information about the activities of The FAO Programme for Community IPM in Asia can be obtained by writing to the project office in Indonesia or by visiting the project website. The address is:

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The author of the Facilitator’s Guide, Dr. Kevin Gallagher, is now based in Rome where he is working for the FAO Global IPM Facility. The Facility is supporting the establishment of IPM Programmes in other parts of the world, particularly Africa and the Middle East. The Global Facility can be contacted at the following address:

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Acronyms

FAO	United Nations Food and Agriculture Organization
FFS	Farmer Field Schools
ha.	Hectare (10,000 m ²)
ICP	FAO Inter-Country IPM Program
IPM	Integrated Pest Management
kg.	Kilogram (1000 gram)
PAN	Pesticide Action Network
TOF	Training of Facilitators
ton	1000 kg.
TOT	Training of Trainers
UNDP	United Nations Development Programme

Chapter 1.

How to Use the Facilitator's Guide

- 1.1. *Goals of the Guide*
- 1.2. *Principles of IPM*
- 1.3. *Basic Concepts and Assumptions*

1.1. Goals of the Guide

The goal of this guide is to document current thinking and methods that have contributed to development of Asian rice IPM training programs remembering that organizing IPM training programs is a process in which IPM becomes owned by farmers. It is about *how* IPM has become owned by Asian rice farmers, and how they are now pushing ahead into non-rice crops and non-agriculture community organizing. It is not a "cookbook" to set up training programs and it will probably be out of date soon, since new ideas and methods are emerging daily from the literally thousands of training programs that are being carried out weekly across Asia. It is, however, hoped one starting point for other countries and programs wishing to build on the Asian rice experience and evaluate for themselves the appropriateness of the concepts, methods, and directions.

**IPM training programs are a process in which
IPM becomes owned by farmers. They don't convince farmers to adopt IPM,
farmers convince themselves...**

"IPM" in the very traditional sense usually refers to Integrated Pest Management: a biologically intensive method of managing pests. But today, for thousands of farmers, "IPM" is more of a movement cry for local control over scientific principles that can be applied in individual fields. "IPM" for us means caring for a field so that it has the highest economic yield, without destroying the environment and health of the community. "IPM training" is a means for farmers to gain more local control over plant protection through community based activities.

In this book, you will not find an academic taxonomy of "mechanical, cultural, biological, and chemical" controls, but you will find methods for learning to make field-based decisions. There are no lists of economic threshold levels (ETLs), because ETLs cannot deal with the great variation of prices, costs, and plant responses found in each country, community, or farm (see more below), but you will see how the inherent natural variation can be made a part of every farm decision. There are also no pesticide recommendations for pests (those are the responsibility of national agencies), but you will find out how IPM training programs can teach ecosystem management of all inputs to improve profits (while including local pesticide recommendations if necessary).

This Facilitator Guide provides in depth information on the steps towards developing an IPM program beginning with IPM field validation, followed by training for facilitators, trainers, and farmer, and subsequent community action (Chapter 2). Chapter 3 presents sample Season-long Field Studies for validating basic IPM principles locally during training programs. IPM concept or skill specific training activities that emerge from rice field ecosystems are studied through the use of hands-on experiential methods. Sample training activities are provided in Chapter 4 which presents numerous Field Guide Activities in several areas. Follow-up possibilities for farmers and trainers are given in Chapter 5. Typical evaluation and documentation methods are discussed in Chapter 6 with emphasis on program development through local initiatives.

But first, let's discuss the scope and basic concepts of IPM from a practical point of view (in contrast to the conventional theory).

1.2. Principles of IPM

Sustainable agriculture requires that today's production needs are met while *improving* the production resource base for future generations. IPM, as a corner stone of sustainable agriculture, seeks to improve farmer practices in order to create higher profits while *improving* environment quality and community health. In order to do this IPM implementation is based on four practical principles:

- Grow a healthy crop
- Conserve natural enemies
- Observe fields regularly
- Farmers become experts

These principles describe the main actions of IPM implementation. Specific processes that take into consideration the variation of each field and farm family backup each principle, so that management is able to be done on a field-by-field, season-by-season basis. Each principle is described below:

Grow a Healthy Crop means using varieties resistant to major pests and diseases but well adapted to the local environment. The principle also includes using proper fertilizers (chemical and organic), irrigation, and soil management which are critical for a healthy plants. A healthy crop can *resist* diseases and *compensate* for damage caused by diseases and insects so that plant injury does not always lead to yield-losses. A robust healthy crop is the first step in IPM methods, and foundation for an optimal yield.

Conserve Natural Enemies. In all agricultural ecosystems, there are predators (e.g. insects, spiders, frogs, etc.), parasites and diseases which attack eggs, larvae, nymphs, pupae, and adult stages of insect pests. These "natural enemies" are the "friends of farmers" and occur naturally in all rice paddies, orchards and vegetable fields. They biologically control most insect pests most of the time. Learning to recognize and manage these natural enemies is one major focus of IPM training so that

they are not destroyed by unnecessary applications of herbicides, insecticides and fungicides but are allowed to work for the farmer's benefit.

Observe Fields Regularly is necessary to assess crop development, diseases, weeds, rats, and insect pest populations. In most cases, an experienced IPM farmer does this observation during a short time (usually less than a few minutes per field) while carrying out other crop maintenance activities (irrigation, etc.). Observations should determine how the crop is growing and if there are pests or diseases causing yield-loss; remembering that not all injury causes yield-loss. Natural enemies are usually present and sufficient to keep pests at low numbers. Weather conditions, soil nitrogen levels, and degree of host plant resistance will determine if diseases will subside or become more serious. In the case of rats, community level dynamics determine rat infestations and control programs. IPM Farmers must be knowledgeable of these factors to properly and economically manage crops. In some cases natural enemies, plant resistance and plant compensation cannot prevent yield-losses due to weeds, rats, insects, or diseases. Proper assessments must be made to effectively and profitably manage the use of inputs such as labor, quality seed, resistant varieties, fertilizers, drainage systems, community organizing and pesticides in order to ensure profitable production. Observation skills and decision making are key to becoming an expert IPM farmer and require field level practice for most farmers and extension staff.

Economic threshold levels (ETLs) are not used for field level decision making throughout most of this Facilitator's Guide. The ETLs are replaced with the Agro- Ecosystem Analysis methods that integrate more decision making parameters. The reason for moving away from ETLs perhaps should be explained here since most IPM programs are based at least to some degree on ETLs.

The first and greatest problem of ETLs is the variability of parameters used for ETL computation. The three main parameters of the ETL are management costs (\$/ha), the commodity price (\$/kg), and the damage coefficient which is the rate of yield loss per damaging factor (e.g. kg/ha loss per degree of soil drought, or kg/ha loss per density of insects no./hill). Management costs depend on the type of compounds used (cheap or expensive), access to tools (owned or rented), labor costs (own or hired), differences between regions (near cities or far from cities), and many other conditions. Commodity prices are stable in some areas for rice, but prices for many crops often fluctuate by a factor of ten over the year depending on local markets. Finally, the damage coefficient will vary according to the variety, water availability, weediness of the field, nutrient levels, weather, farmer competence in growing the crop, disease infection, stage of the plant, plant spacing, etc. More important is that not all injury leads to yield loss. In the case of over-compensation displayed by some crops (e.g. cotton), some injury actually leads to an *increase* in yields. In the almost all cases, published ETLs do not apply to the field situation at hand. The computed ETL applies only to the situation used in the computation; not the local situation (e.g. local costs, prices, weather patterns, plant responses, etc.).

The second major problem is that the ETL is too simple-minded. Farmers deal with very complex systems such as produce marketing, crop planning, and supplying inputs at the right time during the year even though income is not constant throughout the year. A published ETL figure is not

an acceptable guide for making a crop protection decision by farmers that understand the role of natural enemies, plant compensation, and weather effects on diseases.

Lastly, ETLs only compare costs and benefits of a very specific pest problem and the hoped for outcome (control in the first action). The ETL computation does not consider the farm or family budget and the relative benefits that could be gained with alternative investment of scarce financial resources of most Asian rice farmers. The ETL is only a partial analysis of the only one potential economic gain on the farm or in the family. Other investments of scarce capital may have more beneficial or safe returns (e.g. raising livestock) or be more socially attractive (e.g. sending children to school, or participating in local celebrations).

Farmers Become Experts is necessary for a modern agriculture in which farmers are responsible for farm level management. Future gains in yields, profits, and sustainability will be the result of farmers making better use of available and new technologies and limited resources. More emphasis in all agriculture programs must be placed on the ability of farmers to make better decisions, increase their own efficiency, and become better managers. The future of food production and food security will depend on how well farmers can innovate and manage systems. IPM is implemented by farmers and thus requires an emphasis on farmers' skills and knowledge.

1.3. Basic Concepts and Assumptions

The reader should be aware of some of the basic concepts and assumptions that are adhered to through out this guide;

- IPM is not a "packaged technology" that is "adopted" by farmers. IPM is a process of decision making and farming which is gradually improved with greater ecological knowledge, and observation skills.
- IPM skills and concepts are best learned, practiced, and debated in the field. The field is the best teacher. Stay away from energy intensive multi-media lecture halls.
- Season-long training courses allow all plant, insect, disease, and weed development processes and management to be observed and validated over time. IPM training must be carried out over all crop stages.
- Farmers must be allowed to actively participate and share their experiences during training to achieve maximum interest and effectiveness. Local or indigenous knowledge of the environment, varieties, pests, etc. must play a major role during decision making.
- Trainers must not lecture, but should facilitate a process of learning. Trainers do not convince farmers, but rather provide structured experiences so farmers can test IPM methods and convince themselves about which are useful and which are not.

- Young trainers must have a method of working in a respectful manner in groups that often include person older and more experienced than themselves. This is true worldwide, but especially true in most parts of Asia.

The content of IPM training programs for extension staff and farmers is not limited to the traditional "plant protection methods" (e.g. mechanical, biological, cultural, mechanical, and ETLs) but also includes the following:

- crop development and physiology
- agronomic methods for a healthy and profitable crop
- varietal impact on pest management
- soil fertility management
- pest insect, disease, weed, and rat biology and damage impact
- natural enemies of insects and diseases
- field observation skills
- pesticides, including environmental, health and handling issues
- economic management skills

Included in these topics are several new concepts which have been recently introduced to the basic rice IPM training course for farmers and extension staff beyond those mentioned above. The main six improvements are listed in summary form below.

1. Instead of using published ETLs, use an Agro-Ecosystem analysis to compare current and potential yield losses with the cost of managing these effects.

- a. Determine the current potential yield loss factors considering weather, pest and natural enemy populations, plant compensation, fertilizer effect, and plant development and stage interaction with field observation.
- b. Determine the potential of yield loss factors during the coming week considering the current epidemiology and population dynamics based on probable conditions (e.g. potential for of rice blast development given expected weather, current N levels, and plant variety).
- c. Compare the current and potential economic losses with the most economic management decision for crop management (e.g. remove water, add water, add fertilizer, weed, spray and continue observation, continue observation without sprays, change variety next season, organize community rat campaign, set up rat barriers, etc.).

2. Natural enemy populations depend on non-pest prey.

The work of Dr. W. Settle in Indonesia has greatly improved our basic understanding of how natural enemy populations can build up in rice fields, even when pest insects are not present or are at low populations.

Detritivores, filter feeders, and other "neutrals" are important sources of energy for natural enemies in rice fields. The impact of all management practices should be seen and studied in light of these ecological relationships.

3. Disease management depends on infection and epidemic probabilities and density factors.

Many persons wrongly state that IPM focuses on insect pests. In fact the proper choice of variety, fertilizer inputs, and planting are considered the basis of IPM for diseases. Beyond these decisions, observation of the plant and knowledge of weather factors important for epidemics can improve decision making. For example, it is well known that leaf blast up to about 10% does not result in significant yield loss, and that epidemics are most likely on susceptible varieties with high N fertilizer treatments during periods of moderate temperatures (25-30C^o), high humidity, and free water on the leaf. Field factors can be compared with the optimal situation to make predictions on the likelihood of disease problems developing and for making proper decisions regarding field management.

4. Weed management focuses on long-term targeted planning.

Current thinking of weed management focuses on hand weeding or herbicides to remove or stop germination of weeds. In IPM methods, weed seed and rhizome populations are the key target of management. Reducing seed densities with late season weeding, and herbicides, or reducing rhizomes with tillage methods are both important strategies depending of the major plant types in the fields. Longer-term IPM strategies focus on dominant species over several seasons to reduce their presence in the field at all stages.

5. Not all plant injury results in yield loss.

Plant compensation is an important concept which has been well studied in wheat, barley, cotton, and soybeans. The concept has been recently applied to rice in the Indonesian Rice IPM Program with leaf and tiller cutting experiments which show that the rice crop can sustain significant injury without yield loss.

In Korea the role of plant compensation is very important because most farmers apply pesticides in mid- to late-June to control stemborers, although it is now shown that usual stemborer infestation do not cause yield loss. The pesticide applications are made just before brown planthopper immigration, and may be reducing natural enemies at the key moment when brown planthopper outbreaks may begin depending on initial mortality.

6. All pesticides have an environmental impact which is an economic impact.

While it is common knowledge that pesticides kill fish, natural enemies and other non-target organisms, the economic impact of this environmental damage has not been completely appreciated by IPM programs. Protection of the environment for the sake of the environment itself is certainly well accepted by some, but negative economic impact due to pesticide impact strengthens calls for protection and regulation. Easily computed pesticide impact in most countries

include the increased cost of water treatment for urban consumption, and loss of fishing income from fishing in waterways. Less easily computed losses are those related to health, coastal fisheries, and loss of biodiversity.

The following chapter will discuss how these principles and assumptions are brought into long-term training programs that provide farmers with a learning environment to explore IPM methods.

"Sustainable agriculture is a means for ensuring that today's production needs are met while *improving* the production resource base for future generations.

IPM, as a corner stone of sustainable agriculture, seeks to improve farmer practices in order to create higher profits while *improving* environment quality and community health."

Chapter 2.

Developing Training Programs

2.1. *Overview: Steps to Developing an IPM Training Program*

2.2. *Core Trainer/Facilitator Training*

2.3. *Season-Long Training of Trainers*

2.4. *Farmer Field Schools*

2.5. *Farmer-to-Farmer Pre-Training Orientation*

2.6. *Farmer-to-Farmer FFS*

2.7. *Beyond Rice IPM FFS: New Curriculum Development*

Annex 2-1: Trainer and Learner Contracts

Annex 2-2: Sample Schedule Outline Training of Trainers

Annex 2-3: Cotton IPM Training Curriculum Development Matrix (TCDM)

This chapter will focus on developing a successful IPM training program. The first section provides an overview of a typical training program from the first steps of validation through undertaking follow-up steps. The following sections provide specific information on training programs for Core Trainers, IPM Trainers, Farmer Field Schools (FFS), and Farmer-to-Farmer FFS. The "Overview" (Section 2.1. below) is a generalization of numerous program experiences. In reality, each country and local community must pursue a process that is appropriate to their ecological, economic, and cultural system.

In addition, Section 2.7. provides a guide for going beyond rice IPM training and developing a new IPM curriculum for another crop. A cotton IPM course from India is used as an example.

2.1. Overview: Steps to Developing an IPM Training Program

Developing an IPM training program requires several steps in order to build the necessary scientific knowledge, cadre of trainers, field managers, and political/policy support. The national programs associated with the FAO IPM Inter-Country Programme have found that the following steps are essential for IPM training to move from a "good idea" to an established national IPM training program.

- Step 1. Validate IPM methods through field trials and curriculum setting
- Step 2. Recruit and train Core Trainer-Facilitators
- Step 3. Recruit and carry-out a Season-Long Training of IPM Trainers
- Step 4. Implement Farmer Field Schools
- Step 5. Build political/policy support
- Step 6. Develop follow-up activities
- Step 7. Go beyond rice IPM

Step 1. Validation Trials and Curriculum Setting: The first step is simple and direct: go to farmer fields and compare IPM practices with conventional farmer practices. What can your IPM methods do to improve profits, yields, or efficiency over local farmer practices? If there is no improvement, STOP here! There is no sense in having a costly program that generates no improvements. If there is a difference, is the economic benefit sufficient to justify investment in training? Again, small changes may not be economically justifiable, and will probably be of little interest to farmers. Validation trials should be carried out in several locations to compare results across ecological zones. Sometimes, more than one season of data will be necessary to consider seasonal pest fluctuation and management schemes.

Some improvements to farmer practices may be best promoted through mass media, or other non-training means (e.g. "apply fertilizer at the base of the plant"). For IPM programs, however, there is often a large amount of knowledge intensive skills that must be learned in fields such as recognition of natural enemies, or weather dependent disease prediction. Some concepts such as "BPH is a resurgence pest that gets worse with more sprays", or "Plants can compensate for some injury so that there is no yield loss" may be counter-intuitive to farmer's concepts. In these cases, farmers will have to test these points for themselves through conducting studies in Farmer Field Schools.

The validation process is *not* a research step. Validation should be done by extension staff, preferably those that will carry out training programs. Research staff might be involved ("after service") to explain their IPM programmes, but ultimately it is the training program which must validate the IPM practices and evaluate the costs and benefits of educating farmers in these methods.

If IPM can provide benefits to farmers, and a training program is needed, then the next steps should all be planned together with budget allocated for all the following steps - especially for Farmer

Field Schools. ***No Training of Trainers (TOT) should ever begin without budget allocated for post-TOT farmer training activities.*** There are many examples of programs that train trainers then run out of funding without ever working with farmers!

The validation steps will provide a general understanding of areas where training is warranted. This guide assumes that most trainers need at least a field review of all aspects of IPM, and this is reflected in the amount of time spent in the course. The schedule in Annex 2-2 provides a complete training program for one season. Your program should reconsider the contents and perhaps focus on different aspects. Go through Step 7. for rice to create a matrix as in Annex 2-3. The season-long training is best for building teams and strong individuals that can operate alone far from headquarters, but it may not always be politically or socially practical.

Step 2. Recruit and Train Core Trainers/Facilitators: Providing training for a core training and facilitator group is the next step towards farmer training. "Core" means that these persons are the "core" of the training program and will be responsible for most aspects of training developments. This core group will advance through several stages of personal changes during the progress of training programs. First they must be *farmers* in the sense that they can grow the crops from land preparation to harvest. Second they must become *experts* of IPM methods in the field. One way to obtain this mastery of IPM is to be involved in Step 1 above - the core trainers should validate IPM.

The third phase will be as *facilitators and trainers* for the Season-Long IPM TOT Course (Step 3 below). To prepare them for this course, they should have a special training course that includes facilitator, leadership, management, and curriculum development skills as outlined in Section 2.2. below.

The fourth phase will be as *managers* of Farmer Field School (FFS) IPM trainers. After the Season-Long IPM TOT, the core trainers will manage the implementation of the FFS by the IPM trainers. They will ensure that work plans are carried out, assist in problem solving, monitor cash flows, and evaluate the quality of the FFS implementation.

Finally, the Core Trainers will become *resource persons* for new IPM programs as they are initiated on other crops, other regions, or even in other countries.

The Core Trainers should have seniority in their institutions, but must be able to spend a large amount of time in fields with trainees and farmers. Core Trainers should also be available to the program to provide full time inputs for at least five or more seasons. They will need to meet frequently (at least once or twice a season) to assist in planning work plans, budgets, and strategies for improving the IPM training program.

Step 3. Recruit and carry-out a Season-Long Training of IPM Trainers: IPM trainers should come from field level staff - those people regularly interacting with farmers, preferably on pest management issues. These IPM trainers should be able to work full-time on IPM activities for at least four seasons. They will first participate in a Season-Long Training of IPM Trainers (see Section 2.3. below) and then implement FFS in their own work areas. It is expected that these IPM trainers will become expert at growing an IPM managed crop, as well as assist farmers to become IPM experts. In the follow-up stage of the IPM program, the IPM trainer will facilitate community based actions to raise funds and implement further programs as desired by the FFS participants. These are all skills which he or she will learn during the Season-Long TOT, during follow-up training, and at workshops during FFS implementation.

Step 4. Implement Farmer Field Schools: FFS are carried out by the IPM Trainer, under the management of the Core Trainers, and in cooperation with local extension staff, local officials, and the farming community. Usually at least two trainers/facilitators are required for the FFS, at least one of whom is the IPM trainer. During the FFS, IPM trainers should meet at least once or more to discuss problems faced during FFS implementation. A complete FFS curriculum is discussed in Section 2.4. below.

The FFS has several objectives. First, it provides a means to develop IPM expertise among farmers in a farming community. Second, the FFS provides for validation and adaptation of IPM methods to local conditions thereby leading to an evolution of farming practices that include IPM methods (not "adoption of IPM"). Third, the FFS provides an opportunity for local officials to see for themselves that farmer with IPM experience can reduce dependence on pesticides and maintain or even increase yields. This is as important as other objectives because it may lead to a change in local or national policies supporting pesticide overuse and abuse; policies mistakenly supported by local officials "convinced" that pesticides increase yields.

IPM trainers should continue to meet at least once a season to share experiences and continue to learn new methods in community action.

Step 5. Build political/policy support: This step is essential in order to make IPM methods and practices a permanent aspect of local agricultural policies and practices. Community support is built through Field Days at TOTs and FFSs, workshops, and presentation of data from TOTs and FFSs. Building a strong scientific basis is the first step, followed by building confidence through visual demonstration (e.g. FFS field studies) and verbal reports from IPM trained farmers. Data must be collected, analyzed, and presented on cost and benefits of IPM field implementation and training programs. In most cases, farmer-centered IPM training implementation has been shown to be both economically, and environmentally

beneficial. These are very supportable objective for most communities and policy makers; IPM should be declared the basis of national and local plant protection policy by policy makers.

Step 6. Develop follow-up activities: After the first FFS in a community, many farmers will want to continue their field studies. During the FFS in fact, there should be some discussion of follow-up activities in the eighth week in order to make plans in the remaining time of the FFS. Typical follow-up activities include FFS farmers training other farmers in the community, or studying IPM on another crop (e.g. soybean in Indonesia and tea in Vietnam). In some communities, farmers also begin activities in other areas related to community development or establish their own associations (e.g. Vietnam's IPM Clubs, Sustainable Agriculture Clubs, etc.). In areas where rats are a major problem, groups have organized themselves around community rat management teams (e.g. Padang, Indonesia). In areas where water is an issue, water organizations have developed. Some farmers have even established credit unions, and marketing associations (IPM products demand a higher price). Local "Field Labs" can also be established to research local specific problems, and recruit expert resource persons from universities, NGOs, and research centers.

Trainers should promote the independent establishment of farmer associations and assist in writing proposals and requests for local funding. Trainers can provide technical backstopping in some areas, or be a regular association member. In some cases, local funding may allow trainers to set up community programs to support FFS farmers to undergo special "Farmer Facilitator" workshops in which farmers learn facilitators skills and management skills to increase the efficiency of local organizations. When there are plans to create an "IPM village", the FFS graduates should be involved in planning, training, and budgets.

Whatever the interest or direction of follow-up, FFS graduates and IPM trainers should work together to promote local study on local problems with local support to develop local IPM programs.

Step 7. Go beyond rice IPM: As mentioned in Step 6, it is important to have follow-up with FFS groups and to create IPM programs in your local area. But it is also important to initiate new programs in national or local contexts. Core trainers, IPM trainers, and FFS farmers all have skills to organize programs in community development, especially in sustainable agriculture. Allocating funds for local initiatives within national or local training programs for use by trainers and farmers is essential to create an environment of creative expansion focused on solving local problems or creating new directions in food production, income generation, or community welfare.

IPM training programs are at first a method of improving farming methods, health, and the environment, but should also be seen as a door into sustainable community development through building human resources and initiatives.

2.2. Training of Core IPM Trainers: Course Guide

It is assumed that recruits for Core IPM trainers already are proficient in growing crops from land preparation to harvest. It is also assumed that they have a good knowledge of the crop ecosystem and are comfortable with working full-time in the field. The Core IPM Trainer's course will focus on those skills required to carry out the IPM Training of Trainers (Section 2.3. below).

I. Course content

- Training management of TOT for IPM Field Trainers
- Leadership skills
- Non-formal adult education skills
- Work plan, budget and proposal development skills
- Problem solving and supervision skills

II. Duration

The Core Training Course is typically 2 to 3 weeks in length and can directly precede the Season-Long IPM TOT discussed below.

III. Activities

The Core training program should carry out basic activities on non-formal adult education methods and theory, leadership methods and theory, and management methods (work plan development, budgets, evaluations, etc.).

The Core training program should also review the curriculum for the season-long training (see 2.3. below). This review should include revision of season long studies (see Chapter 3), development of a daily schedule (see example in next section), mapping of field plots and ordering materials. During the Core Training Program, the trainers should divide training activity responsibilities among themselves including logistics, field control (irrigation, plowing, etc.), liaison between participants and training center, recreation, religious work shop, and field trips.

2.3. Season-Long Training of IPM Field Trainers: Course Guide

The Season-Long Training of IPM Field Trainers is the basic course required for field trainers to become proficient in growing a crop, in implementing IPM, and in learning how to implement IPM training through the Farmer Field School model. The season-long duration of the program is to insure that all crop stages are studied and all management decisions are seen through to their economic ends (harvest). More over, the season of group training builds a team of trainers that can operate far from headquarters in a predictable way. This is the IPM equivalent of boot camp.

I. Objectives

- By the end of the course, the trainees will be able to:
- Grow a crop of rice from seeding to harvest.
- Make effective plant protection field decisions dealing with insect and disease pests, rats, weeds, birds, and snails (where appropriate) while considering local ecological, social and economic situations.
- Solve new problems presented in the field.
- Initiate training farmers using the Farmer Field School education model.

II. Rational for Season-long Training

The season-long nature of training is required for several scientific and social factors including;

- Pest problems are specific to each stage of crop so training should be carried out over all stages of the crop.
- Population dynamics, disease epidemics, plant compensation, and crop development are processes which develop over the course of the cropping season and need to be observed completely.
- The outcome of management decisions made during one crop stage are observable only at another later crop stage, and most often at harvest (e.g. profitability, yield and yield components).
- Extension workers are often isolated from scientific and social advisors and therefore must be able to solve most problems without outside assistance. A longer field based training provides these skills.

III. Course Activities

The objectives are met through intensive study. There are season-long field activities which provide plant protection concepts, rice production skills, and Farmer Field School training skills. There are also topic specific activities that are completed in a two to four hour sessions. All topics are learned through experiential hands-on activities, allowing for maximum learning to take place. The methods are designed to build on the current level of experience, knowledge and skills of the trainees. The TOT participants are divided into teams of 4-6 participants. The inter-related training components in the Training of IPM Field Trainers field course include the following:

1. Season-long Field Studies carried out by trainees:

a. **IPM vs. Farmer Practice Comparison** (to be carried out by all training groups). All field work carried out by trainees including production, data collection, data analysis, and report writing.

b. **Classical IPM Field Studies** (2-4 studies per training group). All field work is carried out by trainees including production, data collection, data analysis, and report writing.

Examples of Field Study titles:

- Nitrogen response and impact on pests
- Nitrogen efficiency including organic materials and impact on pests
- P or K response and impact on pests
- Variety evaluation and impact on pests
- Stemborer plant compensation simulation
- Defoliator plant compensation simulation
- BPH resurgence with natural enemy exclusion
- No spray on susceptible and resistant varieties
- Weed management comparisons
- Sampling methods
- Rice field ecosystem survey
- Rice garden/time of planting evaluation
- Seed production
- Rice-fish culture
- Other studies related to specific problems and concepts in the area.

c. Collections of insects, natural enemies, diseases and weeds. One collection per person should include at least 100 labeled organisms from the rice ecosystem.

2. **Topic Specific "Field Guide Activities"** are carried out in the field or open room and focus on the following IPM skill and concept areas:
 - Stage specific plant physiology and plant compensation
 - Diseases and epidemiology
 - Weeds
 - Insect pests, detritivores, and natural enemies
 - Ecosystem management (sampling, decision making)
 - Agricultural poisons
 - Health and environment issues
 - Rats, snails and birds as appropriate
 - Evaluation methods
 - Group dynamics, Non-formal education
 - Management Skills (work plans, budgets, leadership)
3. **Non-Formal Adult Education Methods & Processes:** During the TOT trainers will learn about NFE methods and processes and group dynamics. They will develop skills to act as a facilitator during farmers' training in which farmers will discover through experiential learning ecological relations in the rice ecosystem.
4. **Management skills:** Trainers will also learn other skills, e.g. budgeting, necessary to conduct and organize FFS in their own provinces and districts.
5. **Special topics** delivered by experts on specific topics, Field Trips and other activities. These topics should cover specific areas of interest to IPM including technical and social aspects. The involvement of NGO's, community organizers, women's organizations, universities, researchers, and others during this time provides the participants with exposure to numerous resource persons and topics of local value and not already included in the course materials.
6. **Farmer Field School (FFS) Planning** should be carried out during the TOT period, usually during flowering stage. Planning includes decisions on how participants will be chosen, where the FFS study field (1000 m²) will be situated, time of implementation, weekly topics, budgets, opening ceremony, Field Days, certificates for farmers, and other aspects of making an implementation plan to be approved by local officials (extension office head, NGO home office, etc.).
7. A **"Field Day"** should be organized at the end of the TOT for participants to present the result of field studies, field guide activities, and FFS planning. The goal of the Field Day is

to prepare "bosses" for the return of "their staff" and to ensure that participants will be able to implement IPM programs in their home work area with the support of their supervisors. If a participant returns home to be promoted, or moved to a new section, then the TOT was a waste of funds and time. TOT success is determined by the participants work after the TOT!

- 8. Graduation Ceremonies** should be held to award participants with graduation certificates, to honor the local center officials, and to graduate farmers that participated in FFS. This may be done simultaneously with the Field Day.

IV. Training/Facilitation Team

The Season-Long TOT should be carried out by a Training/Facilitation Team in addition to the support staff necessary for training logistics. The Team should have one or two trainers with experience in running a Season-Long IPM training, have extensive experience in the field as well as in running the day to day management of a TOT. Many national programs begin with a guest trainer from another region or even from another country to begin IPM training programmes. There are senior trainers in the Indonesian, Philippine, Vietnam, China, S. Korea, and Indian National IPM Programmes or in the FAO Inter-Country IPM Program with experience in carrying out training programs in rice and non-rice crops.

While Senior Trainers manage the TOT implementation, the Facilitator/Training team will carry out day to day supervision and teaching of the participants. The team members should have already participated in the Core Trainers Training (see above) and have practical field skills since they will be in the field with participants on a daily basis. A ratio of 1 trainer to 5 participants is desired, but a ratio of up to 1 trainer per 10 participants is still possible depending on the strength of the trainers.

This team should be at the TOT site one week before the training to make preparations. This team should also meet daily to prepare for training, and make a daily evaluation of the program. During actual training, the senior training can lead many activities, but it is preferable if the trainers share in this responsibility until participants can take over some of the training activities.

The Training Team should maintain open communication with participants with frequent formal and in-formal evaluations/discussion on the progress of trainings.

V. TOT Duration and Breaks

The course duration is from transplanting or direct seed broadcasting until harvest: the actual number of days depending on the varieties planted. A break of one week (with short duration varieties) or

two weeks (with long duration varieties) is possible during the vegetative stage. A one week break is also possible during the early dough stage.

VI. Weekly Training Programme

Each morning (and evening if necessary), teams will spend time in their Field Studies to take care of the field (irrigation, weeding, fertilization, pest management, etc.), and collect data for the Field Study implementation. IT SHOULD BE EMPHASIZED THAT TEAMS SHOULD TAKE CARE OF THE FIELDS THEMSELVES TO BECOME FAMILIAR WITH GROWING THE CROP - TO BECOME FARMERS THEMSELVES! This has been referred to as the "Learn to respect farmers" portion of the course.

During the late morning and afternoon, teams will carry out the "Field Guide Activities" based on the crop stage and specific problems in the field. Every week certain topics will be emphasized on a fixed day through exercises, discussion, field observations.

Monday	Physiology and Agronomy
Tuesday	Rats and Diseases
Wednesday	Insect pests, natural enemies, and neutrals IPM specific topics
Thursday	IPM specific topics [Optional] Visitor from relevant Institutes/Universities is invited for half a morning (9.30 hrs-12.00 hrs) as resource persons on specific subjects
Friday	Agroecosystem Analysis and Group Dynamics Review and evaluation of week
Saturday	Field Visits in area (including recreational visits)

A sample TOT schedule is provided in Annex 2-2 below. The schedule has modifications which reflect the local constraints for the center where the training was actually implemented.

VII. Site Requirements for the Training of Trainers Course

- a. **Dormitory facilities** for trainees and trainers should be available.
- b. **Trainer's Secretariat** should be one room for trainers to have nightly meetings, for storing materials, and plugging in a computer when available.
- c. **Open room or shade of tree.** An open room with non-fixed seating for trainees and trainers is useful but not mandatory. ALL activities can be done while seated on the

ground under a tree (need shade!). In the absence of a room, all trainees should be provided with a thin (4 mm) piece of plywood about 40 cm by 60 cm for drawing other activities. An easel, black board or other place to write would facilitate group discussions as well. NO LECTURE ROOM IS REQUIRED.

