Rice IPM

Rice is one of the most important staple foods in the world. Over 50 percent of the world's population depends on rice for about 80 percent of their food requirements. About 95 percent of the global output of rice is produced and consumed in developing countries. (FAO, 2000)

There is no debate about the importance of rice in developing countries or in the projected future demands for more rice. What is questioned is how the world's farmers are going to increase their current annual production of 530 million tonnes to the expected need for over 700 million tonnes by the year 2025. This task is especially daunting considering that it will have to be done using less land, less water and less manpower.

Most will agree that intensification of production on already cultivated areas is the only solution but this has serious implications for protecting the long-term sustainability and productivity of existing rice land. A particularly critical concern is how best to protect crops from pest losses without adversely affecting the environment and the health of the organisms it supports.

Fortunately, over the past decade a tremendous amount has been learned about environmentally friendly, economically sound and sustainable pest management practices. These approaches are commonly referred to as Integrated Pest Management - using a range of management tactics to keep pests from destroying farmers' crops and livelihoods. IPM is now said to have matured and reflects a "*more sophisticated appreciation of the structure and dynamics of the paddy ecosystem*" (Matheson, 2000).

This course is designed to give participants just such a sophisticated appreciation of IPM in rice by giving them access to knowledge and information that will strengthen their capacity to give appropriate crop protection advice to rice farmers. It will also focus on ways that agricultural professionals can use to empower farmers by ensuring that they too have access to IPM information. The ultimate objective is to promote more sustainable rice production and higher productivity.

Course Objectives

Rice IPM is designed to improve participants' knowledge and skills related to IPM practices for rice production. It builds on the agLearn.net course entitled "Introduction to IPM" but focuses on specific IPM practices associated with rice cultivation. With the knowledge of rice IPM gained in this course, agricultural professionals will learn:

- How to grow a healthy rice crop and what needs to be done to prevent pests from becoming a problem.
- How to identify and understand the various organisms that make their homes in the rice agroecosystem as well as some of the other factors that impact the rice crop.
- The various management options that can be used to keep pests from causing economic losses.
- Strategies for empowering farmers with the knowledge and information they need to become IPM experts.

The course can be used as either a reference tool or as part of a structured learning exercise. A tremendous amount of information on rice is now available through the Internet and participants will find numerous links to these sources. Primary sources include the International Rice Research Institute (IRRI) - http://www.cgiar.org/irri - and the Food and Agriculture Organization of the United Nations (FAO) - http://www.fao.org.

Within this course we have tried to highlight various publications and tools developed by these two organizations as well as other publishers.

This course is designed to improve readers' knowledge of the principles and practices associated with Integrated Pest Management for cotton. It is anticipated that participants will have professional contacts with cotton farmers and are in a position to advise them on pest management strategies.

Modules

There are five modules in the Rice IPM course:

- Module 1 - Introduction
- Module 2 - Grow a healthy rice crop
- Module 3 - Observe Fields weekly
- Module 4 - Agroscosystem Management
- Module 5 - Unlocking Farmers' IPM Expertise

25F, Rasa Tower, 555 Phaholyothin Rd., Chatuchak, Bangkok, 10900. Thailand.
Telephone: **+66 2 937 0487** ; Fax: +66 2 937 0491
Home - Responsible Pesticide Use - Introduction to IPM - Cotton IPM - Rice IPM - Vegetable IPM - Soil Fertility Management - Contact Us

Module 2. The First Rule of Rice IPM – Grow a Healthy Crop

Module overview

Rule one is the foundation of all IPM programs and is particularly important for rice. So what is involved in observing this rule? Actually, it has very little to do with entomology or pathology but is based on practicing good crop management and following sound agronomic practices.

Growing a healthy crop is a season long process starting with land preparation and continuing through to harvest. Good crop management will result in the prevention of potential pest problems later on in the season. The most important management components include pre-planting land preparation, choosing suitable varieties, using clean disease free seed, seeding, controlling weeds and optimizing the nutritional and water status of the crop.

We will highlight each of these components in separate lessons in this module and supplement our discussion by directing you to visit selected Websites with relevant information. Many of these links are to ***TropRice*** – an information resource and decision making tool developed by the International Rice Research Institute (IRRI) which is available online at - http://www.knowledgebank.irri.org/troprice/. If you would like more information on IRRI and rice you may want to visit their main Website at – http://www.cgiar.org/irri. The Homepage of IRRI's Knowledge Bank is – http://www.knowledgebank.irri.org.

Lesson 2.1: Land Preparation

The aim of land preparation is two-fold: To place the soil in the best physical condition for plant establishment and crop growth and to ensure that the soil surface is left level. Contrary to what you might think, good land preparation may or may not involve actual tillage of the soil. Many farmers are finding that, in certain conditions, it is preferable to plant their rice seed directly on untilled soil. This practice is known as zero or minimum tillage and has the potential to reduce costs, raise productivity and result in environmental benefits. A major drawback of this system is that it is much more difficult to control weeds that grow along with the seeded rice.

More commonly, land preparation does involve tilling the soil. Tillage is most often done to a depth that will make it easy for the plant to develop a root system which will physically support the plant and also allow the extraction of sufficient moisture and nutrients so yield potentials can be realized. This is also a key management practice to control weeds in the early stages of the crop.

A key consideration, whatever method of soil preparation is used, is that the resulting soil surface should be as level as possible. Level fields improve water use efficiency and help to control weeds.