- d. **Study Fields** with a total area of about 2 ha. for 50 trainees (or 2000 m² per team when less than 50 trainees) will be needed for field work during the training. The fields should be close (walking distance) to the training site. An agreement can be made with the farmer-owner to compensate for field use.

VIII. Pre-TOT Preparations

There are numerous pre-TOT preparations that must be done 2 to 3 weeks prior to the course initiation. Usually this will require one or more TOT trainers to be on site before the training begins.

- a. When transplanting is planned for the Field Studies, a seedbed should be prepared 3 weeks (for 20 DAS seedling or 10 days for 8 DAS seedlings) before the training starts so that transplanting can begin on the first day of training. If seedling trays are used, then seedlings should be ready for planting on the second day of training. The participants will then be able to transplant the field during the first week of training. A seedbed will then still be prepared during the first week in order to enable participants to experience and observe this.
- b. Field Preparation should be done beginning 2-3 weeks before the beginning of the TOT. If the trainees are to learn how to prepare land, then set aside a small area for experience. However, to save time (and money!), the fields should be ready for layout of field studies and planting before the TOT begins.
- c. Seed soaking should be done beforehand when significant amounts of direct wet seeded rice is to be grown.
- d. Materials for training should be listed and bought before training. Seed, fertilizer, manures, field signs and labels, etc. should be ready on the first day of training. Other training materials such as paper, markers, name tags, hats, shirts, etc. should also be purchased beforehand. A significant petty cash fund should be available for unforeseen needs encountered at the training site.

- e. The field should be mapped out by the TOT trainers so that teams can begin layout for each Field Study on the first day of the training program.
- f. Logistics such as transportation, sleeping arrangements, meals, bathing, clothes washing, telephone/mail service, newspapers, recreation (football, badminton, TV, video), religious services, etc. should be considered before trainees arrive.
- g. A draft daily schedule should be developed for presentation to authorities and for arranging field trips. As the season develops, the schedule is likely to change due to pest occurrence, weather, and unscheduled visitors...but try to "go with the flow" and expect to make changes. Don't carve the schedule in stone!
- h. A pre-test (field based ballot box style, and/or written exam) should be prepared to test trainees during the first days of the TOT. The pre-test should be field based to test recognition of insect pests, diseases, weeds, natural enemies, damage, etc. as well as problem solving. A written pre-test could also be given to test basic knowledge on life cycles, pesticides, health and environmental issues. The pre-test should be repeated at the end of the course to help evaluate the effectiveness of the training. See Chapter 7. for further discussion.
- i. The idea of a Facilitator-Learner Contract should be discussed among the training team and prepared for discussion during the first week of the TOT. A sample is provided in Annex 2-1 below.

IX. Resource Persons

Resource persons are non-resident trainers and other experts that can provide practical inputs to the TOT. Typically, researchers, university professors, international visitors, NGOs, and others can provide some refreshing input to the season-long training. However, it is important to provide some tips to these resource persons:

- Go to the field together for field walks where questions and answers can take place.
- Leave slides and lectures until after field interactions.
- Request the resource person to be as "participatory" as possible.
- Be sure that the resource person gives an address and other contact information for future reference by trainees.

X. Farmers' Field Schools (FFS)

The TOT is designed to prepare participants to become trainers in FFS. In some instances, it may be desirable to organize FFS in the area around the TOT so that participants can experience organizing and interacting with farmers during the TOT.

In all cases FFS should be run by participants for at least one season after the TOT in the home work area of the participant as a part of the training program. Funds and permission should of course be available for these FFS before the beginning of the TOT and with the cooperation of the TOT participants.

If FFS is to be organized during the TOT course then 5 FFS should be organized in communities nearby the TOT site. Villages and farmer groups will need to be identified before the start of the training. The fields used in the training (about 1000 m²) should be seeded around the same time as the training will start.

One team of participants is responsible for conducting one FFS. A FFS usually consists of about 25 farmers, which will also work in groups of 4-6 persons during the FFS. The FFS is 10 weekly sessions of one morning each, usually on Friday or Saturday starting in the second week of the training. The trainers will be able to use experiences gained and exercises carried out during the previous week with a farmers' group. The programme for the FFS will be planned every week together with the trainers. Ecosystem analysis will be done every week by the farmers. Special topics will be carried out as well every session. Snacks should be served.

At the end of a FFS, a "Field Day" will be organized to present the results of the FFS other farmers, agricultural staff, and local government officials in the community.

2.4. Farmer Field Schools

IPM FARMER FIELD SCHOOL (FFS)

The IPM FFS has been implemented for IPM farmer training on a large scale. The goal of this training is that farmers become field IPM experts able to implement IPM methods on their own farms.

The FFS should have two trainers. One trainer is the local extension staff who usually works in the field providing extension information through extension system. The second trainer is the Season-Long IPM trained trainer. The two persons will work as a team in the field to facilitate training. The approach to training and the content of training are similar to the Season-Long TOT. IPM trainers have extensive experience in both implementation of IPM and demonstration of IPM concepts and skills. The local staff will be introduced to these concepts and methods.

The FFS usually meets on a regular, most often weekly, basis in order to follow all the biological and management aspects of the field throughout the season. This allows participants to follow the life cycles of insects or epidemiology of diseases. It also allows for experimentation such as testing fertilizers, varieties, plant compensation, and other key aspects of rice production and protection.

The FFS is held at the field site. Each FFS should have two fields, with each field about 1000 m². One field is for IPM methods, and one field is the farmer's usual practice or conventional method. This allows validation of IPM methods during the FFS. Farmers should observe the fields each meeting to make management decisions. The Agro-Ecosystem activity in Chapter 4 is the tool to use for learning how to make IPM decisions. Other experiments can also be carried out in these fields using the experimental outlines given in Chapter 3.

The participants of the IPM Field School are usually 25 farmers from the local farming community or farmer association. The 25 farmers should be currently active farmers. The FFS will receive 10-14 weeks of training with one meeting per week (number of weeks to be approved by project working group). The course will be in the morning for 4 hours. At the end of the course, successful farmers will receive an IPM FFS Graduation Certificate. Farmer and course evaluation will be with a "Ballot Box" field method of testing field IPM skills.

Four IPM Field Schools should be set up in each work area of the IPM trainer. The two trainers will visit all the IPM Schools once a week. Based on this schedule, the trainers will visit four IPM Schools in four days. On Friday or Saturday of each week the trainers will work together to organize training for the next week.

The main goal of this training is to provide training to farmers. However, another goal of the field training is to provide a validation of IPM methods locally and to encourage the participation of local communities and government in the development of local IPM programs.

Farmer Field School: Course Guide

I. Objectives

By the end of the Farmer Field School, the participants should be able to carry out the following:

- Describe the development of the crop.
- Describe plant compensation and give an example of the importance of plant compensation for either stemborer, leaf-folder, or disease management.
- Identify the ecological function, life-cycle and give the local name of major insect detritivores, insect pests and natural enemies seen in the rice field.
- Identify the local name and development factors of major diseases found causing yield losses in the field (if they exist).
- Identify rat damage, and rat habitat where appropriate.
- Describe snail growth, development, and ecological habits.
- Describe the toxicity of commonly used pesticides (herbicides, fungicides, insecticides, rodenticides, and molluscicides) and methods to avoid exposure to pesticides.
- Describe the effect of pesticides (herbicides, fungicides, insecticides, rodenticides, and molluscicides) on target pests, natural enemies, non-target pests, the environment and health of farmers and consumers.
- Describe the level of potential yield-loss given a particular field condition and compare with the cost of controlling yield-loss factors (decision making).
- Describe the potential development of pests in the field given the field conditions (plant development and stage, weather pattern, plant resistance, water levels, pests, natural enemies, etc.) and compare to potential management activity costs (irrigation, fertilization,

pest control practices) that could be undertaken to improve yields and reduce impact of yield-loss components (decision making).

II. Farmer Field School Activities

The Farmer Field School (FFS) is typically 10 to 14 weeks in length. The first session begins with transplanting or broadcasting and continues until harvest. The sessions are best held weekly if beginning with transplanting, or less than weekly if in direct seeded areas. Each session begins in the morning and ends before lunch (one half day). The typical contents of the FFS are listed below. The FFS participants may want to alter this schedule to focus on particular local issues.

Season-long Studies

- a. **IPM and Farmer Practice comparison trial.** This trial is conducted on a 1000 m² plot supported by the FFS. 500 m² is used for the IPM field, and 500 m² is used for the Farmer Practice field. This 1000 m² field plot is used as the Study Field for the FFS. All other activities are conducted in these fields.
- b. **Field Trials.** The Classical IPM Study on "Stemborer plant compensation simulation", "Defoliator plant compensation simulation", "Nitrogen efficiency including organic materials and impact of pests", "Seed Production", or other studies can be conducted in the field. Usually on one or two of these studies are undertaken by the FFS depending on major issues of the FFS participants.

Topic Specific Field Guide Activities are carried out in the field or adjacent to the field and cover areas related to IPM and Group Development.

III. Weekly Schedule

The following weekly schedule is a sample from a 12 week FFS. In general it will be necessary to adjust the content and schedule to local conditions, field problems and farmer interests.

Pre-Season:	Prepare seed-bed and seedlings for 1000 m ² to be ready in time for the first FFS session
	Meet with farmers in the FFS area to explain the FFS and to recruit participants. Be sure to clarify all obligations of FFS participation.
	Arrange for a 1000 m ² Study Field within easy reach of the FFS participants. Compensation should be provided to the owner of the land.

Week 1:	Opening ceremony with introductions, Ballot-box pre-test and planting of Study Field by FFS participants and trainers.
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Week 2:	Drawing Together (team building) Ecosystem
Week 3:	Agro-Ecosystem Analysis (decision making) "San Luis" Predators
Week 4:	Agro-Ecosystem Analysis (decision making) "Broken Squares" Roots/Vessels & Pesticides
Week 5:	Agro-Ecosystem Analysis (decision making) "Balloons" Premordium Development and Fertilization
Week 6:	Agro-Ecosystem Analysis (decision making) "Making Sate" (group dynamics) Reduced Exposure to Pesticides & Pesticide Toxicity
Week 7:	Agro-Ecosystem Analysis (decision making) Group Dynamics Rats or other topic
Week 8:	Agro-Ecosystem Analysis (decision making) Brainstorming on follow-up activities Diseases or other topic
Week 9:	Agro-Ecosystem Analysis (decision making) Being a Natural Enemy Life cycles: Parasites, Stemborers, and Leaf-folders
Week 10:	Agro-Ecosystem Analysis (decision making) Proposal Writing, Workplans, Budget Community Self-Survey
Week 11:	Agro-Ecosystem Analysis (decision making) Field Day Planning Seed Selection or other Topic
Week 12:	Post-test Field Day/Harvest and Weighing of Field Trials Closing Ceremony with Certificates
Post-FFS:	Inform FFS participants of pre- and post-test scores Make regular visits to follow-up activities

2.5. Farmer-to-Farmer Pre-Training Orientation

As a part of IPM FFS follow-up, many FFS may desire (or be convinced) to train other farmers in a formal FFS setting. The content and method of the FFS was designed so that no facilitator would need to make a lecture, and that all materials and topics would flow from the implementation of field studies and field guide activities. Once a person has completed a FFS and mastered the materials, it is simply a matter of facilitating field activities to implement another FFS for other farmers in the community.

However, before beginning a new FFS led by a farmer trainer, the IPM Trainer should prepare a several day "Farmer-to-Farmer Pre-Training Orientation". The objective of this training is to provide farmers an opportunity to organize work plans, review the implementation of activities and review the technical content of the course. At the same time, it provides the IPM Trainer with an opportunity to evaluate the facilitation and technical skills of Farmer trainers and correct any problems before the beginning of a Farmer-to-Farmer FFS.

The output of the orientation should include a work plan, including recruiting farmers, field preparation and field study lay out, weekly schedule, material requirements, evaluation methods, and agreement on the extent of the IPM trainer's inputs, if any. Technical backstopping by the IPM trainer can be frequent, and should include standardized data collection for including in a local database on IPM cost and benefits. This type of database will be essential when requesting for local government investment in IPM programs.

Farmers with sufficient facilitator and technical skills should receive a certificate of Farmer IPM Trainer at the end of the orientation to provide some evidence of technical evaluation when organizing the FFS.

2.6. Farmer-to-Farmer FFS

Farmer-to-Farmer FFS are one of the key elements in the development of IPM over large areas. One FFS in a community can spread IPM methods to the entire community if a well organized effort is maintained during a follow-up period in which farmers become trainers in their own communities in formalized and funded Farmer-to-Farmer FFS.

Farmer-to-Farmer FFS are implemented in the same way as FFS described above, except that trainers are farmers and IPM Trainers provide technical backstopping. The cost and funding of the FFS will probably be less due to lower travel and honorarium cost required for a local trainer. Farmers are also more likely to bring their own snack than when organized by extension services. Usually only materials such as paper, crayons, markers, netting, and field inputs (seed, fertilizers) are required by the group to carry out the FFS. Thus Farmer-to-Farmer FFS offer a model for bring IPM training to whole communities at an affordable price to national and local communities.

The role of the IPM Trainer is important in developing the Farmer-to-Farmer FFS at several stages. First, the IPM Trainer should bring up the issue of follow-up during the original FFS and assist in the planning and establishment of the Farmer-led FFS; especially in securing funds for materials and transport when required. Second, the IPM Trainer should organize a Farmer Trainer Orientation as discussed above. Third, the IPM Trainer will act as a technical advisor to the group. Frequent visits during regular duties will help to motivate the group to maintain regular meetings. Lastly, the IPM Trainer will have a as a supporter of community actions and planning. Bring new methods such as log frame planning and community mapping to FFS for future actions are some of the important contributions an IPM Trainer can continue to provide after an initial FFS in a community.

2.7. Beyond Rice IPM FFS: New Curriculum Development

A FFS in rice IPM is similar to an introductory course in field ecology. There is much more to learn and explore beyond this basic program. Numerous examples were discussed in Step 6. and Step 7. above. In this section, however, development of curriculum for a new crop will be briefly discussed using an example developed by Rice IPM Trainers for a Cotton IPM Training Course in India (refer to Annex 2-3 below).

In the matrix, we started by listing the four basic principles of IPM implementation in the first column:

- 1. Grow a healthy crop**
- 2. Conserve natural enemies**
- 3. Observe fields regularly**
- 4. Farmers become experts**

Under each principle the major management aspects related to that principle were listed. For example soil fertility, fertilizers, water management, etc. are all important aspects of growing a healthy crop so they were listed in the first column. Similarly, diseases, deficiencies, etc. are important aspects of regular field observation so that they were also listed in the first column.

The first row was divided into the main crop stages as identified by the trainers. Of course another set of crop stages could be used (researcher based, farmer based, etc.) but for this exercise we choose to use these five main crop periods (i.e. pre-planting, crop establishment, vegetative, square formation, and boll formation).

Then for each cell in the matrix, the group identified management information that farmers (and trainers!) should consider during the crop cycle. Note that many cells are merely identification of recommendations (i.e. N-P-K), while others are conceptual points needed to appreciate development of the crop (i.e. leaf pattern). Note also that many cells include questions which are controversial points; often difference between "official" recommendations and farmer practices or farmer perceptions.

This matrix was then used as a guide to develop training objectives, weekly training schedules based on the crop development stage, and design of field training activities to explore each critical management aspect or question raised during the above exercise. A full course including season-long field studies, comparison trials between IPM and conventional practices, and field guide activities adapted from rice IPM exercises (see Chapters 3 and 4) was prepared in a relatively short period.

In this process, lessons learned from rice IPM were directly and rapidly applied to the development of IPM for a second crop. The agronomic recommendations, diseases, insect pests, natural enemies, etc. are specific for cotton, but the ecological interactions and management schemes are similar to those in rice. Local experts familiar with the crop should be able to provide specific information for the locality, while IPM trainers and IPM farmers can begin implementation of IPM training in the new crop, often answering old questions and discovering new relationships in the process.

Annex 2-1. Facilitator and Learner Contracts (Thanks to Dr. J. Pontius)

After reading this you will be able to state what a contract is between facilitators and learners and why you should use such contracts when you work as a facilitator.

In your role as a facilitator how often have you said to those with whom you are working, "The goal of this activity is...", or "You will learn about ...", or "After this training you will be able to ..."? How many times when you have been a participant in a workshop have you heard trainers start the training by saying the same thing? When you start an activity by saying, "The goal of this activity is ...", you are creating a contract between you and those who are participating in the training activity.

One of the most important things you can do as a facilitator before you begin an activity is to tell participants what they are going to learn because of their participation in the activity. To do this you can use such simple statements as, "Today you are going to learn how to use economic thresholds", or "Today you are going to investigate the growth of rat populations". Such statements tell the participants what they can expect from the training activity that they are about to participate in.

These statements create an expectation on the part of learners and facilitators alike. Learners will know what you expect them to learn and they will expect you to teach it to them. This is the basic learning contract, the creation on the part of both facilitator and learner of an expectation that will be fulfilled by the learning activity that is about to take place.

Why use learning contracts? Have you ever sat in a workshop and wondered where the trainer was taking you. If so, you might have been involved in a training activity that had no contract. With a contract you create a reference point. Learners can refer back to it and check to see how the training fits with their expectation. They can evaluate the trainer and the trainer can evaluate the learners. The contract helps to guide the training. Every training activity must fit with the contracted expectation. With a contract trainers are obliged to meet expectations and learners are obliged to meet their commitment by learning what is expected. A contract demands that both parties to the contract meet their obligation.

As a facilitator a contract helps you by:

- Making clear what learners can expect to learn.
- Holding learners to their commitment if they should resist participating in an activity or not take the activity seriously.
- Providing you with a goal which can help you think through what learning activities will best meet the demands of the contract.
- Providing you with a basis for evaluation.

A learner is helped by a contract because:

- The contract eliminates confusion over why the learner is participating in the activity.
- The contract helps the learner to know what is expected of him.
- The contract tells the learner what you are trying to do and he trusts you to meet your side of the bargain.
- Provides learners with a basis for evaluating you as facilitator.

Contracts are based on the needs of the participants. If you suggest to farmers that they are going to learn about rocket science they may walk away from you. Why do they need to know about rocket science? Thus farmers don't have to agree to a contract and in that case you will need to come up with something else based on their needs.

How does this fit with FFS? At the beginning of an FFS you are contracting with farmers to provide them with the knowledge and skills so that they will be able to be IPM experts in their own fields. Every week of the FFS you are expected to help them get a bit better at IPM. If anyone has questions about the methods you are using you can refer them to the contract and show them how the activities in an FFS fit with the contract. On a weekly basis during the FFS you re-establish the contract and add to it contracts on special topics.

A contract is important in that it works to build trust between a facilitator and learners, if you meet the contract. If you don't meet your contract, participants will be disappointed and less likely to come back to learn from you. If you do meet your contract, participants will hurry back for more.

Annex 2-2. Sample Schedule and Outline Training of Trainers

This is a sample schedule of an actual Rice IPM TOT in Vietnam. Note the changes in visitor days from suggestions above, and that this schedule assumes a FFS built into the TOT on Saturdays. Each day has several activities without pre-defined time periods!

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	Physiology Agronomy	Insects and Natural Enemies	Visitors Preparations FFS	Rats Diseases	Agroecosystem	Farmer Field Schools/Review
Week 1 Soil preparation Transplanting Seeding	<ul style="list-style-type: none"> - Soil preparation - Layout - Pregermination seeds DS - Flood seedbed TP - Prepare seedbed 	<ul style="list-style-type: none"> - Soil preparation - Seeding- DS field - Preparations transplanting - Layout of group experiments 	<ul style="list-style-type: none"> - Planting - Small group discussions on farmers' problems in ecosystem; causes and solutions (NFE) 	<ul style="list-style-type: none"> - Planting - What is this? - Discussion on concepts and principles of adult nonformal ed. 	<ul style="list-style-type: none"> - Planting - Formulating guidelines for appraising community farming practices (NFE) 	<ul style="list-style-type: none"> - Observations and discussions with farmers in villages where FFS will be held - Review of the week
Week 2 Seedling	<ul style="list-style-type: none"> - Pretest - Fieldwork - Seedling stage - Discussion seedling/seedbed 	<ul style="list-style-type: none"> - Fieldwork - Zoo/collection - Discussion on spiders/predators - Make signs 	<ul style="list-style-type: none"> - Field work - Visitor (varieties & fertilizer) - Practicum on setting up ballot boxes for FFS 	<ul style="list-style-type: none"> - Fieldwork - Rats: survey signs/presence - Planning and preparation FFS - Make signs 	<ul style="list-style-type: none"> - Agroecosystem - Group dynamics - Team building exercises - Prep. FFS 	<ul style="list-style-type: none"> - FFS 1st session pretest ballot box - Exchange information FFS - Review of the week
Week 3 Vegetative	<ul style="list-style-type: none"> - Fieldwork - Tillering ability - What is sampling 	<ul style="list-style-type: none"> - Fieldwork - Zoo/collection - Sampling methods 	<ul style="list-style-type: none"> - Fieldwork - Visitor (weeds) - Planning and preparation FFS 	<ul style="list-style-type: none"> - Fieldwork - Sampling methods 	<ul style="list-style-type: none"> - Agroecosystem - Group dynamics - Team building exercises - Prep. FFS 	<ul style="list-style-type: none"> - FFS 2nd session - Exchange information FFS - Review of the week

<p>Week 4</p> <p>Vegetative</p>	<ul style="list-style-type: none"> - Field work - Roots/vessels - Insecticide effect on NE - Ecological functions 	<ul style="list-style-type: none"> - Field work - Zoo/collection - Discussions on defoliators 	<ul style="list-style-type: none"> - Field work - Visitor (leaf folder research/CTU) - Planning and preparation FFS 	<ul style="list-style-type: none"> - Field work - Ecosystem 	<ul style="list-style-type: none"> - Agroecosystem - Group dynamics - Team building exercises - Prep. FFS 	<ul style="list-style-type: none"> - FFS 3rd session - Exchange information FFS - Review of the week
<p>Week 5</p> <p>Primordia</p>	<ul style="list-style-type: none"> - Field work - Primordia - LD 50 	<ul style="list-style-type: none"> - Field work - Zoo/collection - Life cycles 	<ul style="list-style-type: none"> - Field work - Visitor (Environmental Prot. Center) - Planning and preparation FFS 	<ul style="list-style-type: none"> - Field work - Poison symptoms 	<ul style="list-style-type: none"> - Agroecosystem - Group dynamics - Team building exercises - Prep. FFS 	<ul style="list-style-type: none"> - FFS 4th session - Exchange information FFS - Review of the week
<p>Week 6</p> <p>Panicle development</p>	<ul style="list-style-type: none"> - Field work - Demo poison - Pesticide calculations 	<ul style="list-style-type: none"> - Field work - Zoo/collection - What is a predator? 	<ul style="list-style-type: none"> - Field work - Visitor (Health) - Planning and preparation FFS 	<ul style="list-style-type: none"> - Field work - Rat poisons - Rat population growth 	<ul style="list-style-type: none"> - Agroecosystem - group dynamics - team building exercises - prep. FFS 	<ul style="list-style-type: none"> - FFS 5th session - Exchange information FFS - Review of the week
<p>Week 7</p> <p>Booting</p>	<ul style="list-style-type: none"> - Field work - Booting stage - What is ETL? 	<ul style="list-style-type: none"> - Field work - Zoo/collection - What is a parasite? 	<ul style="list-style-type: none"> - Field work - Visitor (natural enemies) - Planning and preparation FFS 	<ul style="list-style-type: none"> - Field work - Risk assessment - Prevention rats 	<ul style="list-style-type: none"> - Agroecosystem - Group dynamics - Team building exercises - Prep. FFS 	<ul style="list-style-type: none"> - FFS 6th session - Exchange information FFS - Review of the week

<p>Week 8</p> <p>Heading</p>	<ul style="list-style-type: none"> - Field work - Heading stage - Spraying 	<ul style="list-style-type: none"> - Field work - Zoo/collection - Sprayer 	<ul style="list-style-type: none"> - Field work - Visitor (sheath blight - densities & fertilizer) - Planning and preparation FFS 	<ul style="list-style-type: none"> - Field work - What to do about rats? - Prevention diseases 	<ul style="list-style-type: none"> - Agroecosystem - Group dynamics - Team building exercises - Prep. FFS 	<ul style="list-style-type: none"> - FFS 7th session - Exchange information FFS - Review of the week
<p>Week 9</p> <p>Flowering</p>	<ul style="list-style-type: none"> - Field work - Flowering stage - Present studies 	<ul style="list-style-type: none"> - Field work - Zoo/collection 	<ul style="list-style-type: none"> - Field work - Visitor (people's theatre) - Planning and preparation FFS 	<ul style="list-style-type: none"> - Field work - Rat materials - Disease collection 	<ul style="list-style-type: none"> - Agroecosystem - Group dynamics - Team building exercises - Prep. FFS 	<ul style="list-style-type: none"> - FFS 8th session - Exchange information FFS - Review of the week
<p>Week 10</p> <p>Milky</p>	<ul style="list-style-type: none"> - Field work - Milky stage 	<ul style="list-style-type: none"> - Field work - Zoo/collection 	<ul style="list-style-type: none"> - Field work - Visitor (BPH pop. dynamics) - Being a natural enemy - Planning and preparation FFS 	<ul style="list-style-type: none"> - Field work - Rat materials - Disease collection 	<ul style="list-style-type: none"> - Agroecosystem - Group dynamics - Team building exercises - Prep. FFS 	<ul style="list-style-type: none"> - FFS 9th session - Exchange information FFS - Review of the week
<p>Week 11</p> <p>Milky</p> <p>Dough</p>	<ul style="list-style-type: none"> - Field work - Present studies 	<ul style="list-style-type: none"> - Field work - Zoo/collection 	<ul style="list-style-type: none"> - Field work - Visitor (participatory research-ngos) - Planning and preparation FFS 	<ul style="list-style-type: none"> - Field work - Rat materials - Disease collection 	<ul style="list-style-type: none"> - Agroecosystem - Group dynamics - Team building exercises - Prep. FFS 	<ul style="list-style-type: none"> - FFS 10th session - post test - Exchange information FFS - Review of the week

<p>Week 12</p> <p>Dough</p>	<ul style="list-style-type: none"> - Field work - Dough stage - Reports 	<ul style="list-style-type: none"> - Field work - Zoo/collection - Reports 	<ul style="list-style-type: none"> - Field work - Visitor (economic data- baseline) - Planning and preparation FFS field day 	<ul style="list-style-type: none"> - Field work - Disease collection - Reports 	<ul style="list-style-type: none"> - Agroecosystem - Group dynamics - Team building exercises 	<ul style="list-style-type: none"> - FFS preparation field day - Exchange information FFS - Review of the week
<p>Week 13</p> <p>Mature</p>	<ul style="list-style-type: none"> - Field work - Mature - Reports 	<ul style="list-style-type: none"> - Field work - Zoo/collection - reports 	<ul style="list-style-type: none"> - Preparation FFS field day 	<ul style="list-style-type: none"> - Field work - Disease collection - reports - Post test 	<ul style="list-style-type: none"> - Agroecosystem - Group dynamics - Team building exercises - Prep. field day 	<ul style="list-style-type: none"> - Field Day - Review of the week
<p>Week 14</p> <p>Harvest</p>	<ul style="list-style-type: none"> - Field work - Harvest 	<ul style="list-style-type: none"> - Field work - Harvest - Planning follow up activities 	<ul style="list-style-type: none"> - Reports - Evaluation and Field Day 	<ul style="list-style-type: none"> - Reports - Planning follow up activities 	<ul style="list-style-type: none"> - Report - Presentation 	<ul style="list-style-type: none"> - Closing Ceremony

Annex 2-3: Cotton IPM Training Curriculum Development Matrix (TCDM)

Topic	Pre-Plant/Crop Estab.	Vegetative	Squares (flower)	Boll (fruit)
GROW A HEALTHY CROP				
Soil fertility	Organic matter/Mulching			
Fertilizer	N-P-K	Micronutrients and "red leaf"	N-P-K requirements	
Water management	Germination	Over/under watering effect	Shedding and drought/logging	
Seed quality	Lots of variation- fungal disease % Germination			
Variety	Several varieties avail. Resistance to soil borne disease			
Plant density	Heavy seeding and thinning?	Compensation for lost hills		Final plant density and yield
Plant compensation		Topping and leaf eating moths Leaf pubescence/gossipol Leaf damage-pestic.-white fly	Square shedding and yield (want square shedding?)	# of boll and size of boll boll shedding
Crop development	Crop stand First leaves and leaf age	Leaf pattern Branching pattern - topping Is shoot borer good for topping?	Are defoliators good for square shedding?	Does all boll shed mean some yield loss?
CONSERVE NATURAL ENEMIES				
Naturally occurring	Survey and evaluation	Survey and evaluation	Survey and evaluation	Survey and evaluation
B.t.		Effectiveness - leaf disk with each instar on various spp.		
NPV		Release timing and amount Evaluation - % infection	% infection	% infection

Topic (cont'd)	Pre-Plant/Crop Estab.	Vegetative	Squares (flower)	Boll (fruit)
Trichogramma	Rearing	Release timing and amount Evaluation of parasitism	Evaluation of parasitism	Evaluation of parasitism
Chrysopa		Evaluation of predation	Evaluation of predation	Evaluation of predation
OBSERVE FIELDS				
Disease	Seed quality issues Soil borne damping off	Angular leaf spot		
Deficiency	Soil sampling, residual N	Red leaf micronutrient deficiency		
Weeds	Land preparation	Timing and cultivation	Timing and cultivation	Seed production reduction
Insect pests	Aphids ???	Aphids Jassids Leaf eating caterpillars (and compensation/topping) <i>[Helicoverpa, Spodoptera, Earious, Pink bollworm, Semi-looper, etc.]</i> Mites (and plant stress) White flies (and pyrethroids) Pheromones and other traps Visual assessment	Aphids Jassids Leaf eating caterpillars (and square shedding) Mites (and plant stress) White flies (and pyrethroids) Pheromones and other traps Visual assessment	Aphids Jassids Caterpillars (and boll shedding) Mites (and plant stress) White flies (and pyrethroids) Pheromones and other traps Visual assessment Cotton stain bug
Natural enemies	(Surveys)	Ground beetles and trapping Coccinellidae, Reduviidae Stryphidae, Anthrocoridae, etc. Chrysomellidae, Pred. wasps Egg and larval parasites Spiders, birds (Surveys)	Ground beetles and trapping Coccinellidae, Reduviidae Stryphidae, Anthrocoridae, etc. Chrysomellidae, Pred. wasps Egg and larval parasites Spiders, birds (Surveys)	Ground beetles and trapping Coccinellidae, Reduviidae Stryphidae, Anthrocoridae, etc. Chrysomellidae, Pred. wasps Egg and larval parasites Spiders, birds (Surveys)

Topic (cont'd)	Pre-Plant/Crop Estab.	Vegetative	Squares (flower)	Boll (fruit)
Neutrals	Detritivores, collembola	Detritivores, collembola	Detritivores, collembola	Detritivores, collembola
Bees			What is the role of bees?	
Pesticide use/effects		White flies, mite induced pest and relation to defoliators	Leaf disk and older leps Insecticide resistance - strains	Residues
Pesticides and health		Pyrethroids, monocrotophos		Residues and pickers
Pesticides and envir		Non-target and runoff		
FARMERS AS EXPERTS				
Sampling Agro-ecosystem anal. Yield loss relations	Ecosystems concepts	All the above	All the above	All the above

Chapter 3.

Season-Long Field Studies: Learning through Experiments

3.1. *IPM validation trials*

3.2. *Classical IPM Field Studies*

3.3. *Collections*

Annex 3-1: How to write a Study Report?

This chapter provides experimental outlines for the Season-Long Field Studies. These studies are undertaken to illustrate and validate IPM principles and should be repeated by all IPM experts in the field so that they will be able to authoritatively help others learn about IPM. All studies are similar to original research undertaken to develop IPM methods. The first section (3.1.) contains outlines for IPM validation trials which should be conducted by TOT and FFS in order to compare local conventional methods with the IPM methods. An optional arthropod survey no-spray field is often included with FFS IPM-Farmer Practice comparisons trials in TOTs.

Section 3.2. are outlines for ten "Classical Studies". These studies should be implemented in TOTs. Some studies should be replaced in case of particular local interests or problems such as rice-fish interests, or special soil problems. Some FFS may wish to implement a few of the studies, such as defoliation studies or de-tillering studies. In areas where BPH outbreaks are a problem, Study 6 on BPH resurgence will provide strong insights into the central role of natural enemies for biological control of BPH.