There is a lot of information available on land preparation for rice and participants should spend some time looking at the sites listed below. The first ones are from IRRI's ***TropRice*** (http://www.knowledgebank.irri.org/troprice/) decision support tool. Participants should access this site and browse the relevant sections under **Land Preparation** and **Land Leveling.** You may also use the shortcut links below to access these pages directly. Some additional sources of information are also listed and should be read.

IRRI's TropRice:

- Principles of Land Preparation - http://www.knowledgebank.irri.org/troprice/Principles_of_Land_Preparation.htm
- Principles of Zero-Tillage - http://www.knowledgebank.irri.org/troprice/Principles_of_Zero-Tillage.htm
- Why Level? Benefits and Principles - http://www.knowledgebank.irri.org/troprice/Why_Level__Benefits_and_Principles.htm
- Considerations in Leveling - http://www.knowledgebank.irri.org/troprice/Considerations_in_Leveling.htm
- Tillage Practices to Maintain a Level Field - http://www.knowledgebank.irri.org/troprice/Tillage_Practices_to_Maintain_a_Level_Field_.htm

Other sources:

- Land Preparation -http://www.philrice.gov.ph/prorice/land_prep.htm
- New Tillage Practices for South Asia -http://www.rwc-prism.cgiar.org/new/docs/posters/Tillage%20Benefits.pdf
- Missouri Rice Tillage Systems Compared - http://agebb.missouri.edu/rice/ricetill.htm

Lesson 2.2: Rice Varieties

Farmers can generally choose from a range of rice varieties. Some of these are locally developed over many years and, through this process, are ideally suited to their environments and are quite tolerant of local pests and other stresses. Quite often these local varieties are of high quality and command a premium in the market place. Unfortunately, local varieties tend to be lower yielding than the high yielding varieties (HYVs) that have been developed by plant breeders working in national and international research programs.

A key characteristic of varieties in relation to IPM is something known as host plant resistance. This refers to the variety's ability to resist or tolerate pest attacks without sacrificing yield or requiring any other interventions. If a plant has resistance to pests and diseases, the need for cultural, biological and chemical plant protection is reduced or even eliminated. Although scientists' efforts to develop varieties with ever increasing yield potential often means that natural resistance is reduced, there are a number of HYVs with both high yield potential and resistance to pests. Many modern varieties have multiple resistance to a range of insects and diseases.

Resistant varieties are one important part of an integrated pest management program for rice for several seasons (Heong, 2001):

- They do not increase farmers' costs.
- They limit damage at all levels of pest population throughout the season.
- They require less pesticide than susceptible varieties do.
- They can be integrated effectively with other control methods in a pest management program.

For additional information on rice varieties and host plant resistance we invite interested participants to browse the following sites:

- Worlds planted rice varieties - http://www.fao.org/ag/AGP/AGPC/doc/riceinfo/plantvar/intro.htm
- PSB Rc Rice Varieties - http://www.philrice.gov.ph/variety/variety.htm
- IRRI Rice Varieties Table - http://www.knowledgebank.irri.org/troprice/IRRI_Rice_Varieties_Table.htm
- Promising varieties for rice production in West Africa - http://www.fao.org/ag/AGP/AGPC/doc/riceinfo/wapvar.htm
- High Yielding Rice Varieties (India) -http://web.aces.uiuc.edu/aim/diglib/india/Rice_HYVs.html
- Internet Resources on Plant Resistance to Pests - http://www.ippc.orst.edu/cicp/tactics/crop_resistance.htm
- Host Plant Resistance and Conservation of Genetic Diversity - http://ipmworld.umn.edu/chapters/eigenbr.htm

Lesson 2.2.1: Genetically Engineered Rice

A lot of current breeding and research work to come up with better varieties is now focused on genetic engineering. This is a promising technology that has the potential to speed up the process and even provide types of resistance which could not be developed by a conventional breeding program. Most early engineering efforts have focused on implanting a gene from a different species which produces chemicals toxic to pest or disease pathogens. More recent work has involved the addition of genes that enhance the plant's nutritional characteristics or give it resistance to abiotic stresses like drought or salinity.

While this approach to varietal development may offer some exciting potential benefits, particularly for IPM, it is not universally accepted as a good thing. In this course we do not take a position on the advisability of using genetically engineered plants as part of an IPM program but we would like participants to examine the currently available evidence and discuss this matter among themselves. Hopefully you will have selected this as one of the topics in the course discussion series.

For additional information on a few select rice biotech efforts, here are some sites to get you started. Looking forward to seeing your comments about these on the discussion board.

- Genetic Engineering of Rice: Contribution to Sustainable Agriculture? - http://www.twnside.org.sg/title/rice-cn.htm
- "A Promising Debut for Bt Hybrid Rice" - http://www.biotech-info.net/promising_debut.html
- Rice, IRRI, and Corporate Earnings - http://www.poptel.org.uk/panap/archives/larice.htm
- What is Golden Rice? - http://www.knowledgebank.irri.org/knowledgeBytes/goldenRice/default.htm
- Golden Rice – A Golden Chance for the Underdeveloped World - http://www.fumento.com/goldenrice.html
- 'Golden Rice' and Vitamin A Deficiency - http://www.foe.org/safefood/rice.html

- Tough new rice strain created using bacteria genes - http://www.lifesciencesnetwork.com/news-detail.asp?newsID=2911
- GM rice can tough it out - http://news.bbc.co.uk/1/hi/sci/tech/2512195.stm

Lesson 2.3: Clean seed

It has consistently been proven that using good quality clean rice seed can result in yield increases in the order of 5-20%. This is really not so hard to understand. If seeds contain disease pathogens before they are planted, plants are unhealthy from the start. If weed seeds are planted along with the rice it increases the weed population and decreases yields because the weeds compete for resources. If seeds are selected from unhealthy or non-vigorous plants, the resulting crop will tend to also exhibit these properties. Fully mature, good quality and healthy seeds are more vigorous and have a much better capacity to overcome adverse conditions in early stage of plant growth. Seeds should have a germination rate of more than 80%.