Directions for making a study report are included in the Annex 3-1. All studies should be reported as scientific studies and become part of the local database on IPM studies at local levels.

Guidelines are given for disease and arthropod collections in Section 4.3.. These collections are required in the TOT for two reasons. First, making a collection motivates trainees to observe the ecosystem more closely during collection. Second, a good collection can be used for Field Days, and other activities where it is not possible for policy makers and others are not enter fields but should at least see a natural enemy in action. I advise separating arthropods into pests, natural enemy, and other classifications.

ADD EXPERIMENTS TO THIS BINDER!

Over time you will be making new experiments or hear of good ideas. The IPM Programme in Vietnam is developing experiments on rice-fish culture, vegetables, and gender issues. CARE in Bangladesh is developing studies on green manure to increase nitrogen and organic material in the soil. You will create your own studies as well, so be sure to share your good ideas.

One final note. Experiments always work better the second time. Be sure to test each experiment at least once to get some experience with the methods, layout, and small details that can make or break a study. Experiments are good to repeat. Each time we do a study we see new aspects if we open our eyes, and build (or break down!) our confidence in the basic concepts of IPM. Good luck and remember - a good farmer is a good experimenter, but not necessarily the other way around!

3.1. IPM Validation Trials

Introduction

This study is designed to compare IPM methods with local farmers' practices or conventional methods. Let farmers test IPM and convince themselves of the merits of IPM methods. There are two treatments which should be prepared on large plots (at least 500-1000 m² each) and compared. In many programs, farmers and trainers will change the "Farmer Practice" during the season as they learn more about the ecosystem and realize much that less pesticide or fertilizer is necessary compared to that previously used. It is therefore very important to set the "Farmer Practice" beforehand and to implement it based on the usual practices. An optional No-Spray practice can be included if there is sufficient land in order to make collections of arthropods, and compare the impact of pesticides if applications are necessary during the season.

Method

1. Use the same agronomic practices for all treatments. Nitrogen applications should be basal, and one or two splits based on usual practices. If fertilizers are not the same for IPM and farmer practices, be sure to include this information on all yield graphs and tables.
2. Treatments. Use 3 to 4 replications per treatment with each plot at least 500m². It is better to have a larger plot size and less replications for this study because of the movement of insect pests and natural enemies when pesticides are applied.
 - T1. IPM methods; observation and agroecosystem analysis
 - T2. "Farmer Practice" or "Conventional Method". Make a survey before the beginning of the season and do not change during the season as a result of comparison with T1.
 - T3. No-spray [optional, but desirable - every person should try to grow rice without spraying at least in their life - it will change your view of pesticides forever!]
3. Make weekly Agro-Ecosystem analysis of all treatments. Treat T1 as necessary based on field observations. Treat T2 based on initial survey and determination of conventional methods. Do not treat T3 with pesticides but do check irrigation, and be sure to hand weed as necessary.
4. Measure yield at end of season.

Analysis

1. Make graphs of the insect and natural enemy populations.
2. Make a cost-benefit economic analysis of all treatments. Include health and environmental impacts if possible.

3.2. Classical IPM Field Studies

These 10 classical studies have been performed by many researchers numerous times and form the basis of recommendations for rice culture using IPM methods. IPM includes four principles:

1. Grow a healthy crop
2. Conserve natural enemies
3. Observe fields weekly, and
4. Farmers become experts.

The 10 classical studies help to understand the meaning and origin of these principles and help understand what one must do to implement these principles. The study topics include:

1. Grow a healthy crop:

Study 1. Yield and pest response to nitrogen dosage.

Study 2. Yield and pest response to phosphate dosage

Study 3. Rice Garden (Time of Planting)

Study 4. Varietal Monitoring

2. Conserve natural enemies

Study 5. Arthropod Survey (No Spray).

Study 6. BPH resurgence. (Caged study).

3. Observe fields weekly

Study 7. Simulation of Stemborer/Rat Damage (tiller cutting)

Study 8. Simulation of Defoliation (leaf cutting)

Study 9. Sampling Method

Study 10. Distribution and abundance of insects and natural enemies in rice fields

Each of these studies is outlined below. Please note that the introductions are summarized and the trainee should expand upon the introduction when preparing reports of the studies. The methods section should also be expanded to include all activities performed during the implementation of the study.

Trainees are required to write up their studies using the standard format of Introduction, Methods, Results, Discussion and Conclusions as given in Annex 3-1. The questions presented are to assist in developing the Discussion and Conclusions section.

Add other studies to this section as you develop them or collect from other programs.

Study 1. Yield and pest response to nitrogen dosage.

Introduction

Yields of most rice varieties easily increase with increasing nitrogen usage. There are negative effects of nitrogen also including lodging, and water pollution. It is commonly stated that increasing nitrogen increases insect pests and diseases. In fact, some diseases such as blast and sheath blight do increase with more nitrogen, especially if the variety is not resistant. In the case of insect pests, increasing nitrogen does not automatically increase insect pests because natural enemies in the field can keep most pest populations to a low level. High nitrogen can sometimes help the plant recover from damage caused early in the season by stemborers and defoliators. In this study, you will implement a common nitrogen response study for observation on pests and yield effects.

Methods:

1. Use agronomic practices recommended for your area for all inputs but nitrogen. Nitrogen applications should be basal, and one or two splits based on usual practices.
2. Treatments. Use 4 replications per treatment. (Treatments with manures can be introduced as well).

T1. 0 kg N/ha

T2. 40 kg N/ha

T3. 80 kg N/ha

T4. 120 kg N/ha

T5. 140 kg N/ha

3. Sampling: Weekly sample the tiller number, plant height, disease intensity, insect pest density, deadheart %, whitehead %, natural enemy density. Measure yields at the end of season.

Results:

Plot sampled data against nitrogen levels. Economic analysis of inputs vs. yields.

Discussion topics:

1. What was the effect of nitrogen on plant development and yields?
2. What was the effect of nitrogen on insect pests and natural enemies?
3. Which level was most profitable? Which level was not risky in terms of potential disease or lodging?
4. What do you conclude about the usage of nitrogen? What will happen to rice yields when nitrogen costs increase in twenty years with increasing petroleum costs?

Study 2. Yield and pest response to phosphate dosage

Introduction

Current TSP recommendations are usually uniform over large areas, but some soils do not need yearly applications of TSP to maintain P levels in the soil. Also P levels may effect the amount of diseases and insect pests in the field. This study will examine the effect of P on yields, diseases and insect pests.

Methods

1. Agronomic practices should be the same as for IPM validation trials.
2. Treatments. Use 4 replications per treatment.
 - T1. 0 kg P/ha
 - T2. 20 kg P/ha
 - T3. 40 kg P/ha
 - T4. 60 kg P/ha
 - T5. 80 kg P/ha
3. Sampling: Pre-season, check the previous usage of P in the study fields. Weekly sample the tiller number, plant height, disease intensity, insect pest density, deadheart %, whitehead %, natural enemy density. At end of season measure yields.

Discussion topics

1. What was the effect of P dosage on plant development and yields?
2. What was the effect of P dosage on pests? Can you explain why these effects were seen?
3. Which level was most profitable? Which level was most risky in terms of potential diseases or lodging?
4. What do you conclude about the usage of P? What will happen to rice yields when P costs increase?

Study 3. Rice Garden (Time of Planting)

Introduction

This study will test the effect of time of planting on disease and insect levels. It is often stated that early or late plantings will have different levels of pests, or that all fields should be planted synchronously but these statements cannot be shown to be generally true. It appears that the actual level of infestation is very location specific.

Methods

1. Use IPM agronomic methods.
2. Divide the field into 5 plots. Plant the fields on different dates separated by two weeks. Begin at one end and plant the next adjacent field so that the youngest and oldest plots are in order. Each planting is a treatment. Replicate twice.
3. Sampling: Weekly sample the tiller number, plant height, disease intensity, insect pest density, deadheart %, whitehead%, natural enemy density. At end season measure yields.

Results

1. Plot plant development, disease, insect pest and natural enemy densities for each treatment (week of planting).

Discussion

1. Which treatment had the highest/lowest yield? Which plot had the highest/lowest disease and/or insect pests? Did pests or natural enemies move from plot to plot?
2. In asynchronous areas, will natural enemies increase because there is always prey available? What are positive and negative aspects of asynchronous and synchronous planting?

Study 4. Varietal Monitoring

Introduction

Diseases of rice are primarily controlled by varietal resistance and nitrogen fertilizer levels. Plant resistance characteristics may change from location to location due to soil and weather. The need for brown planthopper resistance may also change from area to area: BPH resistance is not usually necessary in areas without heavy pesticide sprays, but resistance is necessary in areas with heavy pesticide usage. This study demonstrates how to monitor varieties locally.

Methods

1. Use IPM methods for agronomy.
2. Plant at least three 20 m. rows per variety to be tested. In this study, at least 5 varieties including susceptible and resistant varieties should be planted. Move varieties are preferred.
3. Sampling: For each variety being tested, weekly sample the tiller number, plant height, disease intensity, insect pest density, deadheart %, whitehead %, natural enemy density. At end of season measure yields.

Results

1. Plot plant development, disease, insect pest and natural enemy densities for each variety.

Discussion

1. Which variety had the highest/lowest yield? Which variety had the most diseases and insect pests?
2. If you were a farmer, which variety would you choose?

Study 5. Arthropod Survey (No Spray).

Introduction

It is conceivable that in the near future, most pesticides will not be allowed on rice because of the low price of rice, the high cost of pesticides or the effects of pesticides on the environment and health of farmers. Crop insurance and better production methods could be used to protect farmers from the low level of losses due to pests in rice. This study will examine the yield and pest populations of rice with no pesticide sprays.

Methods:

1. Use IPM agronomic recommendations.
2. There are two treatments. Each treatment with 4 replications.
 - T1. No spray with susceptible variety.
 - T2. No spray with resistant variety.
3. Sampling: For each treatment being tested, sample weekly the tiller number, plant height, disease intensity, insect pest density, deadheart %, whitehead %, natural enemy density. At end of season measure yields.

Results

1. Plot plant development, yields, disease, insect pest and natural enemy densities for each treatment.

Discussion

1. Which variety had the highest/lowest yield? Which variety had the most diseases and insect pests?
2. If you were a farmer, which variety would you choose?
3. How did the no spray compare with the IPM practices? In your opinion, what would happen nationally if no pesticides were allowed on rice?

Study 6. BPH resurgence. (Caged study).

Introduction

BPH resurgence is caused by the application of pesticides which reduces the number of natural enemies in the field. This can be shown using cages which keep BPH free from natural enemies the same way that pesticides remove natural enemies from the field.

Methods

1. Use IPM agronomic recommendations.
2. There are two treatments. Each treatment with 6 replications.
 - T1. BPH caged on susceptible variety. Cage should include at least 16 hills. Cage should be buried in the mud after 16 gravid adult female BPH are put in the cage at 20 DAT.
 - T2. BPH with open cage on susceptible variety. Cage should include at least 16 hills. Cage bottom should be about 20 cm above the water so that natural enemies can go into the cages. 16 gravid adult female BPH are put in the cage at 20 DAT.
3. Sampling: For each treatment being tested, sample weekly the number of tillers, plant height, BPH and natural enemies. At end of season measure yields.

Results

1. Plot plant development, yields. BPH and natural enemy densities for each treatment.

Discussion

1. Describe the outcome of the BPH development for each cage. Was the development the same in all cages? What was the development of natural enemies? How does this study simulate the use of pesticides? What is resurgence?

Study 7. Simulation of Stemborer/Rat Damage

Introduction

Not all stemborer damage results in yield loss. Rice plants are able to compensate for deadheart and whitehead damage. In experiments at IRRI, only damage greater than 25% deadhearts and 5% whiteheads led to yield loss. Of course the exact levels will be different with changes in fertilizer levels, variety, weather and other types of damage. This study demonstrates the level of plant compensation possible due damage similar to stemborer damage. It should be noted that the method used in this study (tiller cutting) has been studied and closely simulates actual stemborer damage.

Methods

1. Use IPM agronomic methods
2. There are 10 treatments which should be replicated 4 times per treatment. Plots may be small.
 - T1. At 14 DAT, cut 10% of tillers in 1 m² block.
 - T2. At 14 DAT, cut 20% of tillers in 1 m² block.
 - T3. At 14 DAT, cut 30% of tillers in 1 m² block.
 - T4. At 30 DAT, cut 10% of tillers in 1 m² block.
 - T5. At 30 DAT, cut 20% of tillers in 1 m² block.
 - T6. At 30 DAT, cut 30% of tillers in 1 m² block.
 - T7. At 55 DAT, cut 5% of panicles in 1 m² block.
 - T8. At 55 DAT, cut 10% of panicles in 1 m² block.
 - T9. At 55 DAT, cut 15% of panicles in 1 m² block.
 - T10. No tiller cutting: Control.
3. Cages may or may not be used. In the case that cages are not used, the actual level of damage should be computed for final analysis.
4. Sampling: Weekly sample the tiller number, % deadhearts and % whiteheads. Note any other insect, disease or rat damage. At the end of the season, measure the yield of the 1 m² block in each replication.

Results

1. Compute the actual damage for each replication and treatment if there was any natural infestation.
2. Plot the yields for each treatment.

Discussion

1. What was the effect of the simulated damage on yield? Was any plant compensation evident? What would happen if the nitrogen level was higher? What does this mean for usual farmer

practice? Do sprays for defoliation reduce yield loss, or increase the chance for BPH resurgence?

Study 8. Simulation of Defoliation

Introduction

Not all defoliation results in yield loss. The plant is able to compensate for most leaf damage during most of the stages of rice growth. The flag leaf is the most sensitive leaf, especially during the panicle initiation and booting stages. During the vegetative stage, leaves are rapidly being replaced by the growth of the plant. During the reproductive stage, the lower leaves are being shaded and often use more energy than they produce. This study will simulate the effects of defoliation on yield loss.

Methods

1. Use IPM agronomic methods
2. There are 9 treatments which should be replicated 4 times per treatment. Plots may be small. Leaf cutting means to cut each leaf on the plant. 25% means one quarter of the leaf blade, and 50% means one half of the leaf blade.

T1. At 14 DAT, cut 25% of all leaves in 1 m² block.
T2. At 14 DAT, cut 50% of tillers in 1 m² block.
T3. At 30 DAT, cut 25% of tillers in 1 m² block.
T4. At 30 DAT, cut 50% of tillers in 1 m² block.
T5. At 55 DAT, cut 25% of tillers in 1 m² block.
T6. At 55 DAT, cut 50% of tillers in 1 m² block.
T7. At 70 DAT, cut 25% of panicles in 1 m² block.
T8. At 70 DAT, cut 50% of panicles in 1 m² block.
T9. No leaf cutting: Control.
3. Cages may or may not be used. In the case that cages are not used, the actual level of damage should be computed for final analysis.
4. Sampling: Weekly sample the tiller number, % deadhearts and % whiteheads. Note any other insect, disease or rate damage. At the end of the season, measure the yield of the 1 m² block in each replication.

Results

1. Compute the actual damage for each replication and treatment if there was any natural infestation.
2. Plot the yields for each treatment.

Discussion

1. What was the effect of the simulated damage on yield? Was any plant compensation evident. What would happen if the nitrogen level was higher? What does this mean for usual farmer practice? Do sprays for defoliation reduce yield loss, or increase the chance for BPH resurgence?

Study 9. Sampling Method

Introduction

Sampling fields is usually done by diagonal walking in the field, but most people prefer to walk along the bund for sampling. This study compares the two sampling methods.

Methods

1. Use IPM methods for crop protection and agronomic practices.
2. Use at least 2 or more large plots. Each of the treatments are implemented in each plot:
 - T1. Diagonal Sampling: 30 hills
 - T2. Edge sampling: 30 hills
3. Sample weekly tiller number, insect and disease density and damage.

Results

1. Plot the sampling results for each treatment together for comparison.

Discussion

1. Each week, do the sampling methods give the same results? If there is a difference why? If there isn't a difference, when might there be a difference?
2. What should be the sampling method recommended for researchers and extension staff?

Study 10. Distribution and abundance of insects and natural enemies in rice fields

Introduction

In the past, it has been assumed that natural enemies main prey are pest species of insects. Recent findings by Dr. W. Settle and colleagues in the Indonesian National IPM Program indicate that natural enemies may actually rely most on neutral (non-pest, non-natural enemies) for their energy inputs. Neutrals include detritivores, and filter feeders in the water. Small gnats, mosquitoes, and collembola are some of the most important and abundant of these neutrals in the rice field.

This study will examine the distribution and abundance of insects and natural enemies on a hill by hill basis throughout a season.

Methods

1. Use IPM methods for field management.
2. Weekly sample 30 hills in 3 plots. Sample the insect pests, neutrals, and natural enemies levels. Also sample the insect damage and disease density for reference. Measure the yields at the end of the season.

Results

1. Make a graph as follows: The x-axis is the density (number per hill) for the insect pest, neutral, or natural enemy. The y-axis is the per cent of hills samples where the insect or natural was found. For example if the average density for 30 hills was 3 spiders per hill, but the spider was seen on only 20 hills $\{(20/30)*100=67\}$ %. Plot the samples for each week on one graph. Use one graph for each insect and natural enemy, or try combining the graphs in different ways.

Discussions

1. Describe how the insect and natural enemy populations developed over one season.
2. Was each hill protected at some point in the season? What would be the effect of "calendar" or "preventive" applications of insecticides?

3.3. Collections

Disease Collection

Introduction

Diseases can be collected by collecting the plant parts which show signs of the disease. For example, for bacterial leaf blight (BLB), infected leaves of different stages of infection should be collected. When collecting the plant parts, collect the whole tiller and keep the base of the tiller moist. After returning to your room, place on the infected parts between sheets of newspaper. Place heavy objects such as books or mattress on top of the papers so that the plant parts are flat when dry.

The dried flat plant parts should then be glued onto a heavy large piece of white paper. If it is difficult to glue the plant part to the paper, use strips of white paper like tape to keep the plant on the paper.

After mounting, keep all sheets of papers flat and out of the sunlight. The collection can be kept in a large plastic bag to keep insects and mites out of the collection. Treat the collection with pesticide if necessary. Occasional drying of the collection will reduce pest damage.

Note that collections are only a *process* in which to learn functions, structures and names of diseases. The final product is nice to look at, and usually very impressive, *but the goal of the collection is the actual collecting process*. Collecting and mounting are good ways to get to know the insect and spider communities in your area, and to understand the ecological relationships between organisms in an ecosystem.

Labels are written in the lower right hand corner of the page on which the plant is mounted.

All specimens should be correctly labeled with the following information where appropriate:

Common Name (Indonesian or better in local language)
Name of collector
Date collected, Place collected
Ecological function
Latin name with genus, species, and order.

Thick paper with writing in black ink should be used for dry labels. Thick paper and writing in pencil should be used for specimens in alcohol.

Weekly activities

Each week during the season, two hours per week should be set aside for collecting, pressing, mounting and labeling.

Scoring System

Usually collections are scored based on three parameters and each parameter given different weighting as follows:

Diversity of collection (60 points). 1 point for each species.

Labeling (25 points). 5 points for legibility. 10 points for completeness of information. 10 points for neatness and uniformity.

Display (15 points). These points for attractive pressing and mounting and for useful ordering of the specimens: taxonomic (bacterial, fungal, virus), or physiological (seedling-veg, reproductive), or organ attacked (roots, stem, leaves, panicle).

Insect Collection

Introduction

Insects and spiders can be collected many ways. The best way is to sit in a field and watch the insects and spiders to observe their activity and behavior. Keep a record of what specimens are doing in the field. Collecting can be done by hand, with a sweep net, or with an aspirator. Kill insects by placing the specimens in a bag with a small amount of alcohol or by placing the bag into a freezer for an hour. Insects, especially parasites and adult moths, can also be collected by collecting larvae or eggs in the field and rearing the insects until adult parasites or other insects emerge.

Insects and spiders that are collected can be divided into two groups. First are hard-bodied insects which are usually adults. Second are soft-bodied insects, which are usually immature nymphs and larvae, and soft-bodied spiders. Hard-bodied insects should be placed on pins and soft-bodied insects and spiders should be placed in 70% alcohol.

All specimens should be correctly labeled with the following information where appropriate:

First label

Common Name (Indonesian or better in local language)
Host (plant or insect)
Ecological function (plant feeder, predator, parasite, detritus feeder, etc.)

Second label

Name of collector
Date collected, Place collected
Latin name with genus, species, and order.

You should use thick paper with writing in black ink for labels on pins. Thick paper and writing in pencil should be used for specimens in alcohol.

Mounting large insects on pins should be done on pins on the right side of the thorax when the head is pointing away from you.

For small insects, the insect can be glued on a triangular piece of paper using most any glue (see below). Clear nail polish is commonly used as a glue for this kind of mounting.

Keep the collection in a safe place away from ants and other insects. Dry the insects well using a desk lamp. Treat with insecticide if the collection is being damaged. Keeping moth balls (paradichlorobenzene) in the collection will reduce insect damage.

Note that collections are only a **process** in which to learn functions, structures and names of insects. The final product is nice to look at, and usually very impressive, but the goal of the collection is the actual collecting process. Collecting and mounting are good ways to get to know the insect and spider communities in your area, and to understand the ecological relationships between organisms in an ecosystem.

Weekly Schedule

Each week two hours should be spent on the collection. One hour for collecting insects in the field, and one hour for identification using microscopes or magnifying glasses, and labeling.

- Week 1. Make boxes, distribute pens, and practice writing labels.
- Week 2. Collect spiders in the rice field and on the bunds.
- Week 3. Collect insects in the water using a simple aquarium net.
- Week 4. Collect hoppers, moths and larva from the rice field.
- Week 5. Collect egg masses and larvae and rear for parasites. Collect beetle predators.
- Week 6. Collect parasites from rearing. Collect web making spiders in the field.
- Week 7. Collect leaffolders and rear for parasites and adult moths.
- Week 8. Collect pentatomid predators and herbivores. Collect dragonflies and damsel flies.
- Week 9. Collect rice bugs and other insects in the field. Finish labeling.
- Week 10. Finish identification and labeling. Organize box and turn in the trainer.

Scoring System

Usually collections are scored based on three parameters and each parameter given different weighting as follows:

Diversity of collection (60 points). Each different stage of each species is one point.

Labeling (25 points). 5 points for legibility. 10 points for completeness of information. 10 points for neatness and uniformity.

Display (15 points). These points for attractive pinning and order of pinning. Straight pinned specimens. Divisions by group of species; orders and families, or ecological function - predators, parasites, herbivores, etc.

Annex 3-1: What's in a Study Report? A simple outline.

Reports are an important part of learning because they force the writer to think about the work done and the results. In our studies, you will make a short and concise report. Some of the important points for your report are given below.

The report has several parts; Title, Introduction, Methods and Materials, Results, Discussion, Conclusions, and References. But what actually goes in each section so that the report is relevant to the subject but doesn't include too much extra materials? The main goal of the report is to say 1) Why did you do what you did; 2) What you did; 3) What you found; 4) What is the meaning of what you found; and 5) how does what you found help you understand the world better.

The **Title** should be concise and include the names of the authors and their addresses.

The **Introduction** should tell the reader why you are going to do the study. You can give references to other people and what they found doing similar studies in other places and times. You should explain what it is about your study that you hope to understand better after doing the study. For example, in the TSP study, we hope to understand the effect of TSP on the growth and development of plants, insects and diseases because TSP is an important and expensive input for rice farmers. If your job is to help farmers get better, stable and low-input yields, then you should understand how these inputs influence the rice ecosystem, yield and profits.

The **Material and Methods** section should concisely describe how the study was done. You can reference the books or guides or put a copy of the study methods in an appendix if desired.

The **Results** section should give results of what happened during the study. Report only results, especially summary statistics like averages, variations, graphs and correlation coefficients. Do not analyze the data during this section, only point out the important points such as "The data indicate that populations of WPP quickly declined after flowering" or "Spiders were at high populations throughout the season". Refer to tables and graphs (example: See table 1). Put the weekly data collection sheets in the back of the report as an appendix and present only summary data in the Results section.

The **Discussion** section is the most difficult and time-consuming section because you should explain what your results mean. Discuss only the data interesting to your title and goal. Do not report that the plant was 115 cm tall unless there is a good reason to know that. For example in the case of TSP, it would be interesting to note that the results showed the plants are 25 cm tall while the expected height was 160 cm high. You should explain that the reason for the gross difference between expectation and actual was that no nitrogen was specified in the methods and that this mistake should not be repeated. Discuss what is interesting and no more.

The **Conclusion** is easy. What did you learn and what is the relationship of this to what you knew before. For example, "This study indicates that a healthy crop without high levels of disease or

other insects can recover from extensive cutting of tillers. This may mean that high levels of deadheart can be tolerated by IR64 and other modern varieties".

The **Reference** section should include any publications cited in the text such as the, the IPM Text Book, or other books.

A single report should not be more than about 5 pages and not include extra information (a typical government report contains so much extra information it is hard to decide what to read..."During this study 150,000 babies were born in the Wonocatur area during the period of the IPM training..."). Be concise. Don't include information unless it relates to the study.

Chapter 4.

Field Activity Guides for Rice IPM: Concept Specific Activities

- 4.1. *Introduction*
- 4.2. *Plant Physiology*
- 4.3. *Diseases*
- 4.4. *Weeds*
- 4.5. *Snails*
- 4.6. *Rats*
- 4.7. *Ecological Relationships*
- 4.8. *Sampling*
- 4.9. *IPM Decision Making: Agro-Ecosystem Analysis*
- 4.10. *Toxic Compound (Pesticides) Related Issues: Poisons in Agriculture*

This chapter includes many examples of Field Activities Guides for Rice IPM. Each activity is focused on a particular concept, or aspect of the rice ecosystem. The materials "guide" learners in the "field" through structured "activities". Each activity sets up a problem which the learner should solve through observation or testing. There are many activities with no one correct answer, but rather lead learners into discussion in which their own experience and local ecology will emerge and blend with new information gained in training.

These activities were originally conceived to allow adult learners (trainers, farmers, etc.) who already have a tremendous store of experiences and knowledge, to explore beyond their current knowledge. Each activity allows for local knowledge to be incorporated into the problem solving and presentations, with the hopes that each activity will be a learning experience for participants and facilitators. Facilitators should consider the various levels of participants within a group and encourage members to bring their experiences to the group.. and remember that as an IPM facilitator you are also one of the group members with a unique set of experiences that you should share.

The activities follow a process of exploring a problem in small groups through a field or classroom activity then analysis and discussion of the problem and concept and finally presentation to the large group with further discussion.

Each activity can be easily adapted to other crops and types of training. Local adaptation to local problems will make the studies more meaningful as well. Good luck!

4.1. Introduction: Field Guide Exercises for Rice IPM

Field Guide Exercises for Rice IPM is a set of activities designed to be carried out in the rice field in order to learn basic skills and knowledge for rice IPM. The approach of study is to understand the rice agro-ecosystem by studying both the ecosystem components and the interactions between components.

The Field Guides include exercises to learn about methodology for studying together in the field. There is a heavy emphasis on discovery and exploration in the field. Drawing field collected specimens is commonly used to emphasize observation skills.

Discussion and questioning are important skills to develop within the study group. The goal of IPM is independent analysis and decision making. Discussion and analysis during training is necessary to develop these as individuals. When facilitators lecture or simply give answers too quickly without discussion does not allow participants to be active and involved in decision making (and the lecture/answer may not be the "best" for that place).

The *Field Guide Exercises* are divided into several sections. During the TOT, a part of each section should be studied each week to provide a complete view of the rice system (see Annex 2-2 for a schedule of daily activities). Plant physiology, rats, insects and their natural enemies, and diseases change weekly in the rice field and therefore these topics should be covered each week. As the season progresses, the other IPM topics such as sampling methods, thresholds, pesticides, etc. can be studied to improve basic skills. At the end of each week, the field situation should be summarized by an Ecosystem Analysis activity.

The *Ecosystem Analysis* provides a method to integrate the many aspects of the rice ecosystem into one drawing that can then be discussed and analyzed. At the beginning of the season, the analysis may take 2 hours to complete. However, by the end of the season, all members of the group should be able to finish the exercise in the field without a drawing. The goal is to be able to assess the situation of the field, taking into account the state of the plant, weather, water, weeds, herbivore populations, predator populations, diseases, past experiences, economics, and other factors.

4.2. Plant Physiology

Anatomy and function are closely related. A nose has holes (anatomy) so that air can enter the body (function). A rice plant's anatomy is important to study to understand the function. The vessels in the leaf (anatomy) are important for transport of water, nutrients and systemic pesticides (functions).

Each week during the crop growth, you will collect, observe and draw plants. Use the microscopes or magnifying glasses for better observations. The micro view of the leaf surface is fascinating as are all other parts of the plant. Drawing is a tool to assist in observation, remembering and for recording what you have seen. Try to spend time to make detailed and well labelled drawings.

You will find that a deep understanding of the rice plant is the first step in understanding the effects of disease and insects on the rice plant. You will also find out why not all injury caused by diseases, insects and rats results in yield losses. Plant compensation is important for reducing the effects of injurious organisms (including us walking through the rice field!).

Rice Seedling Anatomy

Introduction

The early growth of the rice plant has several characteristics which reduce the effect of leaf damage. Each tiller produces many leaves. Usually about 16 leaves are produced early in the season. Leaf growth is rapid but the leaves die and are replaced quickly. Leaves after primordia live for a longer time.

The benefit of quickly exchanging of leaves is that leaves infected with disease or damaged by insects early in the season are quickly replaced. During the first 2 or 3 weeks after transplanting, damage to the plant will not create a substantial yield loss. The plant 'recovers' because new leaves are being formed quickly.

However, good management is important to insure rapid and strong leaf development. Seedlings should have strong stems at transplanting. This can be insured by good seed, a low density of seed in the seed bed, sufficient fertilizer and water. After transplanting, soil fertility from basal fertilization and good water supply are needed to maintain continuous growth. Growing a healthy crop reduces the effect of damage by disease and insects.

Objective

Able to explain that leaves grow and die quickly during the early vegetative.

Able to explain that rapid growth of leaves and replacement of old leaves by new leaves reduces the effect of insect and disease damage.

Able to explain good management for rapid and strong growth early in the season.

Time Required = 120 minutes

Materials Rice plants of 5, 20, and 30 DAS (days after seeding), pencil, paper.

Procedures

1. Collect plants from from the seed bed and fields. Carefully observe and draw the plants. Make a label for the roots, stem, 1st leaf, 2nd leaf, etc.

Discussion and Presentation

1. How many leaves are there on plants of the different ages? Are there any leaves that are dying? Is it usual for the leaves to die? What is a benefit of leaves dying and new ones emerging?
2. If leaves are damaged, what action should be taken for each age plants? Early in the season? What is a good seedling?
3. Why does growing a health, strong crop help reduce the effect of insect and disease damage?

Tillering Ability In Vegetative Phase

Introduction

During the vegetative phase, the rice plant is growing very rapidly. The initial two or three small plants transplanted were simple plants consisting on one stem, a couple of leaves and a few roots. As the plant grows during the vegetative phase several changes are taking place. On modern high tillering varieties, two of these changes have important implications for pest management: tillering ability and leaf growth.

Tillering ability is an important characteristic of the modern varieties. Traditional varieties generally have few tillers and each tiller is very tall. Much nutrient is used for a few tillers in traditional varieties. Modern varieties use the same nutrients for shorter plants that have more tillers and more potential for producing panicles. The ability of modern varieties to produce more tillers is related to their ability to use more nitrogen. In traditional varieties, more nitrogen result in taller plant that are likely to lodge (fall over) at maturity. Modern varieties increase the number of tillers with increasing nitrogen.

Each new tiller a really a complete plant. New tillers produce a stem, leaves, roots, and other new tillers. Tillers can be given names depending on where they emerge. The main tiller is the stem of the transplanted seedling. The primary tillers emerge from the main tiller. Secondary tillers emerge from the primary tillers, and tertiary tillers emerge from the secondary tillers. The main tiller and the primary give most of the yield for the hill, especially on short maturing varieties. Secondary tillers also have good yield but are partly green at harvest. Many tertiary tillers may not produce a panicle if nutrients, sunlight, and water are not available.

New tillers are produced from seedbed to about premordia stage. If the tillers from one plant in the hill are damaged early in the vegetative phase, more tillers will be produced by the other plants in the hill ("compensation"). Early stemborer damage does not seem to effect yield because the tillers are easily replaced. Experiments done at IRRI have shown that there is no yield loss when up to 30% of the tillers are damaged by stemborers or by cutting during the vegetative stage.

The leaves on the tillers are also growing from seedbed to premordia stage. The leaves will emerge and later die. As the bottom leaves are dying, new leaves are emerging from the top. The process allows the plant to renew leaves that are damaged by the wind, insects, or disease. The new leaves are also able to grow larger because of the larger supply of energy from the plant as the plant grows bigger.

The growth of the new tillers and leaves is determined by plant spacing, water, sunlight, and nutrients (fertilizers) available to the plant.