Seed can contain a range of contaminants including disease pathogens, insects, soil and other plant matter. Seeds can be discolored, already germinated, broken, moldy or deformed. Any of these conditions can result in yield losses and contribute to pest problems.

Clean seeds are characterized by being (Mew, 1999):

- Pure
- Full and uniform in size
- Free of weeds, insects, disease and other matter
- Viable

Planting clean seed is a key practice in IPM and in observing the first rule of IPM. Some farmers have access to quality commercial certified or good seed and, if so, this is a good way to ensure that clean seeds are planted. For those farmers without access to commercial seed or who prefer to produce their own, procedures for cleaning seeds are relatively easy and often results in an equally good or even better product. Producing clean seed involves the following steps (Mew, 1999):

1. Select a healthy part of the field for seed production
2. Keep seed field weed free
3. Rogue off-types during the growing season (pull and discard plants that are obviously different in terms of height, maturity, or flowering time)
4. Rogue diseased plants (pull and discard unhealthy, non-vigorous plants or plants with discolored panicles)
5. Winnow, clean or grade seed (to produce full, plump seed of uniform weight and size, to remove partially filled or empty grains and other light weight contaminants)
6. Dry seed to a moisture content between12 and 14%.
7. Store in a sealed clean container in a dry, cool clean area

In some areas it may be advisable to treat seeds to rid them of pests and diseases or to ensure that they have access to needed micronutrients. Treating with a fungicide is the most common. Growers should consult their local agricultural advisors or ask other farmers for their recommendations on this.

Here are a few links to sites with more information on clean seed, seed biodiversity and treating seed:

- Increasing yields through clean seed (slide show from *TropRice*)- http://www.knowledgebank.irri.org/troprice/seedQuality/sq1.htm
- Testing Seed Germination - http://www.mrs.umn.edu/pyg/tips/soil_planting/tip_618.shtml
- Seed germination testing - http://www.training.irri.org/courseware/online/hybridrice/Germination%20testing.htm
- Evaluation of seed health of some rice varieties under different conditions - http://ejournal.sinica.edu.tw/bbas/content/2000/4/bot414-06.html
- Seed treatment study guide - http://ag.utah.gov/plantind/sg_seed.pdf
- Got zinc?: Seed treatment offers another avenue to provide crop with critical micronutrient - http://www.ricefarming.com/home/archive/zincseed.htm
- Seed sense: strengthening crop biodiversity through targeted seed interventions - http://www.icrisat.org/gene_horizon/seed.htm

Lesson 2.4: Seeding (Crop Establishment)

Farmers have developed a range of seeding practices to suit their circumstances. Traditionally, crop establishment for wetland rice involves establishing a nursery or seedbed where plants are raised to a certain age (normally 25-30 days) before they are transplanted into the main production fields. Transplanting is usually done by hand and is quite labor intensive but various manufacturers have developed mechanical transplanters that claim to do a good job.

Transplanting gives a uniform stand and is a very good way to help to control weeds.

More and more, however, farmers are switching to direct seeding, either dry direct seeding (on dry plowed land) or wet direct seeding (on flooded leveled fields). This switch has been driven by the decreasing availability of on farm labor and the associated increase in labor costs. Unfortunately, direct seeding results in other problems. Weeds are a much more serious problem in direct seeded rice. Direct seeding requires better land leveling and water management and planting depth is critical. Plant too deep and plants will not emerge or will be weak. Plant too shallow and seeds will be eaten by birds or rats and the mature plants will be more susceptible to lodging.

Whatever seeding method used, it is advisable to perform a final cleaning process on rice seed before sowing. This involves (Mew, 1999):

- Soaking and rinsing seed in a container of water
- Stirring for 3 minutes
- Allowing light seed to float to surface
- Removing and discarding floating seed
- Draining the water and drying the remaining seeds (this is best done just prior to seeding to avoid needing to re-dry the grain)

IRRI's ***TropRice*** (http://www.knowledgebank.irri.org/troprice/) contains detailed recommendation for crop establishment for different seeding methods. Participants should access this decision support tool and browse the relevant sections under **Crop Establishment** to learn more about the recommendations associated with their local predominant crop establish practices. You may also use the shortcut links below to access these pages directly.