Objective

To describe the growth of vegetative stage plants in terms of tillering ability and leaf formation.

Time Required = 120 minutes

Materials (per group) Rice plants; 20 days after seeding (DAS), 15 and 30 days after transplanting (DAT), knife, pencil, papers.

Procedures:

(Do the following for each age plant)

1. Find fields of different ages and collect plants from the field. Wash all the mud from the plants.
2. Take the plants to a shady place and observe the plants. Begin by removing all the roots from the bottom so that the very bottom of the tillers are easily seen. Wash all mud from the base. Spread the tillers apart and notice how the tillers emerge from other tillers.
3. Make a map of the tillers by finding the primary, secondary and tertiary tillers. Carefully remove the tillers and note where they emerge. Find the first primary tiller and remove from the main stem. On this primary tiller, find the first secondary tiller and remove it. If the secondary tiller has a tertiary tiller, remove this tiller also. Continue this process until you have a map of the tillers on the plant.
4. Count the number of leaves on each tiller. Count the number that are dead. Notice if there are new leaves emerging.
5. Each person in the group should take a turn to explain the structure of one of the plants to the group using a map.

Discussion and Presentation

1. Describe the pattern of tillering from transplanting through the vegetative stage.
2. Why is continuous tillering important?
3. What will happen when some tillers are removed from the plant?
4. What is the effect of stemborers on the plant in the early phase.
5. What is happening with the leaves on the different tillers? Are there dead leaves and newly emerging leaves? Why is this important?

Roots and Plant Vessels

Introduction

Fertilizers and systemic insecticides, such as carbofuran, are often applied to rice plants. How do these nutrients and insecticides get into the plant and then move through the plant?

To enter the plant, the chemicals must be dissolved in water. Without water, the compounds will not be able to move either in the soil from the surface to the roots, or from the soil into the roots. Once the chemical are dissolved in the water, they are absorbed into the plant with the water.

Once the chemicals are inside the plant, the chemicals are able to move through the plant through a system of hose-like vessels between the roots and the top of the plant. Water moves up these vessels and sugars move down the vessels.

Insects feeding on the plant by sucking or chewing of the vessels ingest the insecticide. Planthoppers and stemborers are insect pests which can be controlled using the systemic insecticides because they feed on vessels. Hoppers suck on the vessels, and stemborers eat the vessels while feeding inside the plant.

After the systemic insecticide moves to the leaves of the rice plant, water from the vessels is exuded each evening. This is the small droplet of water found on the tips of the leaves early in the morning. This drop of water on each leaf contains the systemic pesticide. The drop falls back in the water or evaporates each day. If natural enemies come into contact with the water they will be killed by the systemic pesticides. The drop of water often falls on natural enemies or natural enemies drink from the drop of water.

This activity will show how water solutions move through the plant.

Objective

1. After this activity you should be able to describe how systemic insecticides move through the plant.
2. You should be able to explain why systemic control insects sucking or chewing on vessels are controlled by systemic insecticides.

Time Required = 120 minutes (Whole time not used. Best to run activity while doing other activity.)

Material

Water, red ink or food coloring, 2 cups per group, plants and 2 straws

Procedure for one group

1. Go outside and find many kinds of plants including rice seedling, kankong, celery, grasses and other plants.
2. Add water to the 2 cups and place several drops of the red food coloring. The water should be dark red.
3. Place the plants in the cups with the stems in the cups. Also place the straws in the cups. One straw should be flattened first. Place the plants in a bright place.
4. Wait 90 minutes and observe the plants. What has happened to the color of the leaves? How has the red coloring moved in the plants?
5. What do you think happens with rice in the rice field when systemic insecticides are used? Where is the insecticide in the plant? What kind of insects suck on the fluid in the plant vessels? What kind of insects chew on the plant vessels? What about insects that feed on the leaf edge? Do they also feed on the main vessels?
7. What happens after the solution reaches the tip of the leaf? Have you noticed the water on the leaf tips in the evening and morning? Where does this water come from and what does the solution contain? How might the solution effect natural enemies in the field? How about farmers walking in the early morning field?

Premordia Anatomy

Introduction

The premordia stage begins 65 days before the maturity of the crop. So if the crop matures in 110 days then the premordia stage will begin at 45 HSS. This is the case with IR64.

The premordia phase is the most important phase during the growth of the rice plant because during the premordia phase the panicle is being developed. The number of grains and the quality of the flowers that determine the final yield are being developed. The grain number and flower quality should be high in order to achieve a high yield, but these can only be high if the panicle is well developed from the earliest stage.

Good premordia development requires good nutrients, and water. Fertilization at the stage is important for increasing yields. Water should be sufficient. The plant is very sensitive to pest damage during this stage. It is important that the plant be in good health at the beginning of premordia development. The tiller number should be high and few diseases. If the plant is infected with disease, consider changing variety or management methods in the next season.

Being able to identify the premordia in the plant is a useful skill to time fertilizer application. The premordia is formed at the highest node. The last leaf (the flag leaf) is usually still very small and covers the young premordia. The flag leaf has lines on the surface. The premordia does not have lines, but looks like it has many small feathers (the young panicle).

Objective

1. To locate new premordia in the field and observe the state of the plant.

Time Required = 120 minutes

Materials

Pencil knife, pencil, paper

Procedures

1. For each of your field plots, compute the approximate time of premordia. The date of premordia initiation is equal to the days to maturity minus 65 days.
2. Go to the fields and select the tallest and healthiest hills.
3. In the best hills, find the oldest tiller by finding the tallest tiller.
4. Remove the tiller. Carefully remove the leaves until the top internode is exposed. Search for the premordia and don't be fooled by the immature flag leaf. You can also carefully split the tiller open in order to find the highest stem. The premordium should be just forming and still small. It may appear like a very tiny feather.

5. Remove several of the tallest tillers and return to the laboratory. Observe the tillers for premordium and draw what is seen with the microscope.

Discussion

(Please write down the answers to these discussion items so that you can refer to them after one month when we observe the plants again)

1. What are the dates of premordium development for each of the plots?
2. Do you expect that all the tillers in a hill will reach premordium at the same time?
Why don't all the tillers have the same age?
3. What kind of environmental conditions or management problems could make the premordium stage late?

Booting Stage

Introduction

The booting stage is when the panicle has grown large inside the leaf sheath but has not emerged (heading). The tiller looks pregnant, and the flowers in the tiller are still young and tender but not yet fertilized.

The booting stage is most sensitive to diseases and insects on the flag leaf. The quality of the flower parts and pollen production is being determined during this stage. Water should be maintained in the field. Stemborers may be active during booting as the plant is still susceptible to boring larva.

Objective

Describe the panicle during booting.

Time Requirement = 60 minutes

Materials; Paper, pencil

Procedure

1. Go to the rice field and find tillers in the booting stage. Remove tillers and return to the laboratory.
2. Dissect and draw the tiller with the developing panicle inside.
3. Dissect the grains. Count how many grains are produced and how many already have developed flowers.
4. Taste the plant. What is the flavor and texture? How do you think stemborers would like the panicle stem at this stage?

Leaves Before and After Premordia Initiation

Introduction

After premordia initiation, the plant will begin to change the pattern of growth. During the vegetative phase, the plant is producing new tillers with roots, stems, and leaves. At premordia initiation, the plant will begin to put energy and nutrients into the development of the panicle. In human development terms, the plant is the same as a teenager that is stop growing and is ready to have children.

One big change is in leaf growth. The leaves on the plant will have to supply energy for almost two months while the plant is producing flowers and filling grains. No new leaves will be able to replace damaged leaves. The top leaf (flagleaf), and the second leaf from the top are the most important leaves on the plant. These leaves will supply most of the energy needed to fill the grains. The lower leaves are less important because they don't receive much sunlight.

Protection of the leaves are important to protect during the formation of the grain. This is why the threshold is lower during and after premordia formation.

Rapidly increasing height is another change during premordia. The stem internodes will elongate so that the panicle will be pushed out of the leaf sheath. It is amazing how much the elongation of the plant can quickly increase the height of the crop in just a short time. The elongation is due to increased size of the cells. During elongation, the plant is very susceptible to stemborer larvae because they can easily bore into the stem and the stem is usually sweet.

This activity focuses marking leaves with Tip-Ex (Liquid Paper) and measuring the plant height each week for four weeks.

Objective

To observe the growth of upper leaves of the plant.

Time Required = 30 minutes for four weeks.

Materials

Pencil, paper, Tip-Ex or Liquid Paper, ruler.

Procedures

1. Go to the field with paper, Tip-Ex and ruler.
2. Each group should choose 5 healthy hills. Choose hills near the bund. Make a map of the location of these plants by counting the number of hills from one corner of the field to the hill. You will observe the same hills each week.

3. On the underside of the top leaf of each tiller in the hill, put one dot of Tip-Ex. On the underside of the second leaf from the top of each tiller in the hill, place two dots on the underside of the leaves. Measure the maximum height of the hill.
4. Observe the 5 hills each week for four weeks. Note the position of the leaves that were marked. Taste and note the sweetness and texture of the stem each week.

Discussion and Presentation

1. What was the final position of the marked leaves? What new leaves emerged if any?
2. How did the plant height change?
3. Was there any change in the flavor and texture of the stem? When do stemborers that cause whitehead enter the plant?

Heading and Flowering

Introduction

Heading is a the stage when the panicle emerges from the leaf sheath and the flowers become mature. The flowering stage is actually very short for a single grain but very long for the whole plant. The flower parts are already well developed at heading. The rice plant usually opens the flower for a couple hours in the morning. 98% of the grains will be self-pollinated before opening. This type of germination allow the rice variety to say stable over many generation and allow farmers to use their own seed for replanting. Germination is best when there is sufficient water for good pollen development.

The rice flower is simple. The flower parts are easily recognizable and comparable with other flowers.

Objective

Identify the parts of rice flowers.

Time Requirement = 90 minutes

Materials

Paper, pencils (colored)

Procedure

1. Go the rice field and find hills with flowering panicles.
2. Count how many tillers have panicle and how many do not. How many panicles are heading, and how many flowering?
3. Collect some panicles and return to the laboratory.
4. Draw the panicles and note which grains are flowering, and which are before or after flowering. Does flowering begin with the top or bottom grains?
5. Now dissect and draw the parts of the rice flower. Collect some other flowers from around the building or rice field, and draw those flowers. Are there similarities in structure? Label the parts of the flowers.

Discussion and Presentation

1. Did your fields head and flower at the same time? Did all the plants in the field flower at the same time? Why was any variation observed? Can you trace variation back to some management problem? Can all problems (rats, disease, insects) be traced backwards to a problem of management originally? Try an analysis.
2. What are the similarities of flowers? What is the function of the different parts? Which part of the flower becomes the grain?

Milky Stage

Introduction

The milky stage of the plant is after flowering. The grain is beginning to be filled with starch grains produced primarily in the flag leaf. The grains will continue to fill up to the maximum size of the grain, although not all grains will become full. Only flowers that were germinated will become grains.

During the milky stage, there is a pattern of grain filling. Some varieties seem to give even filling of the grains, while other varieties fill some grains full, but leave others mostly empty. Sometimes the grains are filled from the top of the panicle to the bottom, and sometimes from the bottom to the top. Grain filling depends a lot upon variety, sunshine, water, and other factors.

The milky grains are mostly susceptible to rice seed bug. During this stage, this insect is sucking the contents of the grain. Once the grain is in the dough stage the rice seed bug cannot suck the contents.

The panicle is also susceptible to stemborer larva. If the base of the panicle is cut, the panicle will be a whitehead - all unfilled grains. Many tillers can be found that have stemborer larva but with no whitehead. This is because the base of the panicle is not cut. Rats can also be a big problem since they seem to prefer this stage of the crop.

Objective

Describe the milky stage panicle.

Time Required = 90 minutes

Materials

Paper, pencil

Procedure

1. Go to the field and collect 5 milky stage panicles.
2. Return to the lab. and draw the panicles. Note which grains are flowering and which are in the milky stage. What percent of the grains are in each stage of development?
3. Dissect and draw 5 grains at different stages of filling. How full can the grains become?
4. Taste the grains. What does it taste like? What do you think the rice seed bug does when it feeds?
5. Why does the rice seed bug smell so bad?

Dough Stage

Introduction

The dough stage of rice should be a welcome stage for many farmers because it marks the end of most important pest problems. There is still a chance that some caterpillars could damage the panicles, or that some of the fungal diseases reduce the quality of the grains. The important point at this stage is to try for an even maturing of the grains. As you saw in the milky stage, some grains are almost in the dough stage, some are in the milky stage, and some are still flowering. At harvest, we want the field to be at one stage only.

When the plant is harvested, dried and weighed there is a certain weight (kg/ha). This is usually the point that most extension workers feel their job is finished. For the farmer, however, there is another step in some cases. The polishing of the production will have another yield. If the crop was at an even age and completely mature, the yield at the mill will be high. If the maturity of the field was very variable, then the yield will be low. This is one of the reasons that foreign yields are so high compared to Indonesia. In temperate countries, the plants are low tillering and long maturing (up to 150 days). The panicles on the plant are almost identical at harvest so that milling yields are very high. The quality of the grains are also high because of slow field drying versus fast sun drying of high moisture immature crops. Of course temperate countries have only one rice crop so they can grow these kinds of varieties. Their "yield-per-day" are much lower than a tropical crop.

What does this mean? The important point from now to maturity is to attempt even ripening by proper water management and to avoid rat damage at the same time. Draining of the field 10 days before harvest is a common practice and should be followed by draining some low areas with small canals. However, draining fields also increases the likelihood of rats damage. Both aspects should be considered.

Objective

To be able to explain the status of the panicle during the dough stage by field inspection and dissection.

Time Required = 90 minutes

Materials

Pencil and paper

Procedure

1. Go to the field and choose five hills per group. Make a count of the hills by counting the panicles that are in the flowering, milky, dough, or yellowing stage. Give the percent of panicles on each hill by panicle and for total hill:

% flower %milky %dough %yellowing

per panicle

per hill

2. Take panicles to the lab for dissection. Taste the grains. What is the texture and taste? Taste the base of the panicle. What is the texture and taste compare to the flowering stage when we tasted before?
3. Draw the panicle showing which grains are flower stage, milky stage, dough stage and hard. Dissect some of the dough grains and draw what is seen inside. What limits the size of the grains?
4. Why are there few insects during this stage? What has happened in the crop? Will there be any more investment needed in pest control? What are the costs to the farmer until the end of this season?
5. What is important management activity in the until maturity?

Mature Stage

Introduction

In the field at this stage, the plants should be yellow or brown. The leaves are yellow because the chlorophyll is not active and no more sugars are being produced by photosynthesis. The starches have already moved from the leaves, stems and roots into the grains. There is no more addition of materials to the grain now. In fact the weight of the grain is going down every day because of the drying of the crop!

You are losing yield in terms of kilograms per hectare each minute as the crop dries in the field. So how are yields standardized so that the yield of one crop and the yield of another crop can be compared even though one crop is dry and one is wet? The answer is to look at the moisture content. Moisture content is the amount of water in the grain. One way to measure the amount is to weigh the grain before drying and then place in an oven or hot place for several hours or days (depending on the heat). After the grain is completely dry, the grain is measured again. The difference in the weight was the water lost. The moisture content is computed as follows:

$$\% \text{ moisture} = (\text{original weight} - \text{dried weight} / \text{original weight}) \times 100$$

To standardize reporting of yields, it is most common to report yields at 14% moisture content. To compute the yield as though it were at 14%, use the following equation;

$$\text{Weight at 14\% moisture} = (100 - \text{Weight at original moisture}) / 86$$

At lower sun dried moisture levels, rice will store for several months. Storage moisture is ideally less than 10% moisture because insects will not attack the rice. 10% moisture is somewhat difficult to achieve in humid climates.

Harvesting should take place soon as the plants dry. Insects, birds and rats enjoy the dry soil and new grains of rice. Some storage insects can be found in the field laying eggs on the grains at this stage as well! Harvesting can begin when most of the plant is yellow and the lowest grains on the panicle are hard. At this stage a sample of the grains will show a moisture content of 20-30%.

Objective

After this activity, you should be able to determine if the plant is ready to harvest, and should be able to convert the measured moisture content using a moisture meter and balance to a 14% moisture content standard.

Time Required = 90 minutes

Materials

Paper, pencil, moisture meter, balance

Procedure

Field Observation

1. Go to a mature rice field.
2. Observe 20 plants. For each plant observe the following:
Tillers that are yellow (should be minimum 80% for harvest).
Stage of grain on lower part of panicle (should be late dough and already hard).
Moisture of soil (should be dry for easiest and cleanest harvest).
3. Are the grains falling off the plant? This is a sign that the plants are too ripe.
4. Observe the field for weeds. If there are many weeds with seeds, the panicles of the weeds should be removed so that weed seeds are not mixed with the rice. Weed seeds lower the quality of the rice crop. (see attachment).
5. Is the field ready to harvest? Are the tillers and grains mature enough? Is the soil drained and somewhat dry? Are weeds removed from the field?

Moisture Computation.

1. Remove 10 dry panicles from the field and take to the laboratory.
2. Remove the grains from the panicle stem. Separate filled and empty grains. Use only filled grains for moisture testing. Divide the sample grains into 5 sub-samples of even amounts.
3. Measure the weight of the 5 sub-samples of using the balance. Write down the weight of each sub-sample.
4. Place enough grains in the moisture meter to cover the bottom of the moisture meter well. Screw the press until the grains break.
5. Read the percent moisture.
6. The weight of the sample at 14% can be computed using the equation given above.

4.3. Diseases

Introduction

Diseases in rice are not very severe in most rice growing areas due to the good work of plant breeders which have produced very good varieties. Diseases are controlled primarily by good choice of varieties, and common sense use of fertilizers. There are however a few problem diseases including blast (cool-wet environments with high nitrogen and low resistance), sheath blight (hot-humid environments with high nitrogen - > 90kgN/ha), and tungro.

To learn about diseases, you will make a disease collection and explore the actions possible for prevention of disease infection. Prevention is, in fact, the most economic method of disease control in rice. Learning to predict disease probability is another aspect of diseases that is important because some diseases can be monitored (leaf blast and sheath blight) but others need action before they are seen (neck and panicle blast, various panicle diseases).

It is important to read as much as possible about diseases, but it is also important to keep in mind the interactions of agronomic management and disease development.

Disease Prevention

Introduction

Diseases are very difficult to control within a season. Once the rice is planted there is very little that can be done to control disease. Fungicides are available but are not economic nor practical since they are rarely sold in most small towns. There are no chemical controls commercially available for bacteria and viruses. Irrigation and fertilizers are important parameters for diseases, but who will put no fertilizer in their field?

Varieties are one of the most important tools for controlling diseases. However, the time when management decisions must be made is in the current season for the next season. If the variety is heavily infected this season, a change in variety is important for the next season. Where is the information on varietal resistance? Locally who knows which varieties are resistant and which are susceptible? What does the field study on varieties tell about disease resistance?

Time of planting and seasonal effects are important for many diseases. Your experience will tell you which varieties are more susceptible in which season.

In this activity, you will consider the effect of management methods disease development and the importance of time of management decisions.

Objective

Describe management methods to prevent disease infections.

Time Required = 120 minutes

Materials

Large paper and marker

Procedure

1. Divide into groups of 5 persons. Choose a major disease of rice; BLB, BLS, BRS, Blast, Brown Spot, Sheath Rot, Stem Rot, Tungro, Ragged Stunt, Grassy Stunt.
2. On the large paper write the name of the disease chosen at the top. Now make three columns with the headings: "Management Aspect", "Effect on Disease", "Time to Consider Management".
3. In the "Management Aspect" column write the following aspects: Variety choice, Seed source, Soil preparation, Time of planting, Irrigation, Fertilization, Weeds, Vectors, Rat and insect injury.
4. Now in fill in the other two columns. Use reference texts and experience to guide you. "Time to Consider Management" should be before, during, or after infection or planting.
5. Why is "Time to Consider Management" important, especially in the case of varietal choice?
6. Present your results to the other groups.
7. Are there conflicts among the management of various diseases in terms of management? For example, do some diseases increase severity with fertilizer and other decrease (consider diseases not presented)?

WEATHER: General Introduction and Effect on Diseases

Climate and weather are important for the growth and development of diseases, insects, natural enemies and plants. Climate is the long-term general pattern of the daily weather patterns. For example, the climate of West Java is wetter than the climate of East Java because West Java has a higher annual rainfall than in East Java. On a particular day, however, the weather in East Java may be wetter than in West Java. The weather is difficult to predict, while climate is easier to forecast. In fact, weather scientists cannot reliably predict the weather for more than about 24 hours, even with super-computers satellites and vast information networks! Yesterday's and today's weather are still the best predictors of tomorrow's weather.

Weather is very important for determining the development and growth of disease and insects. Is it not surprising then that diseases and insects are also very difficult to predict. Prediction is even more difficult because the short-term pattern of weather is also important (e.g. 4 rainy days vs. 1 day rain - 2 days cold - 1 day rain) but impossible to predict. Besides our lack of prediction ability, scientists do not know the actual effect of certain weather patterns on the development of disease.

Weather can be measured. Temperature (degree centigrade maximum and minimum), rainfall (mm/hour or mm/day), solar radiation (joules/cm square/day), hours of cloud cover, relative humidity (%), atmospheric pressure (mmbar), wind speed (m/minutes), wind direction, and day length (hours) are some of the parameters that can be used to define and measure the weather. "It's a hot and windy-day" can be described as "The maximum temperature is 35 degree centigrade, wind direction southeast blowing at 5 meters per minutes, with cloud cover after 3pm".

So what are the important concepts to have when considering the weathers effect on living organisms? First is the rate of chemical reactions inside organisms. For most chemical reactions the hotter the chemicals, the faster the reaction. Thus rice cooks faster on a hot fire than on a warm fire. Plants, insects, spiders, bacteria, fungi, and viruses also "cook" faster, meaning they develop faster. Rice matures a couple days faster in hot areas. Insects develop from egg to adults in shorter times in hot areas. Fungi grow more quickly on the food left on the table than food placed in the refrigerator. However, every organism has an optimal temperature for best growth and development. Too hot burns rice, and kills plants, insects, etc. Some plants grow best at 25 degree centigrade than at 30 degree centigrade because the plants have an optimum growth temperature (actually the plant's enzymes have an optimal reaction temperature). This is true also for insects and disease organisms. This explains why different plants, insects and diseases are found on mountain tops than at low elevations. Mammals (and most PHP!) are able to regulate body temperature so we (at least our enzymes) are less effected by outside temperature changes.

Temperature can be accumulated. This is called degree-day. Thus one day at 25 degrees may be the same number of degree days as two days at 10 degrees, depending on the growth rate of the

organism at different temperature. Degree-days are used in forecasting models to predict the development rate of insects and disease in different environments.

Another key concept is water. Water is important for all life. Water can be in the form of water on a surface which is important for roots, for insects, and for germination of disease organisms. Water is also in the air as moisture. Low moisture (low humidity) means the air is dry. High humidity means there is a lot of water in the air. However, the amount of water that can be held in the air depends on how hot the air is. The hotter the air, the more moisture in the air. A cold glass collects water on the outside because the air around the cold glass becomes cold, and moisture in the air becomes water on the glass. Humidity is important for the development of microorganisms, especially bacteria and fungi.

Effects on Disease Organisms

Disease organisms for plants include bacteria, fungi, virus, and sometimes nematodes (some plants pathologists don't consider nematodes as 'disease' - in the field it doesn't really matter). Weather can effect the processes of the disease cycle in the following ways:

Transport/movement: Disease organisms are moved by the wind, by splashing rain water, and by flowing or flooding rain water moving soil, plants, and disease organisms. The level of humidity, temperature and solar isolation determines the survival of the disease organisms during movement and before a host is available for infection.

Germination: Is mostly determined by the availability of an appropriate host. However, the ability to germinate is sometimes determined by temperature, humidity, water on the surface after rain or night dew, and solar radiation. The germination of fungi and bacteria is the first step in infection and usually means that a part of the disease organism is developing ready to enter an opening in the plant tissue or is making an opening.

Infection: Success and failure of infection may depend on the growth rate of the disease organism in relation to the defense rate of the host plant. Success of infection is determined more by the plant condition than by the disease organism. Blast will only infect the plant when there is free water on the leaf, and the temperature is less than 25C.

Incubation: Incubation is the time required for an infection to cause symptoms. The development of symptoms is also a function of the plant type and condition, but also a function of the relative development rates of the plant and the disease. Disease is like a race between the plant and the disease organism. If the weather is better for the plant than for the disease (in terms of optimum temperature, water, sunlight, etc.) the plant may never show symptoms or only show minor symptoms. However, if weather conditions are best for the disease organism, the disease may quickly have symptoms, quickly develop inoculum that is ready to be moved to other leaves or plants.

Inoculum development/reproduction: Production of fruiting bodies on fungi can be a function of temperature, sunlight and relative humidity. Movement of inoculum returns us to the beginning of the disease cycle.

In this activity, we will note the specific effect of weather on the disease cycle processes for the major diseases of secondary crops.

Objective

The trainee will be able to describe the effect of weather on the disease cycle processes for at least one major secondary disease.

Materials

Paper, marker, and poster paper

Steps

1. Choose a major disease from the following list:

Bacteria

1. Bacterial blight

Fungi

2. Leaf blast
3. Sheath blight
4. Neck blast
5. Panicle blast

Virus

6. Tungro

2. On a large piece of paper, make two columns. On the top of the left column write "disease process" and list the disease cycle processes in the column.
3. On the top of the right column, write "Effect of disease" and write the name of the disease. In the column, write the effect of the weather for each of the disease cycle processes. For example; "Transport/Movement - Wind moves rust fungi from leaf to leaf, plant to plant, and field to field ...".
4. Find the answer in "Rice IPM: An Ecological Approach".
5. Present your findings to the group.

Weather, Insects and Pathogens: Measuring the Micro-habitat

Background

We discussed the influence of weather on organisms in the first sections on weather, insects and diseases. We said insects (and diseases) were like "bags of chemicals" with optimal reaction temperatures, humidity and moisture. What about in the field? Are there major differences in temperature and moisture on a small scale (several ha.)?

Differences in weather are usually seen over large areas. We will explore different sites and measure the micro-habitat. Micro-climates often are different because of exposure to sunshine or rain. The micro-climate will change when moving from place to place and moving through time in the same place. Remember that an insect or pathogen moves its place when going from the top of a leaf to the bottom of the leaf. Small changes for us, are tremendous changes for insects or pathogens moving with the wind, rain or be themselves.

Objective

To show that weather parameters (temperature, and moisture) are different over small areas of several meters.

Materials

pencil, thermometers (2 per group), plastic bags, scales.

Steps

1. Choosing sites: Choose two locations. The locations should be in the following locations:
 - a. Place with no shade and high on a slope.
 - b. Place with lots of shade and high on a slope.
 - c. Place with no shade and low on a slope.
 - d. Place with lots of shade and low on a slope.
2. Temperature: Use the thermometer to measure three positions for each site:
 - a. Soil temperature
 - b. Air temperature above a plant.
 - c. Air temperature at the bottom of the plant.
4. Make a table of temperatures and soil moisture for the sites.

5. Can you explain why there are differences in soil moisture at each site? Remember recent rains, irrigation, etc. Are these differences important for the growth and development of insects and diseases? Especially in terms of the soil organisms?
6. What are the differences in temperatures? How do you think these values will change over a one-day period? Make a hypothetical graph of these changes. Are these temperature differences important for insect and disease development?
7. Is there an interaction between temperature and moisture for any site? What is the interaction?
8. Can you give examples from your own experience where disease and insects seem to be more dense or less dense because of differences in the micro-climate or micro-habitat?

DISEASES: CONTROL OR MANAGEMENT?

Background

Diseases are an important part of crop protection, but are usually very difficult to understand in the field. This is partly because the causal organisms (bacteria, MLO, fungi, virus and nematodes) are very small and cannot be seen moving around like insects or rats. We must learn new ways of thinking about these organisms in order to have long-term control. There will be four activities for discussing diseases. The topics will cover management methods, observation methods, epidemiology (the spread of disease), and causal organisms.

The most important first step in thinking about diseases is to realize that diseases must be managed not controlled. What is the difference? Management means a complete set of activities that support each other. Management means that these activities are carefully planned and are implemented over several seasons, not controlled within a single season. Management included control methods for prevention, and control methods to slow down epidemics; diseases will never be completely eradicated - only populations reduced to very low levels. Management usually needs the cooperation of several farmers working together to reduce overall disease in an area. Management requires someone who can observe larger areas of disease incidence and levels of infection.

For an example, management of tungro in rice would be impossible without observing the larger picture of disease infection levels. The management system requires distribution of new varieties, careful monitoring of GLH, monitoring of disease incidence, planting time coordination, and sometimes a break in planting rice. These are activities that are done by individual farmers, but managed so that the activities are carried out together. Think about the management needed to control other diseases such as polio, malaria, and small pox!

What are management activities? Below is a summary of activities.

Prevent the introduction of inoculum into the field in order to delay the beginning of infection. This can be done by;

- a. Allowing only disease-free seed and planting materials (example, root stock for trees) into an area. This can be done at any level of organization.
- b. Destroy sources of inoculum such as materials in nurseries and fields with diseases. For large scale removal, it is useful to have funding (or insurance?) to compensate farmers for destruction of sources of inoculum (fruit trees, planted seasonal crops such as soybeans).

c. Small areas planted to a particular crop before the main growing season for the crop should be avoided. These small areas build up inoculum which is then carried over to the next season.

d. Farmer practice to keep disease inoculum from entering new fields. This is done by careful purchase of materials in the market, seed suppliers and plant sellers. It is also important to keep nematode infested soil from moving from field to field on the shoes of farmers, animals, and plows.

e. Sanitation is important to keep inoculum from one crop getting into the next crop. Potato blight (*Phytophthora infestans*) can be reduced by removing excess old potatoes from fields.

Prevent the development of inoculum after it enters the field. Removal and destruction of inoculum can be done before planting, during the cropping season and after the crop is harvested. Deep burial of diseased plant materials by plowing, removal of diseased plants, burning of crop residue while in the field or after collection, flooding fields, and repeated plowing to expose fields to sunlight (for nematodes) are some activities that may be beneficial. The effectiveness will depend on many factors which must be analyzed for each case.

Crop rotation is important if the rotation reduces inoculum. Rotation of tobacco and tomatoes for example is not rotation for the diseases which infect both crops. Crop rotations should be observed since there are many pathogens that survive on numerous types of both living and dead plant materials.

Fertilization may increase or decrease diseases. Most people believe fertilizers only increase diseases. However, there are numerous examples in which addition of nitrogen, potassium, or calcium actually reduced the effects of certain fungi.

Management of the micro-climate is also important. Each site has a different micro-climate each season. A shady slope in the wet season will be different from a sunny slope in the same season. Crop planting times should take into consideration dominant diseases in the area and the effect of the micro-climate.

Remember that in all cases of management, begin with knowing the disease and its methods of infection, and movement. Know your enemy. Then begin planning.

In this activity, we will use a method called **brain-storming** to develop area management methods and activities. The process is as important as the content since management implies participation of many persons.

Objective

1. To outline management activities that could be organized for an area to reduce disease incidence.
2. To use brain-storming techniques to increase/encourage inputs from all sources when problem solving or planning.

Materials

Newsprint paper (4 pieces per group) and marker

Steps

(Brain-storming is a method of getting lots of creative ideas. Many ideas will not be useful, but the ideal will act as seeds to other ideas. Discussion of ideas is allowed only after all ideas have been written down).

1. Appoint one person as the secretary who will write on the large piece of paper. DO NOT USE A SMALL PIECE because the whole group should be able to read the paper. Assign another person to be the facilitator.
2. The secretary should write "Wide-Area Disease Management" on the top of a large piece of paper.
3. The Facilitator should read the above Background for the whole group. Each member should make notes of thoughts that come to them while listening to the reading.
4. After the reading, the Facilitator should ask the following question: "What are activities that can be done in our village to manage diseases on our crops (all crops)."
5. The group members should tell the secretary their idea. The secretary will write down the idea. NO COMMENTS ARE ALLOWED BY OTHER MEMBERS AT THIS POINT. If any member makes comments, the Facilitator must ask the person to be quiet.
6. Continue writing down ideas with no discussion until the first page is full.
7. After the page is full, discuss each idea beginning at the top of the list. The Facilitator should be sure **each** person can make some comments. The Secretary should summarize the discussion on each point. Write the summaries on another large piece of paper.
8. Present the summaries of ideas to the whole group.

9. If there is time, do the same process with the following question, "What can extension staff do to help manage diseases in our village?".

VIRUS AND VECTORS

Background

One of the most difficult aspects of plant cultivation in many countries is the presence of numerous viruses. These are moved from season to season and plant to plant either by the seed itself or by insect vectors.