IRRI's TropRice:

- Principles of Crop Establishment - http://www.knowledgebank.irri.org/troprice/Principles.htm
- Wet Direct Seeded - http://www.knowledgebank.irri.org/troprice/Crop_Establishment_-_Wet_Direct_Seeded_.htm
- Dry Direct Seeded - http://www.knowledgebank.irri.org/troprice/Crop_Establishment_-_Dry_Direct_Seeded.htm
- Transplanted - http://www.knowledgebank.irri.org/troprice/Transplanted_.htm
- Factors affecting crop uniformity - http://www.knowledgebank.irri.org/troprice/Factors_affecting_crop_uniformity_.htm
- Replanting (Filling gaps) - http://www.knowledgebank.irri.org/troprice/Replanting_(Filling_gaps)_.htm
- Wet/Dry Direct Seeding Comparison - http://www.knowledgebank.irri.org/troprice/Wet_Dry_Direct_Seeding_Comparison.htm
- Target Plant Stands - http://www.knowledgebank.irri.org/troprice/Target_plant_stands.htm
- Seed Rate - http://www.knowledgebank.irri.org/troprice/Seed_Rate.htm

Other sources:

- CROP ESTABLISHMENT (Sri Lanka)- http://www.agridept.gov.lk/Techinformations/Rice/Ri_esta.htm

Lesson 2.5: Water Management

Rice is typically produced on submerged soils. Soil submergence maintains soil organic matter and favors long-term sustainability of the nutrient-supplying capacity of soil. Water requirements for a successful rice crop varies with the method of land preparation, method of crop establishment and duration of the rice crop. It also varies with the soil, environmental conditions and the management of the subsequent rice crop. As rice is a semi aquatic plant, it does not need standing water to grow successfully. However, as water supply is usually uncertain and standing water is a very good way to reduce weed infestation, most farmers prefer to cultivate rice in continuously flooded fields. Standing water also helps to provide nitrogen from free living bacteria.

The response of the rice plant to water stress varies with its growth stage and other agronomic practices. Direct sown rice is less prone to drought than a transplanted crop. Highest water use is during the preparation of land, thus land preparation with minimum timing and maximum use of rain water at the correct time of the season is recommended.

Water is lost through evaporation (E) from free water surface, transpiration (T) from the crop, seepage and percolation down through the soil, bund leakages and runoff from the field. Many of these factors, particularly bund leakages and runoff from the field, can and should be managed to avoid water loss. Evapotranspiration is another source of water loss and is determined mainly by the vapor pressure deficit and the canopy size which is beyond the control of a farmer. Given these factors, the main determinants of water requirement (WR) are

evapotranspiration, seepage and percolation (S & P) rates. These can be summarized as follows.

WR = E + T + (S + P)

Water loss through ET, S & P should be supplemented by either natural means such as rain, and seepage from adjoining plots or through irrigation. If an average of 5 mm of water is lost per day by ET, and about 3 - 6 mm/day by seepage and percolation from poorly drained and well drained soils respectively, a total of 8 to 11 mm of water is lost per day from a low land rice field. In this case, if irrigation water could be supplied to a depth of about 7.5 cm per issue, irrigation frequency could be maintained at 7 to 10 days intervals. When initial water height in the field is lower, more frequent irrigation is needed. To conserve water, many farmers choose to keep the crop without standing water for short periods between irrigations. However, if soil moisture level drops below field capacity for an extended period there is a possibility that the soil will form cracks. Soil cracking should be prevented to reduce percolation during subsequent irrigation.

For additional information on water management in rice we have listed several good sites. The first group is again from IRRI's ***TropRice*** (http://www.knowledgebank.irri.org/troprice/) decision support tool. Students should access this tool and the information it contains and visit the items under **Water Management** or use the shortcuts below. Other sites are also listed.

IRRI's TropRice:

- Principles of Water Management - http://www.knowledgebank.irri.org/troprice/PrinciplesWaterMgmt.htm
- Water Requirements - http://www.knowledgebank.irri.org/troprice/Water_Requirements.htm
- Early Season Field Drainage - http://www.knowledgebank.irri.org/troprice/Early_Season_Field_Drainage_.htm
- Water Quality - Critical Values - http://www.knowledgebank.irri.org/troprice/Water_Quality_-_Critical_Values_.htm

Other sources:

- Water Management - http://www.philrice.gov.ph/prorice/water_mgnt.htm
- A scientific approach for water management in rice fields - http://www.icid.org/ws3_2002.pdf
- Sustainable soil and water management of irrigated rice ecosystems - http://www.ciat.cgiar.org/inrm/workshop2001/docs/titles/2-2BPapertRBuresh.pdf
- Water Management in Rice in Asia - http://www.fao.org/DOCREP/004/AB982E/ab982e08.htm
- Water Stress Effects, Water Management Systems and Irrigation Requirements for rice in Sri Lanka - http://www.agridept.gov.lk/Techinformations/Rice/Ri_wat.htm

Lesson 2.6: Nutrient Management

Nutrient management is critical to ensure a healthy crop and fully observe rule 1 – Grow a healthy crop. The key factor to remember when thinking about how to best manage the nutrition of a rice crop is that the crop must be provided **with optimum levels of nutrients** and these must be available to the crop **at the time they are most required**.

Rice cultivation removes a significant amount of needed nutrients as grain and often as straw removed from the field at harvest (see Table 1 below for some figures). If these nutrients are not replaced, subsequent crops will not be healthy.

Table 1. Nutrient removal by a rice crop

Nutrient	Content (%)		Removal (kg) - 5t/ha (grain) crop		Total removal (kg/ha)
	Straw	Grain	Straw	Grain	
N	0.74	1.26	37	63	100
P	0.10	0.26	5	13	18
K	1.81	0.32	90	16	106

Si	5.00	1.70	250	85	335

http://www.fadinap.org/ipns/srilanka/ipnsmanual/chap4sec1.PDF

It is also important to consider balance as research has shown that the availability of various nutrients affects the others. For example, farmers tend to concentrate on nitrogen applications as this is the element most widely deficient and initial applications tend to produce large yield increases. However, this practice is a major cause of soil nutrient depletion in rice fields. De Datta (1985) showed that the application of 174 kg of N to a farmer's field increased the rice yield by a factor of 2.9, but increased the removal of P, K and S by factors of 2.6, 3.7 and 4.6, respectively (Mutert, 1995). Table 2 below provides details.