Seeds are important sources of viruses. Plants infected with viruses in the current season will produce seed that is covered with virus particles which infect the plant in the next season. This process is called seed-born virus transmission and is one of the most important problems in healthy seed supply. Even labeled seed is often not virus free. To compound the problem of healthy seed, the virus infected seed is not easily removed. While some seeds show signs of virus infection, not all infected seeds show infection. It is probably useful (but not economic) to remove poor quality seed when planting. Experts still do not know how much seed-born virus actually reduces production.

Aphids, leaf-hoppers, and possibly whiteflies and thrips are insects that are able to transmit viruses from one plant to another. What do they have in common? Of course, they all have sucking mouth parts and enjoy feeding on soybeans. Some viruses can be transmitted after just a few seconds of feeding (non persistent viruses). This is when the mouth parts of the insect spread the infection from plant to plant as they feed. When insects transmitting this type of virus are sprayed, the insects move from plant to plant and the result can be (but not always!) more virus than if there was no spray! The virus is acquired quickly and the ability to transmit the virus is quickly lost.

The other type of virus requires a longer period of feeding, usually minutes to hours for the vector to get enough virus to move to another plant. The virus must build up in the mouth parts of the insect so that when the insect moves to another plant there is enough inoculum to spread the infection. Insects usually force saliva into the plant when beginning a hole for feeding. This outflow of saliva is sufficient to carry virus into the plant. This type of virus is called "persistent" because the insect can persistently transmit the virus to many plants after obtaining the virus from an infected plant. Persistent viruses can be carried long distances by the vector because the virus is not easily lost. However, the vector must feed for a long time the first time to acquire the virus, and the vector must feed for a long time to be able to transmit the virus. Virus between "non-persistent" and "persistent" are called "semi-persistent".

Prevention of viruses is very difficult. The best way is to have a clean seed source which is very uncommon! The second is to control vectors, but very little is known about vectors in terms of economic loss. The farmer has few choices but to spray if he expects a lot of virus.

Much is known about pesticide sprays. The most important aspect deals with the problem of coverage. The sprays must be applied so that the insecticide hits the bottom part of the leaf. This requires a nozzle that can deliver a very fine spray. This is covered in another activity. It is also very important to use the correct insecticide. Aphids are not effectively killed by carbamate (carbaryl, Seven) but the natural enemies are completely destroyed.

In the following activity, we will collect sucking type and vectoring type insects in order to observe their mouth parts. We will also demonstrate the vectoring process by using our own mouths!

Objective

Able to describe the shape and function of typical vector insects and to use straws to demonstrate the vectoring process.

Materials

Paraffin wax, heat source, magnifying glass or 10x dissecting microscope, straws, red dye.

Steps

I. Observation of mouth parts

1. Collect aphids, leafhoppers, and whiteflies from the field and from other plants such as fruit trees for whiteflies, weed legumes for aphids and leafhoppers.
2. Bring the insects to the laboratory and kill with alcohol.
3. Mount the insects on their back in the wax trays. This is done by partially melting the wax with a wire. Make sure the mouthparts are above the wax.
4. Observe the insects under the microscope and draw their mouthparts.

II. Simulation of vectoring virus

1. Set up four cups. Put water in each cup. In the first cup put a drop of food coloring ("virus").
2. Dip the straw ("mouth parts") in the first cup for just a moment. Then dip into the next three cups. What happens in each of the cups? What kind of transmission does this simulate?

3. Now place some cotton in the end of the straw ("mouth parts"). First dip the straw in the "virus" then into the next cups. Is there any difference in the results from this and the previous treatment?
4. Leave the mouth parts in the virus for a minute. Now dip the mouth parts in the other plants and leave for a minute in each cup. What is the result? What kind of transmission does this simulate?

Discussion

1. In the field, just a few insect are able to transmit virus but often there are many virus infected plants. Why?
2. Why control virus vectors when a large number of plants are infected with virus? Is there a reason to control the insects? What is the economic analysis of such a situation?
3. What are the important viruses in rice and how are they vectored? List both seed and insects.
4. What is the best way to reduce virus infection of seeds over many seasons?

Disease Probability Game

Introduction

Learning to determine when diseases are most likely to develop (probability) is a major aspect of disease management. Each disease has specific climatic parameters or environmental conditions at which it develops best;

Blast develops best between 18°C and 25°C. There must be free water on the leaf for the spore germination usually in the morning up to about 10 am. This usually means cold and wet weather in the temperate rice countries or in the mountain areas. High nitrogen above 90 kg N/ha and susceptible varieties will also increase blast. There are many good resistant varieties for blast. Leaf blast during the tillering stage up to approximately 10% does not usually cause yield loss due to plant compensation. Neck and panicle blast are very dangerous because no compensation is likely. Preventive sprays for neck and panicle blast should be used when there is a high probability of infection.

Sheath blight develops best at over 32°C, and with night time relative humidity of greater than 95%. High nitrogen above 90 kg N/ha will also increase sheath blight. There are no resistant varieties. Infections low on the plant will not cause yield loss but may lead to higher risk of lodging. Infections that extend up to the upper leaves will have high yield loss if it occurs before grain filling.

Tungro is a virus disease that is primarily vectored by green leafhoppers. High nitrogen and continuous planting in the same area with the same variety seems to increase the probability of tungro infection where the disease is established. Changing varieties, and rouging are the primary control methods. Some farmers report that plants may recover with an additional split application of nitrogen.

Objective

Able to develop predict probability of disease infection.

Time requirements: 90 minutes

Materials required: marker pen, crayon, pen, notebook

Procedure:

1. Choose a number with six digits. Use a phone number, birthdays (yymmdd), or other number. This number will determine a certain environment as defined below. The first digit defines the first factor. The second digit defines the second factor. For example if the number is 570304 (zero is even) then the first digit, 5 which is odd, will define the temperature - <25°C. Continue the process to define one environmental situation.

Factor	Odd number	Even number
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Temperature	<25°C	>32°C
Rel. Humidity	<80%	>95%
Rain	none	some
N dose	<80 kg N/ha	>90 kg N/ha
Wind	none	some
Disease resistance	susceptible variety	resistant variety

2. Now use this environment to rate the probability of blast and sheath blight as high, medium, and low. Each person in each group should do once or twice.

3. For the group presentation, the facilitator can prepare special difficult or common situations and test the group. Next, the facilitator should make a game. Randomly choose a disease, and number. The group that responds with the best answer first - and can explain their answer - gets a point. Play up to 10 points to determine the winning team! (Note to facilitator: Prepare some award for the winners!).

4.4. MANAGEMENT OF WEEDS IN RICE

Introduction

Weeds reduce rice yields by competing with the rice plants for sunlight, moisture, and soil nutrients.

Weeds may affect farming in many ways. For example, fertilizer applied may not increase yields in weedy fields because weeds absorb nitrogen more effectively than the rice plants. Also weeds are harmful because they may be alternate hosts for insect and disease pests of rice, and provide shelter for rats.

Usually weed problem is more serious in dry land and dry seeded rain fed than in lowlands. However, if both left to grow in the field it can result to reduce yields.

Objectives:

1. Classify weeds according to economic significance.
2. Identify factors that contribute to severe occurrence of weeds in the field.
3. Develop management strategies for weeds.

Time requirements: 90 minutes

Materials required: marker pen, crayon, pen, notebook

Procedure:

1. Each group should assess weed population in different areas in the rice fields.
2. Each group should collect as many different species of weeds from the rice field.
3. Each group should classify weeds collected according to their gross morphology, qualifying characteristics (i.e. perennial or annual) and distribution.
4. Process data.
5. Distribute discussion question to each group.
6. Present and discuss answer with the big group.

Discussions questions

1. Among weeds collected, which weeds are difficult to control? Why?

2. Based on your experiences, on what stage of the rice crop is critical to weed competition?
3. What are weed management practices can you recommend for direct seeded rice? For transplanted?
4. What are your general recommendation to manage weeds.
5. How will you justify that weeds are also useful to farmers?

4.5. Golden Snails (Golden apple snail)

Introduction

Golden Snails is one of the major of pest in rice in South East Asia at present. The *Canninaculata* species is a native of South America. It was brought to the region via Taiwan. It was promoted to and raised to augment the protein content of diet and for commercial purposes. It however found its way to the rice fields and at present is reported to infest large areas of rice land in many rice provinces. Chemicals were sold for the control of the snail but were detrimental to health of rice farmers. Thus, an integrated pest management for golden apple snail was tested and disseminated focusing on alternatives to chemical control. This section attempts to discuss biology of the pest and validate practices for its management.

Objectives:

1. Discuss the biology of golden apple snail.
2. Validate/test golden apple snail management practices in the area that could be in the area.
3. Conduct participatory action researches related to feeding preference of golden apple snail.
4. Determine feeding efficiency of ducks on different sizes of golden apple snail.

Time requirement: 120 minutes

Materials: mesh wire, ducks, cellophane, sticks, crayon, marker pen, notebook

Procedure:

1. Each group collects and counts golden apple snail in the following areas indicated below. Collection should be classified into egg mass, hatchling, medium, and adult.
 - a. middle of the rice field - 1 m²
 - b. inlet - 1 m²
 - c. outlet - 1 m²
 - d. canal - 1 meter length
2. Collect also sample specimen on the different stages of the rice crop.
3. Note the number of snails collected at each site.
4. Distribute discussion questions.

Discussion Questions:

1. Why was golden apple snail introduced to the Philippines? How did it become a major pest in rice?
2. How will you illustrate the life cycle of golden apple snail?
3. Based on your observations, what habitat is preferred by golden apple snail?
4. Based on your observations, what food sources of golden apple snail?
5. Based on your experiences, how do you manage golden apple snail in direct and transplanted rice? Among these management practices, which one can easily and hardly (at least) be adapted by farmers in your locality? Why?

Follow-up Activities:

- A. Test attractants:
 1. Install attractants (locally available) in the field.
 2. Report observations.
- B. Test Efficiency of Ducks on Golden apple snail.
 1. Put a determined number of golden apple snail of different sizes in an area of 1 x 2 sq. m. fenced with wire mesh.
 2. Introduce one duck.
 3. Count golden apple snail left after 1 hour, 2 hours, 4 hours, and so on.
 4. Each group reports their findings to the group.
 5. Process reports and come up with implications.
- C. Validation Usefulness of cultural practices of golden apple snail management.
 - a. Screen at Inlets
 - b. Small canals in the field and depressed strips
 - c. Sticking
 - d. Hand picking

Each group reports their findings/observations to the big group.

4.6. Rats

Preface

Rats are one of the most consistent and serious pests of rice. The main problem of rat control is that rats must be controlled by community action, and organizing communities is not an easy task.

In this set of activities, you will study rat biology, the different effects of rat poisons, but mostly you will learn activities that are helpful in organizing communities around rat control.

There are a few differences between rats and insects that make implementation of management different. First is the ability of rats to stay in one area even though there is no crop. This means that we can use damaged caused in one season to initiate controls in the next season. The other difference is the methods of control. Rat control must be organized over a wide area to be very effective. Rat drives, baiting, digging, and any other method of control is most effective when done as a community.

One last note. In many communities, rat drive campaign success is determined by how many rats have been killed. A large pile of rats is considered a big success. In fact, the opposite is true. A large pile of rats really means that that there is a lot more rats out in the fields ready to feed on the crops. The number of dead rats is not important. The number of rats still alive and eating the crop is important.

Rat Population Growth

Introduction

Rat populations increase very rapidly because rats have many offspring very often. Rats can live for one year or longer. Females may reproduce up to 4 times a year and have an average of 6 offspring in a litter. This exercise is designed to visualize simple population growth for one year.

Objective

1. Able to show rat population growth over several months using nails, seeds or other items.
2. Able to ask leading questions about rat populations to bring out two management points; (1) It doesn't matter how many rats were killed, it only matters how many rats remain in the field, and (2) continuous rat control is important to keep populations low.

Time Required = 120 minutes

Materials (per group)

2500 maize (or other) seeds, glue and paper, pencil and pen

Procedure

(This can be done using nails on wood, or seed on paper)

1. On the piece of large paper.
2. In the first section place 2 seeds. One nail represents one female rat, and the other represents a male rat.
3. Move to the first month. Add 6 seeds for 6 offspring from the original pair of rats. 3 rats are females and 3 rats are male.
4. Move to the fourth month. Add 6 seed for 6 offspring from the original female, then add 18 seeds for the 3 females in first month (3 females times 6 offspring each). Half of the nails are female rats.
5. Move to the seventh month. Add 6 seeds for 6 offspring from the original female, then add 18 seeds for the 3 females in first month (3 females times 6 offspring each). Add 72 (12 females with 6 offspring each) for offspring from females in the fourth month. Half of the seeds are female rats.
6. Continue this process for the 10th and 13th months.

7. Write on the paper the total number of rats for each of the months, and the cumulative total from month to month.

Discussion and Presentation

1. How many rats are produced in one year? (one section is three month!).
2. If half of the rats are killed in the seventh month, how many rats will be produced by the end of twelve months?
3. If there are 10 female rats in the first month, how many rats will be produced in the 13th month? If you organize a rat drive and kill this many rats, will you be very excited and call your rat drive a success? How many rats are remaining in the field? Do you think the rat drive was a success still? How many rats will be in the field the next month considering reproduction? (Note that reproduction is even greater after many rats are killed because of less competition for food and space!)
4. What is the meaning of the saying "It doesn't matter how many rats were killed, it only matters how many are left in the field to reproduce".
5. Many farmers say that if you kill rats, they will bring their friends and completely destroy a field. Can you explain why fields are destroyed after one rat drive? (remember reproduction, and that reproduction is faster when the population is lower).
6. Why is it important to begin killing rats early in the rice? Why is it important to keep killing rats all season long? What would be the population of rats after 6 months if only 1 female from each group of six offspring survived?

Totals by month; 1st month-6/ 4th month-24/ 7th month-96/ 10th month-384/ 13th month-1536/ Total 2046!!!

Prevention of Rats

"Extensive rat damage is a symptom of a community with no leadership"

Introduction

This week we have looked at prevention of insects and diseases. It was observed that there are many ways to prevent insects and diseases based on management of the ecosystem. It was also observed that each management practice had both negative and positive aspects when related to yield and other parts of the ecosystem. Finally it was seen that extension activities usually begin long before a season begin, and that means beginning the season before.

In fact, the process of prevention usually begins with a problem that is observed in the current season. Prevention management is planned before the beginning of the next season and plans are implemented in the next season. As field workers, we must always be thinking in many time frames; last planting to the present, the present until current harvest, and the present until the harvest of the next season. This takes practice. It takes practice to stand in a field and admit that there is nothing that can be done now to save the harvest, but that plans should be made to protect the next planting. THIS IS THE CASE MOST OFTEN FOUND WITH RATS!

This exercise will explore the prevention of rats. Keep in mind the most important component of the rice ecosystem - MAN as farmer, as politician, and as extension worker. They are three different biotypes!

Objective

To describe ways of preventing rat damage.

Time Requirement = 120 minutes

Materials

Large paper, marker.

Procedure

1. One person should read the following aloud.

In Central Java there is a wide area where about 100 ha. of rice were planted by about 225 farmers. The farmers were generally quite good at planting rice. Each year they met and decided on varieties that they wanted to grow. They had occasional meetings with the PPL and PHP, but most of the time the PPL did not go to the fields. Anyway, the PPL didn't really know anymore than the farmers.

In 1988, several fields near the railroad tracks began to show some serious rat damage. A couple of the farmers used Temik and zinc phosphate mixed with crabs to kill the rats. In fact the saw dead rats and were happy to see their treatment was working. One farmer even put plastic around the field to protect from rats and had good luck for his field. Other farmers in the area began to show some damage in there field also.

By 1989, about 30 ha. of rice had noticeable damage. The damage was reported by the field officer and the head of the Agriculture Office met with the village authorities. The village authorities organized a rat drive. Many of the village and district officials came to the opening of the rat drive. After one day, all the farmers in the area had worked hard to kill and collect almost 1000 rats. The village authorities were very proud and declared their work a success.

By 1990, almost 75 ha. of rice was damaged. 30 ha. had been completely destroyed while the other 45 ha. was still only moderately damaged. Farmers were losing lost of money and could not afford the expensive poisons and baits. Any work they did on their own fields didn't matter because the rats were moving from field to field.

By 1991, most of the area was damaged before flowering. Many farmers were ready to move from the village to earn money in the big city. One family even considered to transmigrate to Kalimantan, another island.

2. Now divide into groups of three. One person should be the facilitator. This person should ask first "Why did rats become a big problem?". To every response, the facilitator must ask "Why?", until the root of the problem is found. The other two members are allowed to give answers.

Discussion and Presentation

1. Each group should present why they thought rats became a big problem.
2. What kind of activities should be done by that group of farmers to prevent the initial problems of rats? What should the PPL and PHP do in this situation?

Material to Focus on Rats

Introduction

Talking and analyzing rat problems is the first and important step in community action programs against rats. Rats are a social problem, not merely a technical problem. Group action is difficult to organize, but essential for rats management.

There are many ways to initiate discussion, analysis and planning in a community groups. Production of theater performances, cassette radio "mini-dramas", village murals, village statues, posters, silk screens and village maps, photo-diaries all have similar goals and process. The first step is to discuss content, and make a scenario together as a group. Working together and discussion are the important characteristics of these activities. Solving rat problems is also done by discussion and working together.

Objective

Use some production activities to focus discussion, analysis and group cooperation on one topic.

Time Required = variable.

Procedures

Below are general descriptions of group focused activities.

"Mini-drama" cassette tapes can be produced using simple cassette recorders and cheap cassette tapes. Scenarios should include dialog, background sound and time limits. A well done tape should not have too many messages. Tapes could be used by radio stations for short messages.

Village murals, statues and posters are relatively inexpensive production methods that include a lot of analysis and discussion.

Village maps allow everyone to include their own knowledge. Where are rats common? What is the topography? What are related characteristics that make rats a problem? How will rat management be implemented?

Photo-diary is a collection of photographs with dialog written on the photographs. Usually it tells a story, often with one or two key actors as they move around the village. Needs a camera and film. A good way to move the production process out of the group and into offices for interviews, etc.

What to do about Rats?

Background

What can be done to control rats? We have discussed that farmer coordination and continued action are by far the most important activities. Indeed, most farmers already know about the technical aspects of rats; sanitation, racumin, and damage. Some groups may not have a good idea about rats drives (the number left are more important than the number caught), or about some kinds of poisons (Racumin kills rats in their holes) but you have skills and activities to demonstrate the points (see other Field Guides).

The most difficult and important step, however, is to work together as a community. We have explored making posters and cartoons (these are good activities for farmers to do themselves for their own village). Now we will explore the way of setting up an organization for controlling rats based on your knowledge and experience of local government and farmer groups. This activity could be used to help farmers organize themselves, but let us use the activity to think about options in organizing farmers.

A warning: this is an activity in which you must use your farmer experience to understand the problems of group action. It is not easy to lead a group yourself, but you can facilitate the making of plans.

Time Requirement = 120 minutes

Objective

After this activity, you should be able to lead a meeting in which farmers discuss and develop a possible organization structure for controlling rats in their area.

Materials

Paper and pastels

Procedure

1. Divide into groups of about 10 persons.
2. Each person has a role in the group. One person is the Head of the Farmer Group. One person is the Village Head. One person is the extension staff that patrols the area. Other persons are Farmer Group members.
3. A "meeting" is opened with a report by the extension staff on the damage in the fields. The field stage is in milky stage. Rat damage is reported to be very high and there is nothing that can

be done this season. The meeting is to discuss what the Farmer Group is going to do for the next season.

4. Discuss what can be done if anything by the group. Discuss the costs and potential budget sources. If everyone agrees to work together make a rat control plan. Each person should play their role as much as possible.
5. Present your discussions to one other groups.

Rat Poisons: Zinc Phosphate and Anti-Coagulants

Introduction

There are many ways of controlling rats without baits. All methods seems to work when they are implemented on a village wide level. In this activity we will look at the differences between two common rat poisons. We do not recommend using these poisons, but we should know about them.

There are several types of rat baits. The first generation poisons (acute poisons) were used for many years and are very toxic to most animals and to people. This group of poisons includes zinc phosphate and "Temik" (= insecticide Aldicarb with LD50 oral 0.8). It is strongly recommended *not* to use these poisons because they are very poisonous. The poisons may not control rats well because the rats do not eat enough to die. The rats will not continue to eat the bait after eating once and becoming sick. This behavior is called bait-shyness. If these acute poisons are going to be used, they should be used correctly. The best way to use them is with several days of pre-baiting in which bait is placed in the field but no poison is added during the first four or five days. On the sixth day, poison is added to the bait. The idea is that the rats learn where food is easily found in the first few days and "trust" the food. When the poison is added, enough bait and poison is eaten to kill the rat. If the poison is put out too soon, the rat will try one time and not feed again.

The second type of newer poisons (chronic) causes the rat to bleed to death because the blood will not clot in the stomach (anticoagulant). The rat will not get sick from eating a little bit of the poison, but must continue to feed on the poisoned bait. It is important to use these poisons from transplanting to two week before harvest. Racumin is an example of this type of poison. Klaret type poisons are similar to this type of poison, but are more expensive.

Objective

After this activity the trainees will be able to demonstrate bait-shyness, proper pre-baiting, and baiting with Racumin.

The trainee should also be able to ask leading questions to get a definition of bait-shyness, and the action of acute and chronic poisons.

Time Required

60 minutes the first day to make cages and set up experiment, and 30 minutes each day for the following week. Rats should be caught after cages have been made.

Materials

Rats, chicken wire (1 cm. holes), wire, pliers (tang), bait (rat food), zinc phosphate, coconut oil, Klaret, dishes (bamboo) for bait and water.

Procedures

1. Each group should make at least 4 cages like the one shown below. Also prepare bamboo pieces 15cm long and at least 4cm diameter for rats to hide in the cages. Use bamboo nodes for water and bait cups.
2. Label the cages: #1. Zinc Phosphate with no pre-baiting; #2 Zinc Phosphate with pre-baiting; #3 Klaret or other bleeding type rat poison; #4 Control with bait only.
3. In cage #1, place bait with zinc phosphate in the cage for food. Also place a dish for water.
4. In cage #2, place bait with no poison for 4 days. On the fifth day, add zinc phosphate to the bait. Keep water in a dish in the cage.
5. In cage #3, place bait with Klaret in the cage. Keep water in a dish in the cage.
6. Each group should collect 4 adult rats and place in the cages. **DO NOT POKE, BURN, OR AN ANYWAY HURT OR SCARE THE RATS!** Rats are very sensitive and are under stress in a cage. Keep the cages in a shaded and protected place where children and adults cannot torment the animals.
7. The poisons have a different effect on the rat's stomach. When the rats die, cut open the rat and remove the stomach. Then cut open the stomach and observe the contents and the texture of the stomach. When cutting open the rats, place plastic bags over your hands for gloves. Do not handle the rats with your bare hands if possible. Bury the rats after you are finished.

Discussion

1. What are the result of each treatment?
2. What is "bait-shyness"?
3. Do these studies convince you that Racumin is an effective rat poison? What is the difference between rats with anticoagulant and toxins?
4. Can you design another experiment to test Klaret?

Note: It is said that a cannibal rat will keep other rats away from a field. To make a cannibal rat follow these steps:

- a. Place several rats in a large bucket. Place 0.5 cm water in a large bucket for drinking water. Do not give any food. After a couple days, several of the rats should be missing.
 - b. Wait until there is only one rat left in the bucket. Keep water in the bottom for drinking.
 - c. When only one rat is left, add one more rat and wait until there is only one rat left.
 - d. Release the one remaining cannibal rat. It is claimed that other rats in the area will run away.
- Try it!

4.7. Ecological Relationships

Ecological Functions of Organisms

Introduction

In the activity "What is it?" learning to answer questions with questions was emphasized. The response could be any question about the specimen. In the rice ecosystem, however, everything has a function, and the function is more important than the name. There are different levels of functions in all ecosystems.

The first level is the producer of organic materials: the plants. Plants include the rice and the weeds. The weeds have an additional function in the rice field. Weeds are also competitors for water, nutrients (N, P, K, and others), sunlight and space. "Weeds" are defined many ways, but one good definition is "a producer that is not wanted by mankind at that time and place".

The second level are organisms that feed on the plant. These include insects, rats and diseases. These are usually referred to as "pests". But "pests" are defined by their populations, not by their function. For example, when a population of planthopper reaches a high level that damages the rice plant, then the planthoppers are a "pest". If the population is low, then they are not "pests". In fact, if there are *no* planthoppers at all then the spiders would have less food and spider populations would be low. In this case, planthoppers at low populations are important to keep spider populations high.

The third level are organisms that feed on the second level. These include spiders, insects (predators and parasites), virus that attack plant fungi and bacteria, owls, cats and other predators of rats. These organisms are usually called "natural enemies" or "friend of the farmer" because they attack things that could become pests. Preserving these organisms is important to keep the second level from increasing.

The fourth level in the context of the rice ecosystem are the decomposers. These include bacteria, fungi, and insects that feed on the dead plants, insects, spiders, rats, etc. that are in the rice system. These organisms cycle the nutrients in the system back into the soil.

In this activity we will practice identifying the function of organisms found in the rice ecosystem. This is a good introductory activity for the study of ecology by farmer groups or students.

Objective

After this activity, you should be able to give the function of specimens found in the rice system.

Time Required: 90 minutes.

Material

5 Rice fields, plastic bags, alcohol, glue and large paper.

Procedure

- 1.. Go into a rice field in groups of two or three person per group.
2. Each group should collect as many different types of organisms in the rice ecosystem. Include plants, plants with disease, insects, spiders, rats, snakes, etc.
3. Go to a shady spot. Add alcohol to the plastic bag and shake the bag so that the insects and spiders die.
4. Discuss and separate the collected organisms by their function in the ecosystem. Place them in levels with plants at the bottom, plant feeders at level 2, natural enemies at level 3, and decomposers at level 4. Glue them onto the paper. If uncertain of the function, ask the trainer or glue on the paper and labeled "uncertain".
5. Were there many organisms of each level in the rice system?
6. Could all the plants be called "weeds"? Why or why not? Could all insects be called "pests"? Why are there many level 4 decomposing insects in rice fields?
7. Present the specimens to other groups, and describe the functions and relationships between each level. Use descriptions of functions such as:

"This is an insect that feeds on the plant. It is not really a problem insect until there are very many. There are many things which eat this insect including spiders and parasites." OR "This is a spider that eats insects and is a friend. It happens to be called a hunter because it moves around the field searching for insects."

What Is This?

(NOTE: Read all the directions and questions in this Field Guide exercise before beginning.)

Introduction

The goal of training is to provide an educational opportunity for participants. The methodology of training is very important for achieving the goal of education. One important method of training is to ask questions that allow the participants to develop their own analysis and understanding. You are stealing an opportunity for education if you reply directly with an answer. Ask questions. Lead the participant to the answer by asking questions. In the rice field a common question is "What is this?".

There are many ways to answer the question "What is this?" For most of us, the natural response is to give the name of the object...often in a foreign language (English or Latin). The question is often answered by saying "Oh that is *Lycosa pseudoannulata*" or "This is *Xanthomonas campestris*"? The result of this answer is that an educational process has been stopped.

A better way to answer the question is to ask a question; "Where did you find it? What was it doing? Were there many of them? Have you seen this before?" The idea is to promote learning by discovery and to lead the person toward their own analysis. Besides questions there are many ways to respond to a question without a Latin or other name; "That's the insect that causes whiteheads. Have you seen all the stages?".

Objective

After this activity, you should be able to give several kinds of responses to the question "What is this?" None of the responses should be its name.

Time Required: 60 minutes.

Material: Rice fields, plastic bags

Procedure

1. Go into a rice field in groups of two or three person per group.
2. In the group, take turns in the following roles;

The *questioner* should take anything in the rice ecosystem (plants, insects eating plants, predators, parasites, dead things, water, ANYTHING!) and ask "what is this?". Write down the responses to the questions.

The *respondent* should respond with one of the following type of responses;

"That is a good question. Where did you find it? What was it doing? (keep asking questions)"

"I don't know. Where did you find it? What was it doing? Did you ever see it before? What do you think it is? (keep asking questions)". *Use this especially when you know what the specimen is. Try not to give the answer!*

"This is an insect that feeds on the plant. It is not really a problem insect until there are very many. There are many things which eat this insect including spiders and parasites. OR this is a spider that eats insects and is a friend. It happens to be called a hunter because it moves around the field searching for insects." OR some other response that only give biology/ecological information.

NEVER GIVE THE ANSWER WITH A LATIN NAME. THAT ONLY KILLS THE QUESTION. THE QUESTION IS A CHANCE TO **LEARN!**

SANCTION: If the respondent gives the Latin name of the specimen, he/she must pay the questioner a fine!

Discussion

1. How often do you usually give just a name for an answer? Do you think it is helpful in training to ask questions to assist in learning?
2. In your usual job, is helping farmers learn an important aspect in day to day work? Do you think it would be useful to answer questions with questions to help farmers?
3. Many field workers think they have to be smarter than farmers, even though the farmer is much older and more experienced. Do you think this method can help you in working with older farmers by facilitating education process? Can you also learn from farmers by asking questions? Do farmers think respect, a desire to learn, or an instant answer is most important for a government worker?

INSECT ZOO

Introduction

The goal of the Insect Zoo is to help you learn about insects and their natural enemies by direct observation and manipulation. Insects and spiders are more interesting when seen alive and active. Think of going to the zoo...a tiger that is tearing the flesh from a rabbit is much more interesting than a snoring tiger hidden in a corner. Imagine a spider sucking the juices from a writhing first instar stemborer larva or leaf folding by a leaffolder. A living organism is much more than what is seen in an alcohol filled jar.

In fact some things can only be recognized when living - the small water striders (*Microvelia*) is an example. The ripples on the water as the water striders glides across the water surface are their most distinguishing characteristic. They are like sharks; they cruise around in the water and when a larva or BPH drops on the water, a whole group will attack together.

The *activity and behavior* of insects and natural enemies can only be seen on live specimens. The Insect Zoo will give you many living specimens for demonstrations that will keep farmers and others more involved while watching spider females eat their mating partners, and help them remember better something about the message that predators and parasites are friends in the field.

The Insect Zoo will also help you learn about the biology of the animals. Life cycles, egg laying, feeding, mating, growth and behavior can be learned directly the process of rearing insects and their natural enemies.

There are many ways to rear insects and their natural enemies. Many parasites can be obtained directly from their host by collecting eggs, mature larva, and pupae from the field and placing in a container of some type. Any plastic, glass, or paper container will work. Place the collected specimens in the container and merely wait. If the specimens were parasitized, the small wasps will emerge. Preying mantis egg cases, stemborer egg masses, large caterpillars, and hopper eggs are the easiest and most often parasitized specimens to rear.

For other insects and spiders, collecting young hopper (BPH) nymphs, adult moths or spiders is the best way to begin rearing these groups. However, for nymphs and for adult moths, you must have prepared plants ahead of time. For spiders, it is best to have lots of insect prey in a rearing cage before beginning to rear.

For parasites that are not collected from hosts, it is sometimes possible to put "sponge plants" in the field. This means that from reared insects you have plants in pots with egg masses or larvae. These plants with the host are placed in the field for up to four days to attract the parasites. The parasites will lay their eggs in or on the host. The "sponge" is then brought back to the pot area and kept in a cage.

Objective

Rear the following insects and spiders for the life stages shown.

Hoppers: adult to adult

Stemborer: adult moth to first instar

Leaffolder: adult moth to first instar

Rice bug: keep nymphs and adults for one week

Various larvae: larva to adult

Hunting spiders: keep for one week

Web-making spiders: keep until makes web

Ladybeetle larvae and adults: keep for one week

Other predators: keep for one week

Stemborer eggmass parasites: keep eggmasses until adult parasite emerges

Leaffolder larval parasites: keep larva until adult parasite emerges

Other caterpillar parasites: keep larvae or parasite pupae (especially *Apanteles*) until adult parasite emerges

Demonstrate the following processes using the insects and spiders in your Insect Zoo. These are the most important processes in the rice ecosystem which effect the crop and pest dynamics.

Demonstrate hopper feeding on the plant

Demonstrate hopper development from nymph to adult (ganti kulit)

Demonstrate eggs in the stem of the plant

Demonstrate hopper mating

Demonstrate egg laying and eggmasses of collected adult stemborer moths

Demonstrate emergence of first instar stemborers

Demonstrate eggs and larvae of leaffolders

Demonstrate rice bug feeding on the panicle

Demonstrate adults of field collected larvae

Demonstrate predation of hunting spiders (number consumed per day) using hoppers for food

Demonstrate web-making of web-making spiders

Demonstrate moth predation by web-making spiders

Demonstrate larval and adult ladybeetle predation (number consumed per day) of hoppers

Demonstration of stemborer eggmass parasites

Demonstration of leaffolder larva parasites

Demonstration of parasites of other larva

Demonstration of parasites emerging from parasite pupae especially *Apantles*.

Time Requirements

Each week at least two hours is needed special for the Insect Zoo. Each day, however, some time must be spent caring for plants and collected insects and spiders. Always carry bottles and plastic bags in order to collect and rear materials.

Materials

Rice plants, cages, small plastic bottles, plastic bags

Procedures for Rearing

There are many ways of rearing insects and spiders. Below are some general methods and some specific tips for specific insects:

General Rearing Methods

1. *Bottles and Plastic Bags* are very useful rearing tools. Always carry a couple in your pocket or bag. If eggmasses, larvae or nymphs are found in the field, collect and place in the bottle or plastic bags. The bottle should have a piece of netting over the mouth of the bottle. Add plant material daily for herbivores. Transfer to larger cages if necessary. Try to collect older larvae that will quickly pupate. Parasites will also emerge from eggmasses, larvae and pupae.
2. *Simple Cages* can be made using waste materials such as transparent glass or plastic bottles. Place leaves and stems in the bottles with insects and cover with netting. For soft drink bottles, place a bouquet of stems and leaves in the bottle and cover with large plastic bag. For seedlings, invert the plastic bottles which have one end open and other end covered with netting material.
3. *Field Cages* are useful to cover infestations of large larvae, hoppers, and other insects. Make cages from large plastic bags, or netting materials. Use bamboo sticks to hold the cages above the plant.
4. *Potted plants and Cages* is useful especially for demonstrations and exhibitions. Grow your own plant in the pot, or transplant from field grown plants. For cages use netting suspended strings or frames, or use plastic bags with netting glued over one end. Expensive thick stiff plastic is also very useful.
5. Be Creative! It is surprizing where insects can be reared. Use discarded cans for pots, and transparent plastic bottles for cages. Clear glass jars and small plastic containers will suffice for most needs.

Rearing Tips For Specific Insects

These are only tips. You can probably improve on all of them.

1. *Planthoppers*: Place at least 3 male and female pairs in cages on young (30-40 HSS) plants. Allow mating and egg laying. After nymphs emerge (8 days after egg laying) remove excess nymphs to other plants when the nymphs are in the second instar. If the plant becomes brown, move the nymphs to new green and healthy plants. Alternative method is to place hoppers in cages on plants in the field. Be sure all natural enemies have been removed first.
2. *Stemborers*: Collect adult moths in the field using hands or sweet net. The best way to collect is with a bottle so that the moth is not damaged. Place the moths that look alike in cages on plants. Observe the egg laying. Wait for emergence of the first instars from the egg.
3. *Leaffolders*: Collect adult moths in the field using hands or a sweep net. The best way to collect the moths is with a bottle so that the moths are not injured. Place many leaffolder moths in cages on young plants. Observe egg laying and wait for emergence of the first instars from the eggs.
4. *Rice bugs*: Collect nymphs and adults from the rice field. Place the insects on older plants in the milky stage. Observe feeding and egg laying.
5. *Other larvae*: Collect larva in the field. Old larvae are easiest to rear to adult. Place the larvae in cages on plants of the same age as those in the field. If the plant is consumed quickly, move the larva to a new plant. Observe pupation and adult emergence.
6. *Hunting spiders*: Collect hunting spiders in the field. Place in cages with or without plants. To demonstrate feeding, do not feed the insects for at least one day before demonstration. On the day of demonstration, place several types of insects from the rice field in the cage. To show the number of hoppers eaten in a day, place many hoppers in the cage (count them first) then leave for one day. Count the remaining hoppers the next day.
7. *Web-making spiders*: Collect web-making spiders in the field and place in cages on older plants so the spider can make a web. Observe web-making. After the web is made, place a moth in the cage and observe the results.
8. *Larva and adult ladybeetles*: Collect larva and adult ladybeetles and place in cages with or without plants. Place young hoppers in the cage to observe feeding.
9. *Stemborer eggmass parasites*: Collect egg masses in the field. Place in small plastic bottles. Wait and observe emergence of parasites or first instars.

10. *Leaffolder parasites*: Collect older parasitized leaffolder larvae and place in plastic pot. Wait for emergence of parasites.
11. *Caterpillar parasites*: Collect older parasitized larvae and place in plastic pot. Wait for emergence of parasites.
12. *Parasite pupae*: Collect parasite pupae (especially Apantles) and place in plastic pot. Wait for emergence of parasites.

Life Cycles And Food Webs

Introduction

Life Cycles of plants, insects and natural enemies are well known to us (see your IPM textbook). The development from egg or seed to adult insect, spider or plant has been seen in the field and in the Insect Zoo.

Food Chains are the interactions between plants, herbivores and natural enemies of the herbivores. The energy from one level of the ecosystem (plants) moves to another level (herbivore) along a chain of interaction.

As a trainer working with farmers, you must begin to integrate these two motions together into a smooth acting dynamic ecosystem. Seeds germinate to be eaten by insects that lay eggs that are parasitized....for example. Every life cycle is part of a food chain.

In this exercise, you will have to put the two systems together so that they are functional. This will help you to understand that interactions have a time frame. For example; the life cycle of hoppers (brown, white-back, and green) all begin with a egg stage inside the plant. In the next stage, the nymphs feed on the stem or leave by sucking. Finally adults mate and lay eggs on the same plant or migrate to other fields. During each stage, different natural enemies attack the hoppers. During the egg stage, parasites complete their own egg/larva/pupa/adult in the hopper eggs and kill the eggs, and mirid bug predators suck on the eggs. During the nymphal and adult stage, hunting spiders, water striders, lady beetles, and other predators feed on the hoppers. Parasites live on the nymphs until nymphs are adults. Web-spinning spiders feed on flying hoppers as the move in the field.

This combination of interacting life cycles of the plant, hoppers, and natural enemies is a good view of the dynamic system of the rice field. It shows also that balance is needed in the system to make each life-cycle possible; for example, a spiders life cycle depends on the hopper. If there are no hoppers then there will be no spiders to protect the feed. In this system, insects such as hoppers at low population are actually very beneficial to the farmer because they are spider food, and spiders are what protect the field from large population changes. Did you ever think that a hopper might be a beneficial insect to the farmer? It all depends on how many are in the field. This can be explained now by looking at how the system interacts.

For this exercise, you will have to integrate much of your knowledge into a big picture. It will not be easy to put the pieces together. USE YOUR TEXTBOOKS TO HELP YOU. Learn to find new information from your books.

Also for this exercise you should think in terms of "guilds". Guilds are a group organisms that have similar types of life cycles and share food sources and are usually attacked by the same natural

enemies. Hoppers are one example above. The many species of stemborers are another guild. Hunting spiders includes many species that hunt in a similar way and have similar prey. Try to use major guilds for this exercise than individual species.

Objective

After this activity you should be able to explain the interaction of the ecosystem factors using both life cycles and food chains for at least one guild of insect pests.

Time Required = 120 minutes.

Materials

Paper, pens, pastels, IPM TEXTBOOK

Procedure

1. Each group should choose a guild to analyze;

Hoppers, stemborers, leaffolders, leaf feeding caterpillars, caseworms, black and other bugs, rice bugs, gall midge, rats.

2. Draw a large circle and write in the general stages for insects of the guild around the circle (see example below).
3. On one side make a list of the stages of the insects in one column. In the next column, make a list of natural enemies (by guild) which attack each stage.
4. On the drawing, draw a circle for each natural enemy which attacks a particular stage of the insect. On the natural enemy circle, write the stages of the natural enemy's life cycle. If their are natural enemies of the natural enemies (example, a spider that eats another spider) then make a third level of circles for these natural enemies. (USE YOUR TEXTBOOK TO GET MORE INFORMATION).
5. After finishing the diagram, do a short role play with another group. One group IPM experts is advising another group of farmers about the insect that was chosen. The group of IPM experts are very smart and they know that asking questions and making discussion is better than giving simple answers. So the IPM experts begin a process of discussing with farmers about the life cycle of the pest insect. (Most farmers know this, but farmers like to talk. Let them talk as much as they like by asking questions).

Next, the group of IPM experts begin to ask about the natural enemies of each stage. Many farmers know this, but the IPM experts may have to help them by giving hints. (example: What about parasites?...)

Work through the whole life cycle.

6. Change roles for each group and repeat the activity.
7. Ask the following questions:
 - a. What would happen to natural enemies if there are no insect pests?
 - b. Do you think insect pests can be beneficial if at low populations? Why are they important?
 - c. In the system, what will happen if you spray broad-spectrum pesticides?

Whorl Maggots

Introduction

Whorl maggots is one of the pests at early stage of the rice crop. The larva feeds on the on the growing leaf before emergence. Thus characteristic damage are whitish pinholes at the side of the leaf blade commonly seen after the youngest leaf emerge. Although whorl maggot is not a major pest, most rice farmers spray their crop when the observed damage cause by this pest. In this section, participants will discuss management aspects of whorl maggot

Objective

- a. to illustrate the life cycle of whorl maggots.
- b. identify natural enemies of RWM
- c. evolve/develop management plan for RWM.

Time requirement: 90 minutes

Materials: marker pen, crayons, manila paper, pencil

Procedure

1. Each group randomly sample 20 hills at early vegetative stage for whorl maggot damage.
2. In each sample hill count no. of whorl maggot (adult, egg, larva), whorl maggot damage leaves, other defoliated leaves, healthy leaves, other pests and natural enemies. Record data.
3. Collect specimen of plant with whorl maggot damage, adult whorl maggots, eggs, larva.
4. Summarize data.
5. Give each group a discussion question. After small group session let them present their answers to the big group.

Discussion Questions:

1. Illustrate the life cycle of rice whorl maggot.
2. How will you describe the damage characteristics of rice whorl maggots?
3. Why are whorl maggots called water loving insects?
4. What are the natural enemies at different stages of whorl maggots.
5. Can you cite management practices for whorl maggots which do not require the use of insecticides?

Rice Caseworms

Introduction

Rice caseworm is one of the pests of rice which is of minor importance. The damaging stage is the larvae that live in sections of leaves cut from young rice plants and rolled into tubes called cases.

Objective

1. Describe the life cycle and characteristics of rice caseworms.
2. Recommended management plan for rice caseworms.

Time Requirements: 60 minutes

Materials: pen, pencil, marker pen, manila paper, notebook, crayon

Procedure

1. Each group randomly sample 20 hills for caseworm damage.
2. Record from each sample hill the following data: no. of caseworm adult, larva, adult, pupa; pests; natural enemies; no. of leaves with caseworm damage and healthy ones.
3. At session area/shade summarize data collected. Analyze data in big group.
4. Distribute discussion questions to each group.
5. Present answer to the big group.

Discussion Questions

1. Illustrate the life cycle of the caseworms.
2. Describe the damage characteristics of RC.
3. Give the natural enemies of rice caseworms.
4. Give the most practical means of caseworm control.
5. Identify factors that contribute to the occurrence of caseworms.

Armyworms and Cutworms

Introduction

Armyworms and cutworms attack rice at different stages. They usually attack in large numbers when drought is followed by rains which cause a rapid uptake of mineralized nitrogen by the plant. Although many species attack the rice crop, their life cycle, damage and management are similar.

Objectives

1. Describe the life cycle of armyworms and cutworms.
2. Develop management plan for armyworms and cutworms.
3. Conduct life cycle, parasitization, and predation on armyworms and cutworms.

Time requirement: 90 minutes

Materials required

Marker pen, manila paper, cellophane, sweep nets, vials, notebook, crayon

Procedure

1. Each group collect different species of armyworms and cutworms (adult, egg, larva, pupa).
2. At session area/shade consolidate data and analyze.
3. Provide discussion questions to each group.
4. Discuss answers in big group.

Discussion Questions

1. How will you differentiate the common species of cutworms and armyworms?
2. How will you describe the damage of armyworms and cutworms.
3. What are the factors that contribute to the occurrence of armyworms and cutworms.
4. What are the natural enemies of cutworms.
5. What management practices can you recommend for armyworms and cutworms.
6. Why is it that swarms occur during the first days of rains after a drought?

Rice Leaffolders

Introduction

Leaffolders may attack the crop at early stages or during the flowering period of the crop. Their occurrence are usually triggered by too much fertilization, rainy periods, and close planting. They can be of major importance if they occur at flowering stage of the rice crop. Hence, farmers are observed to do a lot of spraying during the mentioned stage. However, field experience tend to show that leaffolders have no significant effect on yield. The following activities will enable trainees to become familiar with rice folders.

Objectives

1. Describe the biology and life cycle of leaffolders.
2. Develop management practices for leaffolders.

Time requirements: 60 minutes

Materials

Sweep net, cellophane, marker pen, manila paper, crayon, notebook,

Procedure

1. Each sample 1 m² area with leaffolder damage. No. of hills, healthy leaves, leaves with LF damage, LF specimens (adult, pupa, larva, egg) should be counted and collected. Repeat the process in another 2 sample areas (1 m² each).
2. Summarize and analyze data.
3. Provide discussion question to each group.
4. Discuss answers in big group.

Discussion Questions

1. How will you describe the biology and life cycle of leaffolders? Illustrate your answer.
2. How will you describe the damage of damage?
3. What are the causal factors that lead to leaffolder occurrence?
4. What are the natural enemies of leaffolders?
5. How will manage leaffolders?

Rice Stemborers

Introduction

One of the major pests in the country, stemborers have continued to affect rice production significantly. They are noted for their widespread occurrence. They are found in all rice environments and noted to be abundant toward the end of the rainy season. Through this exercise, the trainees will be able develop practical knowledge in the management of rice stemborers.

Objectives

1. Describe the biology and life cycle of stemborers.
2. Recommend management practices for stemborers.

Time requirement: 90 minutes

Materials: vials, cellophane, sweep net, notebook, crayon, marker pen, manila paper

Procedure

1. Each group should collect different species of stemborers, their eggs, larva, pupa. Three sample plots (1 m²) in random locations should be sampled for deadheart (vegetative stage) and whiteheads (ripening phase).
2. Sample of damage plants should also be collected for use in the discussion activity.
3. Return to session area/shade and process data collected from field.
4. Distribute discussion questions to each group.
5. Discuss answers with the group.

Discussion Questions

1. How will you describe the life cycle of the different important species of stemborers?
2. How will you differentiate the damage characteristics of different species from one another?
3. What are the natural enemies of stemborers?
4. What factors contribute to the abundance of stemborers in rice fields.
5. Based on your experience, what management practices will you recommend for the effective management of this pest.

Brown Planthoppers

Introduction

BPH, *Nilaparvata lugens*, is one of the major pests of rice which predominantly affect crops under irrigation. Its feeding causes plants to wilt and causes a symptom called hopper burn. It also transmit grassy and ragged stunt virus diseases. This pest has a high capacity to reproduce. Its endemic reproduction are often aggravated by indiscriminate use of pesticides. Studies have shown that widespread BPH damage are due to indiscriminate use of pesticides. On the other hand, fields not subjected to insecticides and has therefore with high natural enemies population density has been found to be free from the resurgence of BPH. This exercise will try to provide practical exposure to trainees on the management of BPH.

Objectives

1. Describe the biology and life cycle of BPH.
2. Recommend management practices for BPH.

Time required: 90 minutes

Materials: crayon, manila paper, vials, marker pen, notebook, cutter

Procedure:

1. Each group randomly sample 20 hills for presence of BPH. Nymphs and adult in each hill must be counted.
2. Each group should collect rice stem for determining presence of egg masses.
3. Return to session area/shade and process results of field activities.
4. Distribute discussion questions to each group.
5. Discuss answers to questions provided.

Discussion Questions

1. How will you recognize important life stages of BPH under field conditions.
2. How will you describe migration and population dynamics of BPH.
3. How does BPH injure the rice crop and how does crop compensate for this injury.
4. What management practices can you recommended for BPH? Explain.

Rice Green Leafhoppers

Introduction

Green leafhoppers is one of the serious pests of rice in South East Asia. This is due to their ability to transmit several serious virus diseases. Although their physical damage to the plant is not significant, GLH however are effective transmitter of the rice tungro virus (RTV).

Thus, thorough understanding of the biology and life cycle of the pest is important to develop effective management strategies.

Objectives

1. Describe the life cycle of green leaf hoppers.
2. Identify factors that favors that favors their development.

Time requirement: 90 minutes

Materials: sweep net, vials, cellophane, crayon, manila paper, marker pen, notebook, cutter

Procedure: (Follow same procedure as in BPH)

Discussion Questions

1. How will you describe the life cycle of green leaf- hoppers?
2. What is the migration and dispersal pattern of green leaf hoppers?
3. What type of diseases are transmitted by GLH? How does it transmit a particular disease.
4. What are the factors that favors or reduced GLH population?
5. What management practices can you recommend for GLH.

Follow-up Activities

1. Insect zoo studies on life cycle, predation and parasitization.
2. Collection of egg masses for identification and determining percentage of parasitization.

Rice Bugs

Introduction

Rice bug is one of the pests of rice at ripening stage. It specifically damage the crop by sucking the milk of the developing grain resulting in unfilled or partially field grains. Rice bug predominates in areas where surrounding mountains are found. This provide alternate breeding places for the pest during off season periods. There are many insecticides recommended for rice bugs. Their effectiveness however has not been fully measured due to the ability of the pest to take quick flights. In addition, breathing organs are located at the underside of the the body making it difficult to be penetrated even in full contact with sprays. Thus, discussion on the life cycle and behavior of the insect is of utmost important for developing alternative management practices other than insecticides.

Objectives

1. Illustrate the life cycle of rice bugs.
2. Recommend management practices for rice bugs.

Time requirements: 90 minutes

Materials: test tubes, sweep net, cellophane, marker pen, crayon, notebook

Procedure

1. Sample 20 random hills.
2. Count rice bugs, adult, nymph, egg masses.
3. Collect sample specimens of adult and nymphs.
4. Collect all egg masses found in the field.
5. Process data
6. Distribute discussion questions to each group.
7. Discuss answers.

Discussion Questions

1. What are the different life stages of rice bugs? Illustrate and explain.
2. Why are rice bugs more prevalent in rice growing areas proximate to hills, mountains?

3. What are the factors that favor or reduce rice bug population?
4. How do rice bugs damage the rice crop? Explain.
5. What management practices can you recommend for rice bug control in the area?

Follow-up Activities

1. Insect zoo studies on life cycle, feeding habits, predation and parasitization habits.
2. Collect egg masses and place in test tubes to identify egg parasites and determine parasitization percentage.
3. Install dead frogs and slightly mashed golden apple snail in sticks in and around the rice field as rice bug attractants. Monitor results.

Spiders

Introduction

There are many insects and spiders found in the rice and on the bunds and irrigation ditches. Most of the insects are not pests or even potential pests. In fact they are beneficial to the rice farmer because natural enemies such as spiders feed on these non-pest insects. This is how spiders can survive even when pest populations are low.

In this activity, we will search for spiders and their prey. You should be able to explain where insects and spiders are living in and around the rice field, and what kind of insects and spiders can be found.

Objective

Describe spiders and insects in and around rice fields.

Time Required = 120 minutes

Materials: Plastic bags; plastic bottle (small); alcohol; pencil and paper.

Procedures

1. Go to the rice field. On the rice bund, measure a patch of grass with total area one meter square. Search in the grass in this space for all small insects and spiders. Collect these small insects and spiders in the bags and bottles then add alcohol. Label the containers "bund". Separate pests and natural enemies with trainer. Give common names. List insects, spiders, and other animals seen.
2. Next estimate the total area of grassy bund around the rice field. Multiply the number of small insects and spiders found in the one meter square by the total meter square around the field to estimate the total population of the insects and spiders on the bunds.
3. Repeat steps 1 and 2 for grassy areas in irrigation canals and in the rice field.
4. Draw a picture of the rice field, bunds, and other areas. Use a cross-section. Now draw insects, spiders, and other animals seen on the cross-section. Include the density of the insects and spiders. Make a table of density and estimated total numbers of insects and spiders in the three areas around and in the rice field.

Discussion and Presentation

1. What was found on bunds, irrigation canal and field? Where were the most insects and spiders found? Do you think the hunting spiders will move from one area to another?
2. Did you look in the water for beetles, and dragon fly nymphs?
3. Explain what eats what in your picture.
4. Explain what would happen if no insects or spiders can be found in the surrounding field area if a migration of brown planthoppers hit the field.
5. What is a 'pest'? If at low populations, spiders survive on some insects, are these insects pests? Does 'pest' refer to an insect. a damage or an intensity of insect?
6. Define 'pest' in terms of an ecosystem. (plant-insect-natural enemy)

What Is a Predator?

Introduction

A predator can be defined in many ways. In the rice fields predators are those insects and spiders that kill many insects for their food. All predators have some adaptations which help them be better predators. Mouth parts, legs, eyes, and other parts of the body are well designed for the process of hunting, killing, and eating prey. Predator body structure is linked to the ecological function as predators and help to define a predator.

Objective

Give a functional definition of a predator and draw structural characteristics of some predators.

Time Required = 120 minutes

Materials: Paper, pencil, loupe, plastic bag, plastic bottle, alcohol.

Procedures

1. Each person should have paper, pencil, plastic bag, plastic pot and loupe before going to the field.
2. Go to a rice field, and areas around the rice field and observe predators. Make a list of predators and their behavior in the field. Do observations for 30 - 60 minutes.
3. Observe and draw predators using a loupe or a microscope. Label the drawing to explain characteristics of the predators which are adaptations. Include adaptations for sight and other senses, mobility, feeding, and holding of prey.

Discussion and Presentation

1. Describe parts of predators that are important for their function as killers!

What Is a Parasite?

Introduction

A parasite is different from a predator in one important way. Predators eat many hosts in order to develop through their life cycle. Parasites, however, complete their development on one host. Sometimes more than one parasite is produced on one host. Parasite eggs laid in the egg of a planthopper will finish completion of their life cycle in the hopper egg. Parasites in caterpillar larva will emerge as adults before the larvae can become an adult.

Parasites are important natural enemies because they can lay so many eggs. One parasite of brown planthopper can lay eggs in 300 planthopper eggs. The egg parasites quickly reduce insect populations before they larva or nymphs can do any damage.

Parasites are very sensitive to pesticides. Even at very low dosages parasites easily die. The outbreaks of brown planthopper is due to loss of egg parasites and spiders.

Adult wasp (Hymenoptera) parasites are usually small, dark and winged. There are some flies (Diptera) which are parasites also. Female parasites are able to put their eggs inside or on the host by using their "ovipositor". The egg of the parasite passed through this long tube into of on the host egg or larva.

There are no males in any species of parasites. In other species of parasites, only one or two males may emerge with 200 females! In other species their is an equal number of males and females. Often the males emerge before the female, and mate with the females as the females emerge from the pupa. The males die soon after their job is completed.

Objective

Give a functional definition of a predator and describe structural characteristics of some parasites.

Time Required = 120 minutes

Materials: Paper, pencil, loupe, aspirator, plastic bag, plastic bottle.

Procedures

This activity is best done after maximum tiller stage.

1. Each person should have paper, pencil, plastic bag, plastic pot and loupe before going to the field.

2. Go to a rice field, and areas around the rice field. Search the field for larvae which have been parasitized. Also search for egg masses on the leaves. If there are brown planthoppers in the field, search the plant for eggs in the stem. Collect the materials in the plastic bags or bottles.
3. Use a sweep net with a fine mesh to sweep the rice field. There will be many small wasps in the net. Use an aspirator to collect these small wasps.
4. Return to the classroom and dissect the materials with a microscope. Look for dark eggs or for larva inside a larva.
5. Observe and draw the small wasps. Notice the antennae, legs and ovipositor.

Discussion and Presentation

1. Did you find parasites in the collected materials? What did they look like? Did any host have more than one parasite? What is an ovipositor? Describe what it looks like.

Being a Natural Enemy!

Introduction

Natural enemies include terrible predators and parasites that hunt down their prey. Spiders rip and tear flesh or suck juices. Parasites pierce the bodies of larvae and eggs to inject their eggs through the ovipositor. Female spiders feed on the spouses if the spouses are lazy and don't run fast enough.

In this activity you will bring the great world of gore and drama to life. You will be great stars acting the role of these terrible friends. We should be thankful they are so small.

Objective

To describe behavior of predators and parasites.

Materials: Improvise!

Procedure

1. Divide into teams of two or three people.
2. Each team choose one natural enemy they know. Remember all the kinds of hunting spiders, web-making spiders, mirid bugs, parasites of eggs and larva, ants, dragonflies, etc.
3. List important behavioral and anatomical characteristics of your choice. Now pretend one of you are the natural enemy, and the other is the host.
4. Each group should present their imitation.

4.8 Sampling and Field Assessment

Preface

The following activities are about sampling fields. The goal of sampling fields is to assess what type of action will be needed to best produce a profit for the farmer. Sampling does not have to be done by counting, but can be done by estimation. In these activities, participants should work towards being able to accurately estimate the density of insects, spiders, diseases, rat and rat damage in the field.

The best samplers must be;

1. Good observers,
2. Consistent, and
3. Experienced.

The result of sampling will be used with other information such as thresholds, natural enemy ability, plant health, farm budget and weather to make an analysis of the field for decision making.

The final goal of IPM is to improve decision making for better production and profits. Sampling is one of the first steps in the management methods.

What is Sampling?

Introduction

What is sampling? Sampling is looking at a small part of a bigger picture. Field sampling for IPM is looking at a few plants in the field and estimating what is happening in the whole field. A sample of 20 hills in a field that is 1000 m^2 is only 0.08% ($=20/25000$) of the hills in the field. 10 hills sampled in the same field is 0.04% of the hills! Interestingly, many experienced people in rice IPM can make a good analysis of the field from even such a small sample!

Sampling has many goals depending on the person sampling. For a researcher, sampling usually must be very precise, and requires a lot of observation time. For Pest Observers, sampling should be sufficient to estimate the level of populations in specific fields. For a farmer, sampling should tell him/her if the population is above a damaging level, and if the population is increasing or decreasing. It is not important for farmers to know the exact level of populations in the field.

Sampling is usually done to estimate densities. Examples of density data follows:

- hoppers per hill
- deadhearts or whiteheads per hill
- leaffolders per hill
- wolf spiders per meter square
- rat cut tillers per hill
- tungro infected hills per meter square
- blast infected (greater than 50% leaf area) hills per meter square

All of these densities can be converted to populations per meter square or per hectare by knowing the plant spacing and average tiller number.

Why is density important? Yield loss is always based on area (ton/ha or kg/meter square). The interaction of plant compensation within a plant, between plants in one hill, and between hills means that yield loss should be related to area. The cause of yield loss should also be related to this same area so that the factors can be analyzed. For example we can say that with a population density of 20 hoppers per hill, there will be a yield loss of 200 kg/ha (for optimal fertilizer, seed, and weather). It is useless to use percentage because it is difficult to understand.

In this activity, we begin some sampling problems. In another exercise, we will study the problem of sampling by estimation, the real goal of IPM sampling.

Objective

Demonstrate the concept of density and the different goals of sampling by researchers, and farmers.

Time Required = 2 hours

Materials: Paper (large), pencil, seeds (100 per group)

Procedure (for group of five people)

1. On the piece of paper, draw a grid with lines 5 cm apart (horizontal and vertical lines). Count up the total area of the boxes (each box should be 25 cm^2).
2. Now we will sample like a researcher. We want to find out what is the exact number of seeds on the paper. This is the same problem as the number of insects in a field. One player should scatter the 100 seeds on the paper. Then each player should begin to count the seeds, but for different lengths of time as shown in the table below. Player one keeps time. Make the calculation of seeds per box for each person.

player 1: actual seed density ($100 \text{ seeds}/\text{total cm}^2$)

player 2: sample 10 seconds : computed density = _____

player 3: sample 30 seconds : computed density = _____

player 4: sample 90 seconds : computed density = _____

player 5: sample 3 minutes : computed density = _____

3. Repeat this process 5 times, changing the roles each time.
4. What is density? Which sampling time had the closest computed density to the actual density? Is there a difference related to time (= effort and money!)? Which computed density is sufficient for a researcher? Was any player "a better sampler"? In the field, if two people sample the same field, will they also find the same population density? What does this mean for field sampling for researchers?
5. Now we will play as good IPM farmers with estimation! One player should count the seeds then scatter the on the paper. The other players will then try to estimate the density of seeds. All players have only 15 seconds to make an estimation. Repeat this 10 times, each time changing the roles.

6. Do you get better with estimating each time you played? Are there some people that estimate better than others? How does experience help in making estimates? What is the use of estimating as compared to the method above?

Counting Sampling Methods

Introduction

Sampling gives a farmer an idea of what is in the field, including "pests" and "natural enemies". In IPM, the goal of sampling is to assist in making decisions about the condition of the field. Sampling for plant feeding insects and rats, and natural enemies are important components of a complete analysis of the field. Other factors that we need to know for making a decision include plant health, weather, economics, past history of the field and condition of surrounding fields.

In this activity, we will learn to do quantitative sampling in rice. This means to take an exact number of plants and make an exact count. This is the recommended methodology for researchers, but not for farmers. Management decisions depend upon the relative number of insects, disease, and rats in relation to other factors. Counting is, however, useful for farmers to learn as the first step in learning to sample by accurate estimation. We assume that learning to estimate begins with learning to count. Estimation methods will be covered in another Field Guide exercise.

Objective

Able to sample using the research oriented counting sampling method.

Time Required = 120 minutes

Materials

Paper and pencil

Procedure

1. The group should be divided into pairs. Each pair should have paper and pencil for recording data. On the paper, write the date and name of the field at the very top of the paper. Next, make columns with the following headings: Organism, Hill 1, Hill 2, Hill 3, and so on until Hill 20. The last column head is Average. In the first column, write the names of the insects, natural enemies, diseases and rat damage that are seen in the field. (see example)
2. Now, go to the field. Walk a diagonal across the field and randomly choose 20 hills on the diagonal. For each hill follow this examination process:

Insects: Examine the base of the hill for brown planthopper and white backed planthopper. Then examine the hill from bottom to top for green leafhopper and other hoppers, stemborer eggmasses, leaffolders, rice bug, and other insects. If many of the leaves are damaged by feeding, spread the tillers apart and look for caterpillars between the tillers and leaves, especially at the base of the hill. Estimate

the percent defoliation of all leaves on the plant. Are larvae still present? Collect the stemborer egg masses (to be saved and reared to record number of egg masses with parasites). Count the number of deadhearts or whiteheads per hill. Record the numbers of all observation for the hill.

Disease: Notice the leaves and stems. Is there any discoloration due to diseases? (Ask the trainer is uncertain). Estimate the percent of the leaf/stem area infected. Record all observations

Rats: Count the number of cut tillers per hill.

Natural enemies: Count the number of each type of predator, and the number of larva with parasites per hill.

Tillers: Count the number of tillers per hill.

3. Repeat the steps in one more field.
4. Explain and demonstrate the steps to one other person in your group.
5. This is the method used for training farmers. After you practice many times, do you think you will have to do counting or can you estimate populations by looking at the field condition without counting?
6. If the level insect pests is above the economic threshold, were larvae still present? How many rice bugs did you count? How will decisions depend upon natural enemies, the health of the field, and your past experience?

4.9. IPM Decision Making: Agro-Ecosystem Analysis

Preface

Each week during the season, you will study the components of the rice ecosystem. You will study the plant anatomy and agronomy, herbivores, and natural enemies of the herbivores. You will look at diseases and rats.

Ecosystem Analysis is a way of assembling what we are studying and place into a process useful for decision making based on many factors. Old IPM practices relied on economic threshold levels to make decisions. ETL's, however, are extremely limiting and do not include the other factors in the ecosystem or farm management.

The following activities will lead you through weekly set of questions and drawing. In the beginning, the analysis will take a lot of time. By the end of the season, however, you should be able to do a complete analysis while standing in the field. The scenario at the end of the season will be something like the following;

Sample several hills to make an accurate estimation of what's in the field,

If one herbivore population is high (insects, or rats), are there natural enemies around to control the population and is the plant able to compensate for the damage?,

If rat damage is high, how are other fields and how can I work with my neighbors to reduce populations of rats?,

If diseases are high, how can I change my agronomic practices (fertilizer, water, variety) either in this or the next season to reduce infections.....

Learn about the ecological interactions and the rice ecosystem to be proficient in IPM.

Ecosystem

Introduction

IPM is based on ecological interactions between the environment, plants, herbivores (diseases, insects, and rats), and natural enemies of herbivores (spiders, parasites, snakes, etc.). The health of the plant is determined by the environment (weather, soil, nutrients) and the herbivores. The herbivores are balanced by their natural enemies.

The rice ecosystem in Indonesia has been evolving for at least 3,000 years. There are many interactions which have developed over this very long period that can be destroyed by the introduction of intensive agriculture. The balance between plant and soil is one. The balance between herbivore and natural enemy is another. Fertilizers can cause the plant to benefit for better nutrients, but pesticides can destroy natural enemies.

We need to begin looking at the rice ecosystem from the view point of maximizing profits without destroying the system. We need to understand the interactions and components.

In this exercise we will look at the rice systems interactions.

Objective

Able to demonstrate the balance of the components of the rice ecosystem.

Time Requirement = 120 minutes

Materials

Markers, glue, scissor, blank paper.