Table 2. Nutrient removal with and without N application

aglearn.net - AMOUNT OF NUTRIENTS REMOVED BY CROP HARVEST (KG/HA)

Nutrient element	Without fertilizer			With 174 kg N/ha		
	Straw	Grain	Total	Straw	Grain	Total
N	18	34	52	75	143	218
P_2O_5	2	10	12	5	26	31
K_2O	59	10	69	232	26	258
S	0.8	1.0	1.8	3.3	4.9	8.2
	Yield (mt/ha)			Yield (mt/ha)		
Grain	3.4			9.8		
Straw	2.8			8.2		

Research has also shown that when nutrients are applied also has a big effect on yields. It is very important that nutrients are available when they are most needed. If applied at times when needs are not great, expensive nutrients may be wasted. If not available when needed, yield is lost.

We hope you all will take the time to visit IRRI's ***TropRice*** site (http://www.knowledgebank.irri.org/troprice/) and read through the pages under **Nutrient Management**. There you will find detailed fertilizer recommendations for all major nutrients by season, cropping system, maturity class and variety.

Below are shortcuts to important pages.

- Principles of Nutrient Management - http://www.knowledgebank.irri.org/troprice/Principles_of_Nutrient_Management.htm
- Estimating Nutrient Requirements - http://www.knowledgebank.irri.org/troprice/Estimating_Nutrient_Requirements.htm
- Calculating a Nutrient Management Scheme - http://www.knowledgebank.irri.org/troprice/Calculating_a_Nutrient_Management_Scheme_.htm
- N Split - http://www.knowledgebank.irri.org/troprice/N_Split.htm
- K Split - http://www.knowledgebank.irri.org/troprice/K_Split.htm
- Phosphorous and Potassium - http://www.knowledgebank.irri.org/troprice/Phosphorous_and_Potassium.htm
- Zinc and Sulphur - http://www.knowledgebank.irri.org/troprice/Zinc_and_Sulphur.htm
- Examples of fertilizer management based on Variety maturity class - http://www.knowledgebank.irri.org/troprice/Examples_of_fertilizer_management_based_on_Variety_maturity_class.htm
- Fertilizer Recovery - http://www.knowledgebank.irri.org/troprice/Fertilizer_Recovery.htm
- Fertilizer Sources - What's Best? - http://www.knowledgebank.irri.org/troprice/Fertilizer_Sources_-_What_s_Best_.htm
- Fertilizer Content - http://www.knowledgebank.irri.org/troprice/Fertilizer_Content.htm
- Nutrient Conversions - http://www.knowledgebank.irri.org/troprice/Nutrient_Conversions.htm

Lesson 2.7: Importance of Organic Fertilizer

While many farmers try to provide needed nutrients through the application of only inorganic fertilizers, current research is increasingly showing the value of organic fertilizers – particularly bulk organic fertilizers like farm yard manure, compost or crop residues. Bulk organic fertilizers are known to have a strong positive effect on the chemical, microbiological and physical properties of soil. A key concept for IPM is that soils with high levels of organic matter have greatly improved microbial activity. This results in making soil nutrients more readily available to the plants and is also the foundation for a healthy agroecosystem. Soil organic matter is the starting point for energy cycles that ultimately support high populations of natural enemies. There is some recent evidence showing that rice fields with low levels of organic matter suffer from lower natural enemy populations and more frequent pest outbreaks (FAO, 2001).

(FAO, 2001).

While the importance of bulk organic fertilizer cannot be denied there are some associated factors to consider. Farmers tend to prefer inorganic fertilizers because of their convenience and their almost immediate effect on yield. The effect of organic fertilizer on crop yield is long term and requires the acquisition, transportation and application of tons of organic material. For example, it has been shown that changing the soil organic matter (SOM) of soil by one percent by weight will require approximately 20 tons of organic material (the recommended ideal SOM in soil is 5% by volume). A farmer's socio-economic and cultural conditions will also have considerable influence on how much organic matter he or she can or will apply.

Using one source or another exclusively is not recommended. Much research has shown that neither inorganic fertilizers nor organic sources alone can result in soils with sustainable productivity under highly intensive cropping systems. This has led many experts to recommend the application of a combination of inorganic and organic fertilizers and this practice is widely recognized as a way of increasing farm yield, sustaining or improving productivity of the soil and ensuring a health crop. Inorganic fertilizers supply the basic chemical nutrients (N,P,K, etc.) and bulk organic fertilizers improve the soil, make nutrients more available to the crop and increase biological activity.

Again we would like you to visit some key informational sites and we have listed these below. The IRRI ***TropRice*** (http://www.knowledgebank.irri.org/troprice/) sites are found under **Nutrient Management>> Organic and Inorganic Fertilizers** or you may prefer to use the shortcuts below.