Procedures (For groups of five persons)

1. Go to rice field for 30 minutes and record all kinds of plants, insects, and spiders seen in the field. Use a net to catch more small insects and see the smallest wasps.
2. Return classroom and write the names of things seen in the field on the photocopy paper; make paper 2cm X 5 cm.
3. Add papers with names "sunshine", "rain", "high fertilizer", "low fertilizer".
4. Discuss with group members how the parts interact. Paste the names of ecosystem components on the newspaper, and draw lines between all components which interact. Explain what the lines mean.

5. Next discuss the outcome of the following situations. Discuss what happens to each component over one season.
 - (a) A spray is used that kills all insects and spiders. Then pest migrate to field.
 - (b) The plant is resistant to all pests, so that no pest is in the field. What happens?
 - (c) The plant has high fertilizer and sunny conditions.
 - (d) The plant has high fertilizer and rainy cloudy conditions.
 - (f) The plant dies.
6. Present your groups discussion to other groups.

Ecosystem Analysis

Introduction

Decision making in IPM requires an analysis of the ecosystem. We have seen how sampling, and thresholds are an important parts of that analysis. We have also discussed how some parts of the ecosystem interact. Now we will begin to use a method of *Ecosystem Analysis* to facilitate discussion and decision making.

The Ecosystem Analysis will be done weekly, following monitoring activities and studies of components of the rice system. The results of the field observations will be drawn on a large piece of paper using specific rules given below. The drawing will then be used for discussion. There are questions designed for discussion during each stage of the crop. After discussion it is important that the results are presented to other groups. Everyone should be involved in the observations, drawing, discussion, and presentation. Changing the person who gives the presentation each week is important to keep everyone involved.

Objective

The goal of the activity is to analyze the field situation by observation, drawing, and discussion. At the end of the activity, the group should have made a decision about any actions required in the field.

Time Required = 120 minutes

Materials (per group)

One piece notebook paper, one large size paper, pencil and drawing crayons.

Procedure

1. Go to the field. Walk a diagonal across the field and randomly choose 20 hills on the diagonal. For each hill follow this examination process and record your observations. This should be done for each plot.

Insects: Examine the base of the hill for brown planthopper and white backed planthopper. Then examine the hill from bottom to top for green leafhopper and other hoppers, stemborer egg masses, leaffolders, rice bug, and other insects. If many of the leaves are damaged by feeding, spread the tillers apart and look for caterpillars between the tillers and leaves, especially at the base of the hill. Estimate the percent defoliation of all leaves on the plant. Are larvae still present? Collect the stemborer egg masses (to be saved and reared to record number of egg masses with parasites). Count the number of deadhearts or whiteheads per hill. Record the numbers of all observation for the hill.

Disease: Notice the leaves and stems. Is there any discoloration due to diseases? (Ask the trainer is uncertain). Estimate the percent of the leaf/stem area infected. Record all observations.

Rats: Count the number of cut tillers per hill.

Natural enemies: Count the number of each type of predator, and the number of larva with parasites per hill.

Tillers: Count the number of tillers per hill.

2. Find a shady place to sit as a group. Each group should sit together in a circle, with pencils, crayons, data from each of the field activities (IPM, Local Package, and other studies), and the drawing of the field ecosystem from the previous week.
4. Now make a drawing on the large piece of paper. Everyone should be involved in the drawing. Make a drawing for each plot observed (IPM versus local package). There are several rules for drawing as follows:

Draw the plant with the correct average number of tillers found in one hill. Write the number of tillers on the plant somewhere. If the plant is healthy, color the plant green. If the plant is diseased or lacking nutrients (low in fertilizer) then color the plant yellow.

Draw dead or dying leaves in yellow.

For weeds, draw the approximate density and size of weeds in relation to the size of the rice plant. Draw the kind of weeds in the field (broad-leaf or grass type).

For pest population intensity, draw the insect as found in the field *on the right side of the plant*. Write the average number next to the insect. Also write the local name next to the insect. The data can also be summarized in a table on the right side.

For natural enemy population intensity, draw the insects and spiders as found in the field *on the left side of the plant*. Write the average number of natural enemies and their local names next to the drawing.

For rats, show the average number of tillers cut by drawing the tiller laying on the ground and cut from the side.

If the week was mostly sunny, add a sun. If the week was mostly sunny and cloudy together, draw a sun but half covered with dark clouds. If the week was cloudy all day for most of the week, put just dark clouds.

If the field was fertilized, then place a picture of a hand throwing N's, P's or K's into the field depending on the type of fertilizer used.

If insecticides were used in the field, show sprays with a nozzle and write the type of chemical coming out of the nozzle. If granules were broadcast, show a hand with the name of pesticide being broadcast.

Example:

5. Keep your drawings for comparison with weeks later in the season.
6. Now discuss the questions listed below for each stage of the plant depending on the crop observed. One person in the group is designated as the questioner. (change the person each week). This person will ask questions about the field. Write your answers on the paper and add a summary.
7. Each group should make a presentation of their field observations, drawing, discussions, and summary. A different person should make the presentation each week.

Ecosystem Analysis Questions

Early Vegetative Stage

(4 to 10 days after transplanting)

1. Have the plants recovered from transplanting and beginning to produce tillers?
2. Are new leaves on the plant?

(If the plant is not tillering and new leaves are not developing, ask why this is so. In your opinion)

3. Why is it important that the plant is tillering and new leaves are on the plant?
4. Is there any evidence of disease or fertilizer deficiency on the plant? Is the plant yellow anywhere?

(If there is Bacterial Leaf Blight (BLB), ask about the period of transplanting, the climate conditions, the damage to the plant, the amount of BLB in the field last season, the variety used last season.)

(If the plant has yellow lower leaves and green new leaves, then the leaves are either old and dying this is normal, or the plant is deficient in Nitrogen. Ask about the way plants grow do leaves last for ever or do they emerge and die? Ask about the amount of fertilizer used, and the way

it was applied. Nitrogen fertilizer should be applied when water is in the field and then the water kept in the field. It is best to mix the fertilizer into the soil. Does more nitrogen have to be added?)

5. What is the effect of the weather on the growth of the plant? (more sun, faster growth).
6. What kind of natural enemies were seen in the field? How many of each kind of natural enemy were counted? Where did the natural enemies come from? What were they eating in that area before coming to the rice field? Were any egg masses collected and reared to detect parasites? Was any insecticide used that might kill natural enemies? How does the natural enemy population compare with the previous week? What is the importance of many natural enemies at this stage?
7. What kind of pests and what was their average population density in the field?
8. What was the main insect pest seen? Is there anyway to prevent these insects from increasing in numbers? (lowering water, increasing water, add fertilizer, reduce fertilizer, etc.) What was the reason that this insect is increasing numbers in the field? What is the condition of other fields in the area? Do the other fields influence your fields?
9. Considering the density of natural enemies, and the density of insect pests in the field, is there any need to apply insecticides? How many insects does one spider eat in a day?
10. Were any rats or signs of rats seen? Was any rat damage detected? What can be done? Should a rat drive be organized in the village? Should baiting start? What kind of baits and how many bait stations should be used per hectare?
11. How does the condition of the field compare with the previous week?
12. What do you expect will happen in the next week? Are there any pests to monitor more carefully?
13. What is the management plan for the next week?

Mid-Vegetative Stage

(2 to 4 weeks after transplanting)

1. Have the plants recovered from transplanting and beginning to produce tillers? How many tillers have been produced?
2. Are old leaves found dead at the base of the plant? How many leaves does one tiller have?

(If the plant is not tillering and new leaves are not developing, ask why this is so. According to you)

3. Why is it important that the plant is tillering and new leaves are on the plant? If the young leaf is damaged by a larva, or the plant has a few deadhearts, will the leaves and tillers be replaced quickly with new leaves and tillers?
4. Is there any evidence of disease or fertilizer deficiency on the plant? Is the plant yellow anywhere?.

(If there is BLB, Bacterial Red Stripe or other bacterial disease, ask about the period of transplanting, the climate conditions, the damage to the plant, the amount of BLB in the field last season, the variety used last season.)

(If the plant has yellow lower leaves and green new leaves, then the leaves are either old and dying - this is normal, or the plant is deficient in Nitrogen. Ask about the way plants grow - do leaves last for ever or do they emerge and die? Ask about the amount of fertilizer used, and the way it was applied. Nitrogen fertilizer should be applied when water is in the field and then the water kept in the field. It is best to mix the fertilizer into the soil. Does more nitrogen have to be added?)

5. What is the effect of the weather on the growth of the plant? Is the field wet enough?
6. What kind of natural enemies were seen in the field? How many of each kind of natural enemy were counted? Where did the natural enemies come from? What were they eating in that area before coming to the rice field? Were any egg masses collected and reared to detect parasites? Was any insecticide used that might kill natural enemies? How does the natural enemy population compare with the previous week? What is the importance of many natural enemies at this stage?
7. What kind of pests and what was their average population density in the field?
8. What was the main insect pest seen? Is there anyway to prevent these insects from increasing in numbers? (lowering water, increasing water, add fertilizer, reduce fertilizer, etc.) What was the reason that this insect is increasing numbers in the field? What is the condition of other fields in the area? Do the other fields influence your fields?
9. Considering the density of natural enemies, and the density of insect pests in the field, is there any need to apply insecticides?

10. Were any rats seen? Was any rat damage detected? What can be done? Should a rat drive be organized in the village? Should baiting start? What kind of baits and how many bait stations should be used per hectare?
11. How does the condition of the field compare with the previous week?
12. What do you expect will happen in the next week? Are there any pests to monitor more carefully?
13. What is the management plan for the next week?

Late Vegetative and Maximum Tillering
(5 to 7 weeks after transplanting)

The field should be reaching its maximum tiller number at this stage. New leaves are not emerging as often, and the top leaves will have to survive until the end of the season. A few more leaves will emerge, and they will be the most important leaves for a good yield. Healthy and abundant tillers at this stage is a good sign of a good harvest.

Note: Premordial stage in most modern varieties occurs 65 days before maturity. For a 130 day variety, premordia initiation is expected at 65 days after seeding.

1. How is the water situation? Is the soil moist or flooded? Fertilizer should be applied at premordia initiation and should have water in the field. (why?). Are there too many weeds in the field? What is an economic threshold for weeds according to your opinion?
2. How many tillers are on the plant? How does this compare with the expected number of tillers for the variety? Are the leaves dark green? If there was earlier damage of stemborer, was there a difference in the number of healthy tillers between infested and non-infested hills? What will happen if one plant in the hill is less vigorous? Do the other plants in the hill compensate for the one plant?
3. What is the level of insect pests in the field? Is there anything in the field that can be called a "pest". Are populations increasing, decreasing or staying the same? Are there some insects that are neither pest nor natural enemies? Are there decomposers that eat dead material in the soil? Are there stemborer eggmasses in the field? Are the eggs parasitized (rear them to find the answer).
4. What has happened to spider populations? Are web making spiders becoming common? Are parasitized larva more common? It should be easy to find a larva with small with pupa on the sides at this stage of the crop. Is there a balance of natural enemies and pests in the field? How many insects can a spider eat in a day? What does this say about "balance"? What if the field

is sprayed and all natural enemies die, then there is an immigration of pests? What would happen?

5. Are there signs of rats in the field or on the bunds? The crop will be too desirable in a few days to be able to use baits. Community action is the best control. Does your community have a good action plan for rats?
6. What do you expect will happen in the following week? What should you do to in the next week to have a good yield?
7. What is your summary for this week?

Premordia

Note: Premordial stage in most modern varieties occurs 65 days before maturity. For a 130 day variety, premordia initiation is expected at 65 days after seeding.

1. Can you find premordia initiation in the field? This is important stage for development of the panicle and determines the potential number of grains.
2. Fertilizer should be applied now. Is there sufficient water available to flood the field? Are weeds already removed from the field? Are there any common diseases that will benefit with fertilizer application?
3. Are rats a problem? What can be done in the community to control rats?
4. Are there any insects at high population? If so, will the plant be able to compensate for damage? Are there natural enemies which will control the insects? Are there stemborer egg masses in the field? Are these parasitized? (This is the process which we should now be using - is there a problem? If yes, how's the plant and natural enemy situation? Then what?....).
5. What is the balance of pests and natural enemies? What will happen in the next week? What is your summary of important actions to be taken?

Booting stage (panicle development)

Developing panicles should be visible in the tillers. Most tillers should have passed premordia stage and developing the panicle. Water is very important. Coordination of water management in a block will be crucial for everyone in the block to achieve a good yield. Water is necessary to develop the panicle, to allow the panicle to expand, and finally for the flowers to develop completely. Water management should be considered daily.

1. What is the current stage of the panicle development? How long is the panicle? Have all tillers already reached premordia? Why are some panicles more developed than other panicles within the same hill?
2. Are new leaves still being developed by the plant? How long do you think these leaves will live? Are new tillers still being formed? Did the plant height change? The internodes will begin to elongate and the average plant height will increase rapidly. The stem will be very soft and easy to attack by stemborers.
3. Why is it important to protect the leaves at this stage?
4. Is there any evidence of disease or fertilizer deficiency on the plant? Is there any plant yellowing?
5. What is the state of diseases? Is BLB, BRS, or any fungal diseases becoming important? How does fertilizer, water and varietal type effect disease development?
6. What is the effect of the weather on the growth of the plant?
7. What kind of natural enemies were seen in the field? How many of each kind of natural enemy were counted? Where did the natural enemies come from? What were they eating in that area before coming to the rice field? Were any egg masses collected and reared to detect parasites? Was any insecticide used that might kill natural enemies? How does the natural enemy population compare with the previous week? What is the importance of many natural enemies at this stage?
8. What kind of pests are in the field? What was their average population density in the field?
9. What was the main insect pest seen? Is there anyway to prevent these insects from increasing in numbers? (lowering water, increasing water, add fertilizer, reduce fertilizer, etc.) What was the reason that this insect is increasing numbers in the field? What is the condition of other fields in the area? Do the other fields influence your fields?
10. Considering the density of natural enemies, and the density of insect pests in the field, is there any need to apply insecticides?
11. Were any rats seen? Was any rat damage detected? What can be done? Should a rat drive be organized in the village? Should baiting continue? What kind of baits and how many bait stations should be used per hectare?
12. How does the condition of the field compare with the previous week?

13. What do you expect will happen in the next week? Are there any pests to monitor more carefully?
14. What is the management plan for the next week?
15. How must the water be managed at this stage?

Flowering and Milky Stage
(35 to 30 days before harvest)

At this stage, rats and disease can be a big problem. Rats are very difficult to control with baits at this phase so rats drives would have to be organized. Diseases will have a strong impact on the yield if they are serious. What is the state of your fields in terms of these two important problems. Leafhoppers can be very prevalent, but this insect usually is quickly reduced by spiders and parasites in the field, if these natural enemies are still common. Water is important for pollen formation and complete germination.

1. How is the water situation? How does the flower become fertilized? Why is water very important for complete germination? What happens if the flower germination is very poor? What is the good point about rice being self-pollinated in terms of seed production and seed quality?
2. How are rats? Rats must be controlled by this stage. Finding many rats only means more control must be applied. Are the rats pregnant now?
3. Are any insects a problem? Are there ways to protect the crop? Are natural enemies sufficient to control the crop? Have rice seed bugs entered the field? Why do you think they smell so bad? How do they feed?
4. What will happen in the next week? What is your summary for the week?
5. Try to think as a farmer. Are you happy with your results in your field so far? What would you do different next season for activities up to this point? What would you have expected from your PPL or PHP in your area so far? What could the PPL or PHP have done for you?

Dough stage

1. In one panicle, are there some grains that are flowering, some that are milky, and some that are in the dough stage? In one hill, what number of panicles are mostly dough stage versus mostly flowering panicles or mostly milky panicles? What is there are variation in the age of the grains and age of the panicles? What does this mean for insects such as rice seed bug that feeds on flowering and milky stage grains?

2. Are there many empty grains? Why? What does germination have to do with the filling of grains?
3. How is the level of diseases? Will you use the same variety next season? Are you preparing a seedbed now? What variety and what seed will you use?
4. Are there areas in the field with heavy rat damage? Where else is rat damage heavy in the village? What is the reason for the high damage? If there is high damage, why isn't there a good community action program? How can a program be developed or improved for the next season if rats are heavy this season? Rats should be controlled continuously.
5. Are there any insect pests that can't be controlled by natural enemies in the field? Are there many whiteheads? If yes, why? What should be done for better observation in the next season to improve stemborer control?
6. What will happen in the next week? How will you control water to make the grain ripen more evenly? Can the field be drained? Why does draining the field improve yields and grain drying?

Maturity and Harvest

1. What percent of the leaves are brown? What percent of the panicles are hard and brown? Is the soil dry?
2. Are there many insects in the field that are a problem? What could be a problem insect?
3. After harvest, what will happen to natural enemies?
4. What will be done about rats in the next season? Is there a good community action program planned and ready to start after harvest?
5. What could you do different to improve yields for next season? What could you do different to improve profits for the next season?
6. From your ecosystem analysis, can you do an economic analysis? How about an environmental impact analysis?
7. How can you assist other farmers in the next season?

Economic Threshold Levels

Preface

The goal of training for IPM is to empower farmers to make their own decisions. These decisions are usually economic decisions about pest control - if I don't spray, will I lose some yield that is worth more than the cost of the spray? The decision requires knowledge of the rice ecosystem: recognition of pests and natural enemies, understanding of the interaction of pests and natural enemies. The decision also requires knowledge of the effect of pests on the yield of the plant and the effect of pesticides on natural enemies.

We have seen that *sampling* is the first step in making decisions. This is the step of getting information. Using *Economic Threshold Levels* is the second step. *Assessing the risk* of pest populations is part of the economic step that begins the third step of analysis.

In the next section we will explore the meaning of Economic Threshold Levels and look at risk assessment when pest populations have surpassed their ETL.

What is the "Economic Threshold Level"?

Introduction

The Economic Threshold Level (ETL) is an attempt to improve decision making practices by using partial economic analysis on the impact of a control practice, such as spraying a pesticide. The ETL is computed usually based on three parameters using the following equation:

$$\text{ETL} = \text{cost of control (\$/ha)} / [\text{commodity value (\$/kg)} \times \text{damage coefficient (kg/ha/\#pest/ha)}]$$

At the ETL, the benefits of spraying are equal to the losses caused by the insects in the field. There are many ways of making this definition, but they are usually based on the same parameters.

What is the use of the ETL? Traditionally, when the ETL was surpassed (field populations are sampled and found to be higher than the ETL) the farmer was advised to spray.

IPM now includes a larger analysis of the ecosystem (like the IPM being taught in the field!). Other factors including levels of natural enemies, plant health and ability to compensate for damage, other investment opportunities, personal health, and weather are involved in the decision making process. The ETL is still useful a part of the analysis, but the ETL is not the only analysis.

Objective

Able to give definition of Economic Threshold Level including parameters for computation, and demonstrate how ETL changes with changes in at least two of the parameters (commodity value and cost of control).

Time Required = 120 minutes

Materials

Paper and pencil.

Procedure

1. For the Cost of Control parameter, calculate the cost of chemicals, labor, equipment, etc. that is required for a control action. Try to consider at least two alternatives (e.g. to methods of control for same problem).
2. Find the price of rice on a monthly basis. Also consider the price of tomatoes, cabbage, and other vegetables.
3. Compute the monthly ETL using the information in 1. and 2. above and the equation given at the top of the page. Use a constant of "0.1" for the damage coefficient.
4. Plot the ETL on the y axis against the months of the x axis. What happens to the line? Why? Can we use an ETL that is so variable over time, place, and control option? How is the Agro-Ecosystem Analysis similar to the ETL and how is it different?

4.10. Toxic Compound (Pesticides) Related Issues: Poisons in Agriculture

"These aren't medicines, they're poisons!"

Introduction

Pesticides are necessary to in some fields, in some years in areas. In many seasons, many rice fields do not need pesticides. Pesticides are poisons. They are very dangerous to both the person who uses the pesticides and to those that are living or playing near the fields where pesticides are used. These poisons kill aquatic animals (fish and frogs), beneficial predators and parasites, and other beneficial animals such a pollinating bees. There is no use of pesticides that can be called "safe" to everything in the ecosystem. Even the very selective insecticide, Applaud, causes problems for the growth of shrimp and prawns. There is no "safe use of pesticides". We can only avoid their use and reduce exposure when used.

Predators, parasites, pathogens, resistant varieties, growing a healthy crop, and proper monitoring of the fields are methods to reduce the population growth of potentially harmful insects and rats. Pesticides are not the "last method" to use as commonly thought. They must be integrated with other aspects. Seed treatments are a good example of how pesticides are used before other methods, but used in a way which reduces their impact on natural enemies, on the environment and human health. In general, pesticides should be used as a "last method" because they do have many bad effects and are expensive in terms of actual "out-of-pocket" costs.

When pesticides are needed to reduce economic losses by insects, they should be used correctly and carefully. The first step is to know the area to be sprayed, and the proper amounts. Care should be taken in measurement and handling of pesticides. The second step is the actual application of sprays in the field. Proper protection is needed in field application and possible with simple adaptation.

Demonstration of Pesticide Poisoning.

Introduction

Sometimes seeing is believing. This is a terrible activity for demonstrating the effects of toxic compounds on animals. This activity should be done with discussion on other persons experiences with poisoning. There are antidotes available for poisoning. Read pesticide labels and ask at the local health center if these are available.

Objective

Demonstrate pesticide poisoning.

Time Requirement = 120 minutes.

Materials

Wire cages or buckets, small paper dishes, chicken feed, chickens (and/or fish, frogs, cats, etc.), temik for rats, carbofuran, spoon, pencil and paper.

Procedure

1. Place chicks in cages (or fish in buckets with water). Frogs can also be used if forced to feed. Do not feed the animals for several hours before the activity.
2. Mix granular carbofuran or temik with chicken feed. (or directly in water if using fish).
3. Feed the food to young chickens. Let some chickens feed a lot and other chickens a little. Change dosages for each group.
4. Observe the behaviour of the chickens for 45 minutes. Note the symptoms of poisoning and the time at which each symptom begins.
5. What are the reactions of the chicken to the feed? Have you ever seen similar symptoms of friends or other farmers after spraying? Have you ever seen a pesticide suicide? What happened? Do you think that antidotes will work? How different is the physiology of chickens and people? With long-term exposure to pesticides, what do you think is the result to the rural population?
6. Present your result to the other groups.

Poisons in Agriculture: Health Aspects

Introduction

Pesticides are poisons which cause physiological changes that result in the death of insects and other organisms such as humans. Most pesticides attack the nervous system of organisms, both invertebrates (insects, spiders, etc.) and vertebrates (fish, frogs, people, etc.). The carbamates and organophosphates both interfere with the correct transmission of nerve pulses. The action of interference can be the result of a high single dose (common in suicide by insecticides), or over a long period such as in farmers and children working and playing in fields with pesticide applications.

How are the poisonous effects of insecticides measured? There are many types of studies done before a pesticide may become registered for general usage. Some of the tests are the effects of chemicals on skin, on eyesight, and on moist tissues such as lungs. There are also tests to see how much pesticide is needed to kill insects, and mammals. For most of these tests, rats and rabbits are used in large numbers. For example, insecticide is sprayed in the eyes of these animals and the reactions are noted.

Test on the dosage of insecticide which kills test animals are called Lethal Dosage tests. Basically the process is simple and depends on the fact that not all animals will die with the same dosage because some individuals are more sensitive than others. If a very low dose is applied to 100 individuals, only a few individuals will die. If a very high dose is given, then most of the 100 individuals will die. The dose at which 50 of the 100 (50%) die is called the 50% lethal dosage or LD50. The dosage at which 90 of the 100 individuals (90%) die is called the LD90. This is a moderately useful measure, except that even at low dosages there is still an LD10 in which 10% die. What does this 10% probability mean in another example? It means that there is a probability that for every 10 people that cross the road, one will die while crossing the road. In other words, 10% probability is still very high. Dosage for mammal is usually measured in mg/kg. This means that a LD50 of 1 mg/kg (the oral LD50 for Temik) for a person who weighs 50 kg is about 50mg, which is a very small quantity. Lethal dosages are usually given in both oral (through the mouth) and dermal (exposure to skin) levels.

But pesticides cause other effects besides death. Other symptoms of pesticide exposure include nausea, dizziness, headaches, fatigue, diarrhea, irritation of nose, eyes, throat. Recognition of these effects is an important part of pesticide safety and in your job as an IPM field expert. These and other effects of pesticide exposure will be explored in this activity with demonstration of pesticide effects on animals.

Objective

After this activity, you should be able to explain what is an LD50 measures, recognize common insecticide poisoning symptoms and demonstrate with live animals the effect of pesticides.

Time Required = 60 minutes.

Materials

Graph paper, pencil

Procedure

Part I: Compute LD₅₀

1. The following are the results of several trials for different dosage levels.

Trial Dosage	100 test individuals	
	Dead	Alive
0 ppm	1	99
30 ppm	2	98
60 ppm	3	97
90 ppm	10	90
120 ppm	25	75
150 ppm	45	55
180 ppm	65	35
250 ppm	85	15
300 ppm	90	10
400 ppm	95	5

- a. Graph the trials. Use dosage on x-axis, and %dead on the y-axis.
- b. According to the data, what is the LD₁₀, LD₅₀, and LD₉₀ for this population of 100 individuals.?
- c. In a field of rice, if there is one BPH per hill, and hill spacing is 20 x 20, how many BPH are killed when a spray at the LD₅₀ is used? How many are alive? What do you think is the best dosage to use for field application? How about at the LD₉₀? What do you think farmers are doing?
- d. Natural enemies are usually more susceptible to insecticide than pests because natural enemies usually do not build up resistance. What happens when a low dosage is applied to the field (i.e. a dosage that is LD₅₀ for BPH, but LD₉₀ for natural enemies)?

Poisoning Symptoms

1. Use the following list. Go through the list and check any symptoms you have seen or about which farmers complain.

After spraying have you are had the following symptoms immediately or within a few days:

Mild symptoms

Irritation of eye, nose, or throat	_____
Headache	_____
Dizziness	_____
Fatigue	_____
Diarrhea	_____

Moderate symptoms

Redness or itching skin	_____
Upset stomach	_____
Blurred vision	_____
Extreme weakness	_____
Excessive perspiration	_____
Muscle twitches	_____
Rapid heartbeat	_____

Severe symptoms

Vomiting	_____
Pinpoint pupils	_____
Difficulty in breathing	_____
Unconsciousness	_____

2. These are important symptoms that you should always keep in mind while working in the field. Many farmers do not know that these symptoms are cause by insecticides. They can be confused with excessive heat exposure, food poisoning, or other illness. But pesticide illness is common and can be avoided by using pesticides only when needed and using them carefully in the field.
3. How could farmers become more aware of the effects of pesticides?

Pesticide Calculations

Introduction

There are some who claim that farmers cannot do IPM because it is too complex. These same people claim that simple pesticide recommendations are "easier".

In fact, IPM is not too complex for anyone to implement, and pesticides are not easy to use. Pesticide calculations are somewhat complicated for proper application based on plot size, dosage, and calibration (rate of spraying).

In this activity, we will investigate the typical calculations needed for recommended pesticide applications and at how to provide farmers with useful measuring methods.

Objective

After this activity you should be able to (1) find the area of a field, and (2) compute the amount of poison needed to cover the field.

Time Required = 120 minutes

Materials

Meter stick, paper, pencil, balance, spoons.

Procedure

[DO NOT USE A CALCULATOR, USE PENCIL AND PAPER]

1. To measure your foot step;
 - a. Lay the meter stick on the ground for about 12 meters.
 - b. Take 10 steps next to the meter stick and measure the length of 10 steps.
 - c. Divide the length by 10 to get the average footstep length.
 - d. Try to make a step that is exactly 0,5m or 1,0m. This will make calculations of area easier.

2. Compute area of fields (most farmers say they know, but few farmers actually know the area of fields);
 - a. Make a map of the field with the approximate shape.
 - b. Measure the sides of the fields by walking and counting the steps.
 - c. If the field is not a rectangle, then divide the field into rectangles and triangles to estimate the area. Remember the area of a rectangle is the height times the width. The area of a triangle with a right angle is one-half the height times the base.

3. Compute amount of granular pesticide in one spoonful; (for farmers without balances..)
 - a. Make a paper tray for the top of the balance and write down the weight.
 - b. Using your spoon, measure 10 spoonfuls of carbofuran.
 - c. Weigh the granules and minus the weight of the paper.
 - d. Divide the weight by 10 to find the grams per spoonful.

4. Compute the amount of granular pesticide needed for a field;
 - a. Most insecticides recommendations are given based on 1 ha. Compute the actual amount needed using the following computation:

$$\text{Actual Needed} = [\text{Recommended Amount}(\text{kg/ha}) \times \text{Field Area} (\text{m}^2)]/10,000 \text{ m}^2$$

- b. Compute the following

Field Area (m ²)	Recommended Amount (kg/ha)	Actual Amount (kg)	Number Spoonfuls Needed
800m ²	17kg/ha	___kg	___spoons
1200m ²	8,5kg/ha	___kg	___spoons
750m ²	17kg/ha	___kg	___spoons
1050m ²	12kg/ha	___kg	___spoons
350m ²	10kg/ha	___kg	___spoons

5. Compute the amount of liquid in a spoonful;
 - a. Most liquid pesticide recommendation are given in ml. To find the number of ml is a spoon, put 10 spoonfuls of water in a measuring glass. Read the measurement and divide by 10 to get the number of ml in a spoonful.

6. Compute the number of sprayer loads and number of spoonfuls of pesticides needed for a field.
 - a. To spray a field, usually 200 to 500 liters per hectare are required. In the early stages, 200 liters per hectare is sufficient. In the later stages, 400 liters is necessary because there is more foliage to cover. These are recommendations which are not usually implemented for good reasons (weight, time, access to clean water, etc.) To properly compute the number of tank loads, simple divide the amount required by the number of liters held in the sprayer.

- b. Compute the following:

Sprayer	Amount	Number of
---------	--------	-----------

Size	Needed	Sprayer loads
11l	300	_____ loads
13l	500	_____ loads
15l	300	_____ loads
9l	400	_____ loads
13l	500	_____ loads

- b. Now for each sprayer load, some insecticide must be added. You have to multiple the usually recommendation of number of ml per liter to get the total ml needed for the sprayer. Then you must figure the number of spoonfuls is enough for that number of ml. The number of spoonfuls is the total number of ml divide by the number of ml per spoonful.

Sprayer Size	Recommended ml/l	Total ml/load	Number of spoonful needed
11l	2 ml/l	_____ ml	_____ spoons
11l	3 ml/l	_____ ml	_____ spoons
13l	5 ml/l	_____ ml	_____ spoons
13l	2 ml/l	_____ ml	_____ spoons
15l	3 ml/l	_____ ml	_____ spoons
15l	4 ml/l	_____ ml	_____ spoons

{Now you can see that pesticides are poisonous and the computations also give you a headache!}

PESTICIDES

Background

Application of pesticides is a very important skill in order to apply dangerous poisons without heavy self-contamination and to assure that the application is effective against the pest being sprayed.

Minimum contact with pesticides is the best way to avoid their effects on humans. Not spraying is one alternative and the safest. If it is determined that a spray must be applied, using less toxic pesticides and choosing selective pesticides is the best choice. We saw that *Bacillus thurengensis* is an option for caterpillars (Lepidoptera), and Applaud is an option for planthoppers.

For broad spectrum pesticides, the LD50 of a pesticide is the indication of toxicity (see appendix 1). You should know the LD50 of the most common pesticides. (Remember that the LD50 is given in mg chemical per kg body weight (mg/kg). Example: LD50 of 8 (monocrotofos) means that it requires only 400 mg to kill a person weighing 50 kg). Reduction of contact should be done at all stages of handling, including transport from market, transport to field, pouring, measuring, mixing, spraying, and cleaning the tank. Protective clothing including face mask/scarf, hat, gloves/plastic bags, boots and plastic apron to cover legs. Safe disposal of the pesticide containers and remainder of sprays is also important: bury or burn, DO NOT throw in the river or irrigation canal where children, adults and animals are exposed.

Application which will enable correct contact of pesticide to the pest is also important. The spray method should match the position of the pests. Insects on the upper surface are easily contacted by most sprays, but aphids and mites on the bottom surface are much more difficult to reach. A spray with large droplets (course) will cover tops of leaves but the drops will roll off the leaf and onto the ground. A spray with small droplets (fine) will float in the air and some of the droplets will hit the bottom surface of the plant. The difference in sprays is determined by the nozzle. Different kinds of nozzles are available at the Kiosk. While the nozzles are costly, a spray that does not reach the pest is a waste of money.

In this activity, we will look at the LD50 of common pesticides, consider ways to reduce exposure and practice spraying.

Objective

Look up the LD50 of common pesticides used in rice, describe the weight of common articles with small weights (100 mg to 1000 mg), describe methods to reduce exposure and demonstrate spraying techniques.