IRRI's TropRice:

- Organic Sources – Principles - http://www.knowledgebank.irri.org/troprice/Principles_of_organic_sources_of_nutrients.htm
- Organic Sources – Advantages - http://www.knowledgebank.irri.org/troprice/Advantages.htm
- Organic Sources – Difficulties - http://www.knowledgebank.irri.org/troprice/Difficulties.htm

Other sources:

- Soil Biota and Biodiversity: the "Root" of Sustainable Agriculture - http://www.fao.org/ag/AGL/agll/soilbiod/docs/SB-brochure-sept.pdf
- Effect of organic resources management on soil biodiversity and crop performance under semi-arid conditions in West Africa - http://www.icrisat.org/gene_horizon/effect.htm

If you are still interested in learning more about nutrient management after going through the above sites here is some supplementary reading:

- Plant nutrient balances in the Asian and Pacific regions: The consequences for agricultural production - http://www.agnet.org/library/article/eb415.html#eb415t2
- Integrated Plant Nutrition Systems - http://www.fadinap.org/ipns/srilanka/ipnsmanual/toc.htm
- Nutrient Management - http://www.philrice.gov.ph/prorice/nutrient_m.htm
- Database on commercially available organic fertilizers and water-retaining products - http://www.fao.org/WAICENT/FAOINFO/AGRICULT/AGL/agll/orgfert/default.htm
- Fertilizing Rice - http://agebb.missouri.edu/rice/ricefert.htm
- Integrated Nutrient Management in Rice - http://www.indiaagronet.com/indiaagronet/Technology_Upd/contents/integrated_nutrient_management_i.htm

Lesson 2.8: Straw Management

Farmers manage straw in many ways – removal, burning, piled or spread on the soil surface, incorporated into the soil or used as mulch. Each of these practices has a very different effect on the soil's nutrient balance and soil fertility and the most appropriate choice will depend on many factors.

However, given the previously discussed key role of organic matter in maintaining a healthy crop, the generally preferred way to manage straw is to get it back in the soil. Incorporated rice straw and stubble improve soil texture and tilth, improve drainage, and store nutrients in an available form for the next crop. Straw is a good source of organic material and is often the only one readily available in significant quantities to most rice farmers. About 40 percent of the nitrogen (N), 30 to 35 percent of the phosphorus (P), 80 to 85 percent of the potassium (K), and 40 to 50 percent of the sulfur (S) taken up by rice remains in vegetative plant parts at crop maturity (Dobermann & Fairhurst, 2002) and it is a shame to waste this.

Nutrient balance is also strongly affected by straw management. Straw contains more than 85

percent of the potassium (K) contained in the above-ground biomass. Thus, much greater amounts of K must be applied to maintain the soil supply where straw is removed from the field. Removal of N and P is mostly associated with grain harvest.

Refer to Table 1 to illustrate this concept.

Here are a few sites you should have a look at to improve your knowledge of straw management.

- Rice Straw Management - http://www.ppi-far.org/ppiweb/bcropint.nsf/$webindex/FB3AD2851347BE1F85256BDC0072F3B5/$file/BCI-RICEp07.pdf
- Organic Sources - Straw Management - http://www.knowledgebank.irri.org/troprice/Effects_of_Straw_Management.htm
- Rice Straw Management Today & Tomorrow - http://agronomy.ucdavis.edu/uccerice/STRAW/incorp.htm
- Straw management - http://www.ricejournal.com/backissues/february2001/story3.asp
- Straw management - http://www.buttecounty.net/BIFSinRice/incorporation.htm

Module 3. The Second Rule of Rice IPM - Observe Fields Weekly

Module overview

It has been proven consistently that the most successful farmers, and the ones with the least amount of pest problems, share two characteristics.

- They have a good understanding of the biological processes that determine the health of the crop agroecosystem and their crops.
- They spend a significant amount of time in their fields observing their crops and the various organisms that make their home there.

These characteristics are what rule 2 is all about - observing the crop frequently and accurately, being able to identify the various organisms observed and knowing something about these organisms' biology and ecology. Key considerations are being able to tell friend from foe and in knowing how friends and foes interact.

Although you will be asked to look through and become familiar with a great deal of material in this module you shouldn't find it particularly difficult. Most of the information here is really just reference that you may find useful in future IPM activities you may be involved in or in answering questions that may be put to you.

Lesson 3.1: Scouting

Farmers, and agricultural professionals, must understand and become familiar with the natural processes going on in the crop and the organisms present in the rice ecosystem in order to make good judgments on whether to take action, when and how. Periodic **scouting** (looking carefully and systematically at the crop) gives farmers the kind of information needed before deciding whether actions are necessary and what kinds of actions will have the most success. The purpose of scouting is to determine whether and which pests are present and if the application of a pest management procedure is justified. Scouting is also beneficial to determine whether nutrient deficiencies, soil compaction or other disorders are affecting crop health.

Scouting should be carried out each week or more frequently. It means walking through the crop and stopping 10 - 20 times to examine the leaves/stems/panicles for pests, disease and nutrient deficiency symptoms and natural enemies. The numbers and types of organisms (pests, parasites, predators, weeds) and disease should be noted as well as any abnormalities like discolorations or yellowing. On the basis of this information and a consideration of the time of the year, stage of growth of the crop, and weather conditions, an experienced grower can predict population trends and potential damage based on an understanding of such processes as plant compensation, fertilizer effect, and plant development.

Based on the information collected each week, the grower thinks about (predicts) current and potential economic losses and chooses the most economic management practice (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.). After all, the ultimate goal of IPM is to improve the decision-making skills of the grower for better production and profits.

A well-designed scouting program includes three main activities:

1. Sampling to provide an accurate estimate of pest densities and crop health.
2. Identification of pests or diagnosis of the cause of crop injury based on observable symptoms.
3. Comparison of observed pest pressure or crop injury to an assessment of the most likely outcome if nothing is done.

It is not practical to observe every plant within the field, so fields are **sampled** to estimate the level of infestation. The challenge of sampling is to balance the accuracy of estimates with the time and labor required to collect the samples. Although the reliability of estimates increases as sample size increases (up to a point), the collection of too large a sample is costly and inefficient and it wastes human resources.

Lesson 3.1.1: Scouting Forms

Some growers and IPM practitioners find it useful to use a form to record their observations. For more information on scouting, including a suggested scouting form, you should access the following article.

- Introduction to crop scouting - http://muextension.missouri.edu/explorepdf/agguides/pests/IPM1006.pdf

IRRI has also published a good scouting form for rice in its newly developed ***RiceDoctor*** tool. To access this click on the following link:

- Field Observations - http://www.knowledgebank.irri.org/RiceDoctor_MX/Process/fieldObservation.htm

We'll be talking more about ***RiceDoctor*** later but if you want to check it out now just go to IRRI's Rice Knowledge Bank site at - http://www.knowledgebank.irri.org/ and find and click on **[Rice Doctor].**

Lesson 3.2: Rice Growth Stages

An important skill in scouting and sampling, and later on in determining what to do about pests, is to be able to recognize the growth stage of the crop. Some pests are only dangerous at particular stages in a plant's growth. Some management practices are only effective when done at a particular stage.

For rice, most people recognize 9 stages starting from the germination of the seed to a plant that has produced mature grain. The stages of growth and development of a rice plant are listed below:

Vegetative Stage

0. Germination

1. Seedling

2. Tillering

Reproductive Stage

3. Stem elongation

4. Panicle initiation to booting

5. Heading

6. Flowering

Mature grain stage

7. Milky grain stage

8. Dough grain stage

9. Mature grain

Participants should visit the following sites if they would like to learn more about rice growth stages.

- Growth Stages of the Rice Plant (MSU) - http://msucares.com/pubs/publications/pub1624.htm
- Growth Stages of the Rice Plant (IRRI slide show) - http://www.training.irri.org/courseware/online/growthstages/

Lesson 3.3: Identification and Diagnosis

IPM practitioners are sometimes compared with medical doctors. Like them, a person practicing IPM must first diagnose health problems before deciding on the best treatment. Perhaps the most important skill in diagnosis is being able to identify the specific pest causing the problem. In IPM, an important part in pest identification is to also be able to identify beneficial organisms. Various studies have shown that many farmers (and also many agricultural professionals?) are not good at pest identification and know little about pest biology and behavior. In rice pest management, if farmers cannot distinguish between pests and friends, they will be likely to control anything, whether helpful or a genuine pest. As we discussed earlier, killing of beneficial organisms in the rice ecosystem can have disastrous results.

So how to make a correct identification? The traditional source of information is the local extension office which should have field identification guides for local common pests and diseases. Sometimes such guides are also available at universities or colleges and more and more this kind of information is available through the Internet.

In the following lessons you will find links that will take you to Websites that contain tips on how to identify the weeds, insects, diseases and nutrient deficiencies you may find through your scouting activities. Many of them also contain supplementary information on these

your scouting activities. Many of them also contain supplementary information on these organisms' ecology and behavior.

Lesson 3.3.1: Identification of Weeds

- Major Weeds of Rice in the Tropics (click on the name to the weed for pictures) - http://www.knowledgebank.irri.org/troprice/Major_Weeds_of_Rice_in_the_Tropics_.htm
- Weed Photo ID Guide - http://www.ricefarming.com/home/2002PestGuide/2001weedguide.asp
- Weeds - http://www.lsuagcenter.com/Subjects/rice/RiceWeeds.html

Lesson 3.3.2: Identification of Insects

Pests

- Pests and When They are Important - http://www.knowledgebank.irri.org/troprice/Pests_and_When_They_are_Important.htm
- Damage Symptoms and Likely Pests Involved - http://www.knowledgebank.irri.org/troprice/Damage_Symptoms_and_Likely_Pests_Involved_.htm
- IPM Levels (insect pests) - http://www.knowledgebank.irri.org/troprice/IPM_Levels.htm

Beneficials

- Predators - http://www.knowledgebank.irri.org/troprice/Predators.htm
- Parasites - http://www.knowledgebank.irri.org/troprice/Parasites.htm
- Pathogens - http://www.knowledgebank.irri.org/troprice/Pathogens.htm
- Most Commonly Seen Beneficials - http://www.knowledgebank.irri.org/troprice/Most_Commonly_Seen_Beneficials.htm
- Major Pests and the Most Important Beneficials - http://www.knowledgebank.irri.org/troprice/Major_Pests_and_the_Most_Important_Beneficials.htm
- Predators Often Confused with Pests - http://www.knowledgebank.irri.org/troprice/Predators_Often_Confused_with_Pests.htm

Other sources:

- Insect Photo ID Guide - http://www.ricefarming.com/home/2002PestGuide/2001insectguide.asp
- Rice Insects - http://www.lsuagcenter.com/Subjects/rice/RiceInsects.htm

Lesson 3.3.3: Identification of Diseases

- Common Diseases and their Symptoms (click on the disease name for additional information and pictures)-http://www.knowledgebank.irri.org/troprice/Common_Diseases_and_their_Symptoms.htm
- Disease Photo ID Guide - http://www.ricefarming.com/home/2002PestGuide/2001diseaseguide.asp
- Rice Diseases - http://www.lsuagcenter.com/Subjects/rice/RiceDiseases.htm
- Common Names of Plant Diseases: Diseases of Rice (*Oryza sativa* L.) - http://www.apsnet.org/online/common/names/rice.asp