Materials

- Paper, pen, newsprint, market.
- Scale, coins, and common medicines (Stop-Flu, vitamin, etc.).
- "Pesticide"; mix in a 100ml bottle water and cloth dye coloring that will stain the clothes and skin of the participant (red batik dyes are very good)
- Sprayer, teaspoon, ember, measuring glass (25ml), gloves/plastic bag, hoe.
- Hand sprayer

Steps

1. Look at the list of recommended chemicals from your national guides.
2. Find the chemical name for each recommended pesticide (example: Azodrin = monocrotophos) and LD50 dermal (skin) and oral (mouth) for each of the compounds and make a list. Note Lebaycid and Levin are not listed.
3. Find the same information for *Bacillus thurengiensis*.
4. Now compute how much pesticide it will take to kill a person of your weight using both the LD50 for dermal and oral contact.
5. Weigh several common items in your pocket such as different size coins, a pencil, some medicine pills, stones of different sizes spoonful of rice, and other compounds. Compare the weight of these items with the amount of pesticide needed for killing you.
6. Which compounds are the most dangerous? What compounds are used by farmers? Are there any compounds that have the same effectiveness but higher LD50's?
7. The question of farmer poisoning responsibility is a current social issue. If you make a recommendation to a farmer and know the farmer doesn't have protective clothing, who is responsible for the farmer if he becomes sick from the poisoning? You, the Department of Agriculture, or the farmer?

Practice spraying and reducing contact

1. Identify two or three people in each group to be the "SAFETY INSPECTOR". Give these people a badge with the title of "HEALTH AND SAFETY INSPECTOR".
2. The other people in the group will be the "APPLICATORS". These people should also have a badge with their title.

3. The APPLICATORS should now proceed to prepare a tank load of pesticide using a dosage of 2ml/l and 500 l/ha for one plot of 400 m square. Do the calculation, then the mixing of water and pesticide, and spraying in the field. (Note: Put the water in the tank first! and then add the pesticide. Mix in the tank!)/
4. The INSPECTORS should be watching every step of the process and make notes of contact with the compound and make notes on how to improve techniques so that less pesticide is contacted.
5. The INSPECTORS should present their notes to the group. Discuss how the process should be different. Test the process in the field.
6. What are other ways to protect farmers from spraying?

PESTICIDES

Background

A major problem of pesticides is their effect on "non-target organisms". Most pesticides are very toxic to predators, parasites, fish, and people who come into contact with these chemicals. There are insecticides which are very specific to particular groups of insects. Applaud (buprofezin) is a good example of a selective pesticide which kills only brown planthopper type insects (Delphacidae).

For other types of insects there are other pesticides. A major new pesticide is *Bacillus thurengiensis* usually called "Bt". This insecticide is active against most lepidoptera (butterflies and moths). The insecticide must be consumed while most insecticides only need contact. Also the insect does not die as quickly after eating Bt than when sprayed by a broad spectrum insecticide. In this activity, we will look at a selective pesticide and compare with a typical broad spectrum pesticide.

Objective

Demonstrate the difference between selective and broad spectrum pesticides.

Materials

Plastic bags
Spiders and caterpillars collected from the field
Small fish, and plastic buckets
Monocrotofos, and *Bacillus thurengiensis*
Cups, netting, rubber bands and sprayer

Steps

1. Collect caterpillars, spiders and other natural enemies from the field. Keep the caterpillars on soybean plants so that they don't die. The plants should have the roots so there are enough leaves for the insects to live on for two days.
2. Place the natural enemies in two cups and over with netting.
3. Place the caterpillars on the plants in cups with water. Prepare two cups.
4. Place fish in two plastic containers.
5. Prepare monocrotofos in hand sprayers and Bt. in another hand sprayer. Use typical field dosage (1-2 ml/l)
6. Spray one of the cups containing natural enemies with monocrotofos and one cup containing enemies with Bt.

7. Spray one of the cups with caterpillars with monocrotofos and the other with Bt.
8. Spray one of the plastic containers of fish with monocrotofos, and one with Bt.
9. Observe the results after one hour and after one day. If the larvae haven't died in one day, observe again after another day.

Discussion questions

10. What are the results of the treatments? Prepare a table for presentation of results.
11. Why are selective pesticides useful for secondary crops? Why is it important to use selective pesticides?

Carbofuran, Carbamate Spray and Spiders

Introduction

"Systemic" pesticides are those pesticides that are absorbed by the plant and the pesticide is able to move through the plant through the network of plant vessels. It is commonly said that systemic pesticides are safe for natural enemies because the compounds are in the soil and in the plant. But how do the pesticides finally get into the soil? Where is carbofuran broadcast? Is there any difference in the application of granular carbofuran and liquid sprays?

In this activity we will look at the effect of carbofuran on spiders. The effect will be compared with a neutral control and a sprayed BPMC.

Objective

Demonstrate the effects of carbofuran on natural enemies.

Time Required = 120 minutes.

Materials

Plastic bags, 3 cups, netting for the cups, 3 rubber bands, water, carbofuran, liquid carbamate (eg. BPMC), natural enemies, hand sprayer (1 liter for indoor plants), pencil and paper. (Try also some herbicides, and fungicides).

Procedure

1. Go to the field with plastic bags. Collect spiders and predatory beetles.
2. Return to a shady place. Set up three cups with the names "carbofuran", "carbamate", and "control" written on them. Add water so the cup is half-full. In the cup for "carbofuran" add a small amount (two pinches) of carbofuran to the water and mix so the carbofuran begins to be dissolved.
3. Now in each of the cups, add the same number and same kind of natural enemies. Cover the cups with netting and rubber bands.
4. In the cup labeled "carbamate", spray the inside with the hand sprayer. The concentration and dosage should be the same as in the field.
5. Watch all three cups for changes in activity or death of natural enemies. Record the time of activity changes and deaths over 45 minutes.

6. What happened? How did the natural enemies in the control compare with the other treatments? Why did natural enemies die in the carbofuran treatment? Do spiders and beetles walk on the water in the field? What is the significance of a basal application of carbofuran?
7. Present your results and answers to the above questions to the other groups.

Spraying

Introduction

Spraying pesticides is dangerous. The compounds used for spraying are in a concentrated form which makes them even more dangerous than usual exposure. Concentrated liquids direct from the bottle, and exposure to sprays in the field during application will cause numerous symptoms such as skin rashes, dizziness, nausea, and headaches.

The usual recommendation for gloves, boots, rain cloths, and respirator are impossible to implement for most farmers because of the cost. But all these articles can be substituted; plastic bags for gloves and boots, large plastic sheet cut like a rain poncho or apron, a hat and cloth for the nose and mouth.

The direction and velocity of the wind should be considered when spraying. If the wind is blowing hard, do not spray! Your chemical will never reach most of the plant. Never walk into the wind when spraying. Always walk at a 90^o angle to the wind.

Remember that when you broadcast carbofuran in the water, you are walking in a soup of water and dissolved carbofuran.

In this activity, you will see the result of spraying in the field.

Objective

Demonstrate simple adaptations to reduce exposure to poisons.

Time Required = 120 minutes.

Materials

Sprayer, bucket, red batik dye, white pants and shirt.

Procedure (for group of five)

1. Go to the field. One person in the group should put on the white pants and shirt. Four other members should make notes on what the first person is doing. Note especially how to make reduce exposure to the spray liquid.
2. Fill the tank with water. Add red batik dye. Add a lot so that the water is very red. Close the tank and shake the tank to mix the water and dye.

3. Now spray 500 meter square of the field with the tank of water. Others should measure the time required and observe the spraying.
4. After finished spraying, empty an excess spray.
5. Now observe the sprayer. Is the red dye on the skin or clothing of the person who sprayed? What could be done to reduce the exposure? What would happen to the person if the liquid was a real pesticide and the farmer used his regular spraying clothes?
6. Present you observations, discussion and clothing to the other groups. Discuss "Is there really '*safe application*' of pesticides?".

Poison Sprayer Maintenance

Introduction

Pesticides are not medicines, they are poisons to be used and handled with great care. Some chemicals such as carbofuran can be broadcast (using gloves and boots). But many compounds are liquid and need to be sprayed on the crop.

Proper maintenance of the sprayer is necessary to avoid direct exposure from leaking valves, leaking hoses, bad nozzles, and bad rubber rings on the tank openings. Many sprayers spill chemicals on to the back of farmers as the are spraying.

Proper maintenance is also required to have complete coverage of the plant. A nozzle that is old or clogged will not give good coverage of the plant. Many poorly maintained sprayers put out a stream of poison like a person urinating. This wastes money, and exposes the farmer to heavy dripping of the poisons. The spray should be small droplets and spread over the entire spray path.

In this activity we will look at how to maintain a sprayer.

Objective

Identify parts and function of a sprayer, and able to take apart and put a sprayer back together.

Time Required = 90 minutes.

Materials

Sprayer, bucket, hand tools for disassembling the sprayer, large piece of cloth or paper.

Procedure

1. In a shady place, sit down in a group with one sprayer. Have one bucket of water and tools already to be used before beginning.
2. The sprayer is made of many parts. Look at the sprayer and identify all the parts and their function.
3. Fill the tank with clean water and operate the sprayer. Test the pump and valves. Note any leaks when the sprayer is being operated and when it is on its side.
4. Now empty the sprayer back into the bucket. Begin to disassemble the sprayer. Someone should keep track of the how the sprayer is built so that it can be put back together. Make sure

the pieces are placed on the cloth or paper. Any dirt on the pieces will cause problems when the sprayer is put back together.

5. Locate all the potential places for leaks. How do the rubber rings appear? Are they new or old? Were all the parts put together tightly so that the rubber ring is compressed? If the rubber ring is old, where do you buy a new one? Can you make one from an inner-tube or tire? Are the seals on the top of the tank still good? If the farmer bends over with the sprayer on his back does the pesticide go on his back or head? Is there any corrosion on or in the tank?
6. Practice changing the rubber rings. Practice explaining what the rubber rings are used for.
7. Now look at the nozzle. Can the nozzle be adjusted? If so, how? What size wire is needed to clean the nozzle (the wire should be smaller than nozzle hole)?
8. After you have examined all the parts, put the sprayer back together. Fill the tank with water. Check for leaks and check to see if the sprayer is working.
9. How often should a sprayer be checked for problems? When should the rings be changed? When should the nozzle be changed?
10. What is the cost of a new rubber ring? What is the cost of a new nozzle? What is the cost of pesticide poisoning from a leaking tank?

Chapter 5.

Ice-Breakers, Energizers and Team Building Exercises

5.1. *Ice Breakers*

5.2. *Energizers*

5.3. *Team fun*

5.4. *Team skills*

Annex 5-1: Team Building Exercises from KASAKALIKASAN

Introduction

Facilitators should build up a repertoire of activities that can be used for interesting openings that help participants to become comfortable with each other ("Ice Breakers"), activities that boost the energy level of the group after visiting the field or after a break ("Energizers"), activities that are just fun to do in groups and make getting together a better time ("Team Fun"), and activities that build team capacity through learning techniques for planning, organizing, and action ("Team Skills").

The term "Team" is used here to emphasize that a group needs to work together with common goals for common interests and that teams often have structure. There are coaches, captains, and players with various positions. No team can work well without each team member, and the team succeeds more often when everyone works together while each improves individual skills and commitment.

During the cycle of the FFS over one season, energizers and team fun might be used more at the beginning of the season, with more emphasis on Team Skills near the end of the season, especially in preparation for community organizing.

Remember that training should be enjoyable for the facilitator and FFS members. Ask members of the group to lead other activities like warming up exercises at the beginning of each meeting, or other activity that they may have learned at another training program.

Please refer to the annex prepared by the National IPM Program of the Philippines (KASAKALIKASAN) for specific information on each of the activities listed.

5.1. Ice Breakers

Introduce neighbor

Expectation picture

Fruit observation

Throw a ball
Name memorization in circle
Simon says
Money under chair
Fruit and Salad

5.2. Energizers

Coconut and other songs
Group words (boy - hmmm, girl - clap, cow - stomp)
Hand games
Parasite (pen in bottle)
Ballons on leg
Profit (same goat)
Number on paper (practice makes perfect)
20 questions
Give characteristics game
Judo/Karate/Taekwondo

5.3. Team Fun

Twenty objects
Water passing
Broken squares
Strings
Team walking (cross, centipede, ski)
Spider web (pen in bottle)
Drama (moving parts)
Tiger, hunter, lawyer

5.4. Team Skills

Draw together (plan and divide labor)
Making kabob (work plan)
Mini-tower and bridge (leadership style)
Message passing (communication)
Johore's windows (perception)

Annex 5-1: Team Building Exercises from KASAKALIKASAN

INSERT Team Building Exercises from KASAKALIKASAN here.

Chapter 6.

Local Organizations and Follow-up Activities

6.1. *Local Organizations*

6.2. *Farmer Field School Follow-up Activities*

Introduction

After the completion of a FFS, many farmer groups become interested in pursuing solutions to other agricultural or community problems. The types of problems may range from IPM on other crops, specific pest problems, livestock, marketing IPM items, soil fertility management, credit unions or consumer cooperatives. To effectively tackle these issues, many FFS organized themselves into formal or informal community organizations in order to undertake follow-up activities. The likelihood of such organizations forming will be greatly enhanced if the process is facilitated during the FFS. This facilitation should begin about the tenth week, by bringing up some examples of other FFS (see section 6.2. below), and then if the group shows interest to use some of the suggestions from section 6.1 on developing a local organizational structure.

6.1. Local Organizations

Community Organization and Self-Funding requires some action on the part of the facilitator to create the organization. Each organization needs;

- Objectives
- Name
- Officers
- Funding

Objectives are created by the group in a Farmers' Planning Meeting (see below). The organizational objectives should be clear and achievable. The objectives may be technical ("Have monthly meetings with an expert speaker on agricultural topics"), social ("Train all farmers in the community in IPM"), or a combination of the two. The objectives might also include a clear statement of the time frame of the organization ("The organization will dissolve after one year").

Name of the organization is important to for identification of the group and to establish group spirit.

Officers and Structure give organizations some members with specific jobs. The structure may or may not give hierarchy in that some organizations have Board with not Chairperson, while other elect a Chairperson as the top ranking member. Five officers are usually elected by the group to sit on the Board. The officers should determine one person as the Secretary to keep notes and records, a Treasurer to keep records of finances, a Chairperson if desired, and special officers as needed (e.g. recreational officer, or technical officer). This Board should meet regularly to plan meetings for the Organization, and to do the preparation work necessary to carry out activities.

Funding can be gotten in many ways, limited only by the imagination. Dues are the usual method, and dues can be in the form of money, rice, time contribution, etc. The group may try to get funding from local stores, factories, or large land owners by preparing a proposal that includes Goals, Plans, Budgets, and Expected Results. Many Agricultural offices can provide some inputs in terms of time, materials, stamps, etc. Spending one meeting to brain storm on fund raising methods is a good start to discovering sources of funds to support the organization's activities.

6.2. Farmer Field School Follow-up Activities

The following is a short list of activities that have happened as a result of FFSs in Asia. The possibilities are numerous, but will require action on the part of facilitators and the group the get organized.

Farmers' Planning Meetings are one step towards farmers determining what type of follow-up activities are appropriate to their interest, time availability, and funding situation. The planning meeting should try to assess the common problems the members are facing, and establish goals towards which to work. Work plans and success criteria should also be developed, although these will usually have to be undertaken at a second meeting established specifically for that purpose.

Community Surveys have been developed most in the Vietnam IPM Programme for determining the level of pesticides and pesticide poisoning in one village. The members of the FFS make a questionnaire, and visit neighbors in the community. The data is then pooled, and analyzed by the group. Results are put in table of graph form and displayed at Field Days with presentations. Similar surveys could be done for other topics related to rice-fish, pest abundance, fertilizer use, etc.

Community Mapping is actually a process of planning, and can be extended to include monitoring and evaluation. A method used in Indonesia for establishing rat programs involves making a map of the village rice and non-rice areas with information on the migration, and permanent living sites of rats. A yearly time line is used to give calendar information, such as when rice is planted, in booting stage, and harvested. The map and time line together will help to determine when and where baiting control should be undertaken (before booting and after harvest), and when and where mechanical methods are needed (beating and herding during reproductive phase). Similar community mapping methods can be used for planning when and where trees should be planted, green manures could be introduced to the

crop cycle, or environmental sampling points established to capture fertilizer and pesticide pulses during the season.

Farmer to Farmer FFS was discussed in Chapter 2.

Problem Specific Field Labs have been undertaken in Indonesia, and the Philippines. In these Field Labs, specific pests are targeted for research by the community. The Field Lab often recruits assistance from colleges, NGOs, and research stations for planning experiments, specialized equipment, and processing data.

1,000,000 Rat Traps was a project of FFS in the Medan area of Sumatra, Indonesia. The FFS working with the Regional Crop Protection Laboratories made traps with local materials, did community mapping to create action plans, and established the goal of keeping one million rat traps active for several seasons. The project was a success.

IPM Clubs were established by the National IPM Program in Vietnam to carry out follow-up activities. The Clubs usually focused on non-IPM problems, but often related to agriculture. Like many organizations, the name merely reflects its history and not its focus. The Clubs have officers, local budgets, and action plans.

Savings and Loan was created by one FFS in Indonesia in which members contributed to a community fund to build a saving and loan with no or low interest for its members.

IPM Labeling of rice was initiated in South Korea by one FFS, and received about a 10% premium. Other FFS have started to label their rice with the IPM Project symbol and an explanation about IPM for consumers. The rice is bagged in plastic 5 kg and 10 kg bags.

IPM Villages are FFS that focus on developing a block of IPM fields with lower pesticide inputs that have grown out of the efforts of World Education in Indonesia. The blocks include rice and vegetable areas.

IPM Trainer Association grew from a TOT held in Tamil Nadu, India under the FAO Inter-Country IPM Programme. Trainers made a newsletter and sent it among themselves for reading and comparison of efforts with their self-proclaimed goal of training at least four FFS each year. Personal opinions and information, research results, and progress reports are included in the newsletter.

"Entering Pesticide Free Zone" is in Kevin Gallagher's dream of what some communities could work towards in their own community. This would be a title displayed along the side of the road as one travels into an area where IPM has advanced to the point where pesticides have been replaced with non-pesticide plant protection methods, where fireflies are still seen, and fish are collected from rice fields and streams.

Chapter 7.

Evaluation Methods for Facilitators and Groups

7.1. *Evaluation of a Training Season*

7.2. *Evaluation of Training Impact*

Annex 6-1: Quality Checklist

Annex 6-2: Self-Evaluation Matrix for Facilitators

Evaluating training has at least three steps. The first step is to evaluate each session with the goal of ensuring the each participant was able to learn some useful management skills, ecology, or other point that makes it worth the farmer's time to participate in the training programme. At the end of each training, the facilitator should go through the Quality Checklist and Self-Evaluation Matrix given in annexes 7-1 and 7-2. These two lists will help the trainer to improve the FFS during the season. This list can be used by the facilitator as an individual or as a group. The "T Chart" evaluation method given in section 7.1. is also useful for evaluation after one season by the group, especially in the early weeks when facilitator and group are getting to know each other, and getting used to field training methods.

The next level of evaluation is to consider the improvement that occurs during one season of training. These methods mostly consider changes in knowledge and field skills between the beginning and the end of the training; changes assumed to have taken place as a result of the training activities during one season.

The third and perhaps most important evaluation is check for impact of training. Farmers may improve their basic skills and knowledge, but this may not always lead to a change in field action or even to a desirable change such as reduction in toxic pesticide use, improved yields, or improved economic returns.

Always remember that the goal of an IPM programme is long-term impact. Our goal is not to "train everyone in the village" as I have often heard. Training is one means to an end. There are other ways that should also be considered (policy changes, media, etc.) to achieve our long term goals. Evaluation will help us know when we arriving to where we think we are going.

7.1. Evaluation of a Training Season

It is important not to confuse the improvement in knowledge and skill from one training season with training impact (see next section). It is sensible that impact is more likely with more skills and knowledge, but we can not assume immediate changes from improved skills and knowledge. An

example that I like to use is the following. After a training or media programme directed at smokers to help them learn about the effects of smoke on their and their neighbor's health, most smokers will score highly on an evaluation. Most will know that smoking is bad for them. This indicates the training program is working well to disseminate knowledge. But the impact of the training will only be found when we check how many smokers stopped or reduced smoking.

There are numerous ways for a facilitator to evaluate the progress of one training season, but four methods that have been widely used are explained below.

1. Ballot Box evaluations are field based methods that use real specimens and field situations to test field abilities. The Ballot Box test should be given before and after training with levels of difficulty that are the same. The questions on the test should be developed before the beginning of the season and relate to the core objectives of the course. Questions should focus on;

- agronomic practices and plant compensation
- recognition of pests, natural enemies, diseases
- recognition of damage from pests, diseases, rats, and birds
- management of pests, diseases, rats, and birds
- other areas covered in the course

The mechanism of the test is to write a question on a thick paper board and mount it on a stick in the field. Questions should be multiple choice. The board and stick are placed like a sign in the field next to a real condition or object that is being asked about in the question. For example:

1. What caused this damage?

A) Stem borer

B) Rats

C) Tungro

D) Wind

The sign should have a string connecting the sign to the plant part showing the damage. The participant will then mark A, B, C, or D on the answer sheet for question one. Alternatively, each farmer is given many small pieces of paper (Ballots) with the same number specific for him or her. One the sign envelopes or small containers marked A to D are present so the farmer can put in their Ballots. If the correct answer is A, then the person puts their number in the A container.

Twenty to thirty questions should be prepared for the test. After everyone has taken the test, the facilitator should walk with the group to each question and determine the correct answer. If the question or answer is not clear, the group or facilitator may decide to discard the question.

2. Written Exams can also be used together with the Ballot Box. Of course it is important to consider the literacy level of the group, and the knowledge of names or technical terms. The names used in one

village, may not be the officially accepted names nationally and this can lead to confusion. Written tests must be tested for clarity beforehand, and checked to ensure local applicability. Remember that knowing the name of something is not important for field management, but knowing its function and ecological attributes is important. Don't be academic about names. Also don't be academic about definitions. Be practical and keep tests focused on real issues, skills, and knowledge.

Give the test before and after training. After the test, always review together to determine the correct answer. Discard unclear questions.

3. Field Walks are the best evaluation method because there is time to clarify questions and answers. Field Walks are basically walking in the field in pairs (facilitator and farmer) with a predetermined list of questions. The facilitator should have already prepared questions, and know parts of the fields where the questions can be used. Questions will be similar to the Ballot Box. The list of questions should not change significantly between persons and from the beginning and end of training.

This method is also useful for testing farmers after some seasons to test retention of information, and also for determining the kind of knowledge and skills that farmers in one group may be lacking most.

4. Group methods include the "T Chart" and some other fun visual forms given below (thanks to Simon in Indonesia);

- **"T Chart"**: On a large piece of paper, draw one line down the middle, and one across the top to form a "T". On the top of one column, write "Needs to be improved". On the top of the second column, write "It's good". Now ask the group to make a list of items in the training that fit under each title. Each point can be considered as they are given, or you may use it like a brainstorming session in which only phrases are written with no comments first, then go back and ask for clarification of each point with further discussion. The points under "Needs to be improved" should be discussed with the aim of finding solutions.
- **Before and After Picture**: Give a large piece of paper to each person (or group). Ask them to divide the paper in half. On one side draw something that represents your life before the training, and another item which represents your life afterwards. After drawing both, ask each person to explain their drawing. The facilitator should record the explanations.
- **Fruit**: Give a piece of paper to each person and ask them to draw a fruit which represents their experience during the FFS process. Have each person explain their drawing and experience.
- **Piling Up**: On the ground or piece of paper, make drawings that represent various aspects of the program (field study, snacks, group activities, special topics, field days, etc.). Give each person many seeds, coins or some other item and ask them to pile them on top of each drawing. Put five if they felt the activity was useful to them, and none if not useful. After

all persons have put their seeds on the drawings, discuss why some have more than others, and how some points can be improved.

- **Changing Roles:** Another interesting method is to organize a formal discussion, but in which the facilitator sits in the group, and the group leader leads all discussions. The facilitator may speak, but only with the same rules as others in the group. The group leader may wish to ask each person to say something, facilitate one of the methods above, or other culturally appropriate method for that community. The basic idea is to take the facilitation away from the facilitator and give it to the group leader.

5. A few do not do's also:

- Do not use pictures (photographs or drawings).
- Do not assume the name of something is the same everywhere.
- Do not assume anyone knows the nationally accepted proper name.
- Do not use Latin names whenever local names are available.
- Do not assume your question is very clear (they never are!).

It is certain that many other methods can be used to assess the training. Recall that each group may have had a learning contract or the group may have had a list of learning objectives. These too can be used to assess the success of the training program.

7.2. Evaluation of training impact

Evaluation of the training impact is very difficult. One major problem is the time of impact. Does one season of change represent an impact? Or must the change or benefit occur for several years after the training to be considered a successful impact? In the case of IPM, how can we define an "IPM Farmer"? Sometimes I have the feeling that evaluators believe that IPM training is like getting a tattoo - something that can be easily seen and facilitators can say "Oh yes, we have one thousand and forty three IPM Farmers in this community. Just look at their tattoo." Seriously though, trying to measure impact is very difficult.

So far three major areas have been developed as indicators of impact;

- Economic benefits
- Environment and health benefits
- Community organization and self-funding

These of course are the main areas on which FFS focus training, and in the long run, are perhaps the major areas of interest to farmers. Below, each area is described in general. Here I only provide notes on factors to measure. The statistical analysis, sampling methods, etc. are not given because they will depend on local conditions. Long-term impact should be done with the assistance of experts in this area that can assist in designing studies and undertaking proper analysis. However, indicators of impact can be determined by community groups or facilitators if sufficient time is given for collecting data, and looking at basic statistics such as means, and variation.

1. Economic benefits are by far the most sought after measures of FFS impact by those that paid for the FFS. The investment in training is usually expected to produce some political good will, but moreover, should increase economic benefits to the farmer and community, and eventually the nation. The major factors to be measured are inputs such as pesticides, time and labor, fertilizer, water use and equipment. Outputs include rice yields and benefits from residual fertilizer, water, etc. Time is becoming a major issue in IPM because of increasing labor costs or alternative income available if less time is used. In many cases the time required for observation by an experienced farmer is very much less than the time to apply pesticides, and this in itself is a major benefit. Outputs minus inputs will give the financial benefit. Other benefits should also be considered such as higher rice prices for low or no spray crops that may be obtained with special labeling or improved soil fertility in cases where organic material is built up in the soil using IPM methods (green manure or compost). Such economic evaluations could be done on a seasonal or annual basis with IPM trained farmers to see long term impact.

2. Environment and health benefits may accrue with implementation of IPM. Less pesticides, and less toxic pesticides use is a common outcome of beginning field observation and IPM methods. Measuring these benefits is not easy, however, a few indicators may be used. For environment, the occurrence of more natural enemies, or other wild life may be considered. Also wild bird, fish, shrimp, and shell fish (clams, mussels, etc.) populations may be measured in the rice field, drainage ditches,

and estuaries in the area. Environmental indicators are most difficult because water flowing from sprayed areas to unsprayed areas carry pesticides and fertilizers thus reducing the benefits of IPM in the area. These indicators take many years to emerge and should correlated with changes in pesticide and fertilizer use in the area. Setting up the evaluation as a community activity, local school action, or academic thesis may provide the longer time series data required to measure these changes.

For health, immediate benefits can be measured by counting such indicators as lost work days, stomachaches, headaches, visits to local clinics for post-pesticide treatment ills, and other common illness related to pesticide exposure. A baseline should be made be measures before training at one season or more. It is important to separate crops: some farmers continue to spray heavily on some crops while reducing sprays on rice after a rice IPM FFS. Again setting up the evaluation as a community action, school project, or thesis research will provide sufficient data in a longer time series to draw some conclusions.

3. Community Organization and Self-Funding can also be evaluated, and is one of the important goals of organizing the FFS. Factors to measure include the frequency of meetings and participation, focus of the organization, activities actually implemented, and level of self-funding (or local funding). Community organizations may not continue to pursue IPM activities, but if the FFS group gets organized to take on other issues, then the impact of the FFS will be much greater. Follow-up activities are discussed in Chapter 6.

Conflicting factors to watch out for: Their are many factors which influence farmers and communities. The impact of training may be boosted by other inputs from other projects, neighbors, IPM-positive media campaigns, credit schemes, etc. Impact can also be altered by changes in pest complex, IPM-negative media campaigns, community pressure, etc. It is important to consider the impact of these other factors so that positive or negative change can be attributed to the correct source, if possible. The daily environment of a farmer is a flood of information and mis-information from extension, advertising, salesmen, media, and neighbors. One way to account for changes is to compare groups across sites and times. This method of group comparison is very dangerous because no group will be completely isolated or exposed to just one factor different (that's only in physics). Don't be too quick to reach conclusions about long-term impact without full consideration of other factors.

Annex 7.1. Quality Checklist

The following questions can be used to assist an observer in examining the quality of IPM training in all IPM training contexts. These questions identify the key points in a IPM activity that must be present if the quality of the process of training is to be maintained. While most of these questions can be answered by "yes" or "no", don't stop there. Explain why you answered "yes" or "no". This checklist can also be of used as an outline for reports on IPM training.

"What's this?"

1. Are questions answered by further probing or leading questions?
2. Do probing questions concern functional relationships in the agroecosystem?
3. Are participants able to define functional relationships in the agroecosystem?

Agroecosystem Activity

1. Before the activity begins are participants told the goal of the activity and the process to be followed in the activity?
2. During observation do participants get into the rice field?
3. Do participants look at all parts of the plant as part of their observation activity?
4. Do participants note down what they find?
5. Do participants collect specimens?
6. Are observations summarized in the agroecosystem drawings?
7. Does the leader pose problems, ask questions relevant to the drawings, or use the list of questions in the Field Guides to encourage participant analysis of the drawings?
8. Does discussion take place concerning field conditions?
9. Are "what if" scenarios posed by the leader and discussed by the participants?
10. Are previous weeks agroecosystem drawings used for comparisons to the situation this week?
11. Are field management decisions taken and critically examined before acceptance?
12. Are other factors considered in addition to the economic threshold in decision making around control issues? (Have farmers developed their own "intuition threshold"?)
13. Are participants active and working together in the small groups?
14. Can participants state the difference between pests and natural enemies?
15. Are decisions based on levels of insect populations and analysis of their functional relationships in the rice field?

16. Does the leader, by means of questions, help the participants to analyze the activity and what they have learned?

Special Topics

1. Before the activity does the leader explain the goal and process of the activity?
2. During the activity are participants involved and active?
3. Are group activities dominated by one individual?
4. Can participants present results stating or summarizing what has happened and why?
5. Can participants state what they have learned from the activity?
6. Does the leader ask open ended questions to: help participants examine what happened during the activity; generalize from the activity; apply what they learned to "real life"?

Group Dynamics

1. Before activity does the leader tell participants the goal and process of the activity?
2. Are all participants involved in the activity?
3. Does the leader ask open ended questions to: help participants examine what happened during the activity; generalize from the activity; apply what they learned to "real life"?

Ballot Box

1. Does the "ballot box" test field based knowledge?
2. "Ballot box" questions should not have Latin names, but are they still used?
3. Does the leader use the "ballot box" as a learning reinforcement tool by reviewing each item with the participants?

Annex 7-2: Self-Evaluation Matrix for Facilitators

Facilitation Skill	Poor	Good	Better
1. Preparation	None	Basics done	Extra prep.
2. Study site/Field	Hot/Uncomfort.	Comfortable.	Extra prep. (signs, promotion)
3. Objective	None stated	Stated	Stated but varied (questions, shares, tells story)
4. Time frame	None stated	Stated	Discussed with participants
5. Introduction	None stated	Stated	Stated but varied
6. Steps/procedure	Not clear	Clear & complete	Ask for restatement for complex steps
7. Moves from group to group when in small groups	None	Little	In depth discussion
8. Response to questions	Direct	Direct & question	Varied and may return to group (who can answer?)
9. Time management	None	Announces time	Checks, adjusts, provokes, pushes as necessary
10. Asks questions	None	Few	Provokes critical thought, participation, analysis, challenges
11. Discussion	None	Little	" "
12. Summary	None	Too brief	Varied style - does by self requested participant, etc.
13. Who's talking?	Self	Self and Farmer	Mostly participants
14. Ongoing evaluation	None	Some	Always using various styles - questions, graphics, restatement
15. Overall evaluation	None	Too Short	Varied: Informal, T chart, graphic, etc.
16. Next meeting organization	None	Announced	Follow-up contact before next meeting.
17. Snacks	None	Some	Sufficient to keep alive training process.
18. Enthusiasm	None	Some	Sufficient to keep alive training process.
19. Courage	None	Some	Sufficient to keep alive training process.
20. Politeness	None	Some	Sufficient to keep alive training process.
21. Motivational	None	Some	Sufficient to keep alive training process.