Lesson 3.3.4: Identification of Nutrient Deficiencies

- Major Plant Symptoms of Nutrient Deficiencies (click on the nutrient's name for more information and pictures) - http://www.knowledgebank.irri.org/troprice/Plant_Symptoms_of_Nutrient_Deficiencies_.htm

Just an additional note on this. Diagnosing nutrient deficiencies is relatively more difficult that identifying pests as doing so involves looking primarily at symptoms and not at identifiable organisms. Farmers have traditionally relied on their ability to correlate various symptoms with probable causes. Leaf color is one of the key points they observe and some new tools are now available to strengthen this skill. A relatively expensive option is to use a SPAD (**s**oil **p**lant **a**nalysis **d**evelopment) meter. This is a small handheld device that measures the greenness of leaves. The readings of color by this machine are highly correlated with relative chlorophyll content and nitrogen status. A simpler (and more affordable alternative) that provides similar information is the Leaf Color Chart (LCC).

Here are some sites with more information on these tools.

- SPAD Meter - http://www.knowledgebank.irri.org/troprice/SPAD_Meter.htm
- Adaptation of the chlorophyll meter (SPAD) technology for real-time N management in rice: a review - http://www.irri.org/IRRN25-1Minireview.pdf
- Leaf and Color Chart (LCC) - http://www.knowledgebank.irri.org/troprice/Leaf_and_Color_Chart_(LCC).htm

- Using the Leaf Color Chart (LCC)
  http://www.knowledgebank.irri.org/knowledgeBytes/lcc/default.htm

Lesson 3.3.5: Identification of Rat, Bird and Snail Damage

- Rice Field Rats -
  http://www.knowledgebank.irri.org/RiceDoctor_MX/Fact_Sheets/Pests/Rice_Field_Rats.htm
- Birds -
  http://www.knowledgebank.irri.org/RiceDoctor_MX/Fact_Sheets/Pests/Birds.htm
- Snails -
  http://www.knowledgebank.irri.org/RiceDoctor_MX/Fact_Sheets/Pests/Snails.htm

Module 4: The Third Rule of Rice IPM - Agroecosystem Management

Module Overview

If we were strictly following FAO's IPM rules this module would only focus on the conservation of natural enemies. However, as we explained in the first module, we have taken a broader interpretation of this rule. In this module we will therefore talk about a wider range of management practices that growers can implement to actively manage the rice agroecosystem. Good agroecosystem management can minimize pest damage from insect pests as well as the many other pests affecting rice. On the following pages we will spend some time on practices that can be employed to actively manage weeds, insects, diseases and non-insect pests like snails, rats and birds. We won't spend any time on nutrient management as we feel that this has been covered in enough detail in previous lessons.

Lesson 4.1: Weed Management

Effective weed management depends on the integrated use of a range of practices. It has been shown that, even when farmers are using herbicides, these are not nearly as effective (or economical) unless care has been taken in land preparation and the farmer uses water control to manage weeds. No one weed control method is likely to control all weeds, and in the long term this can lead to a build-up of certain species. It is highly recommended to use direct weed control methods (herbicides or hand weeding) with indirect methods (land preparation, flooding, growing a competitive crop).

Weed control in rice, particularly the shift towards herbicide use, is another fairly controversial subject in rice IPM. While the shift is easily understood from the farmer's perspective (lower costs, unavailability of labor) not everyone agrees that herbicides are the answer. Critics point to environmental and health risks as well as the potential for herbicide resistant weeks.

Below are links to a number of sites with information on actively managing weeds.

IRRI's TropRice:

- Principles of Weed Management - http://www.knowledgebank.irri.org/troprice/Principles_of_Weed_Management.htm
- Cultural Practices - http://www.knowledgebank.irri.org/troprice/Cultural_Practices.htm
- Herbicide Effect on Sedges - http://www.knowledgebank.irri.org/troprice/Herbicide_Effect_on_Sedges.htm
- Herbicide Effect on Grasses - http://www.knowledgebank.irri.org/troprice/Herbicide_Effect_on_Grasses.htm
- Herbicide Effect on Broadleaf Weeds - http://www.knowledgebank.irri.org/troprice/Herbicide_Effect_on_Broadleaf_Weeds.htm

Other sources:

- Rice Integrated Weed Management - http://axp.ipm.ucdavis.edu/PMG/r682700111.html
- Weed Management in Small Holder Rice Production in the Tropics - http://ipmworld.umn.edu/chapters/johnson.htm
- Weed management in wet-seeded rice in tropical Asia - http://www.agnet.org/library/abstract/eb364.html

Lesson 4.2: Insect Pest Management

It was stated early in this course that one of the key concepts in Rice IPM is that insect pests are rarely a problem in a well managed and healthy rice agroecosystem. In most cases, if insect problems develop, it is because something has been done to reduce natural enemy populations. If pests do reach dangerous levels or damage starts to become severe farmers may turn to insecticides.

Key concepts to keep in mind when thinking about managing insect pests is that the best approach is usually to do nothing and that much of the insect damage observed will not affect yields. For example, studies have shown that no yield loss was detected even when 60% of leaves were damaged by whorl maggots. Japonica rice at tillering stage can compensate for as much as 67% of leaffolder damaged leaves.

For additional information on insect pest management participants should visit the sites listed below.

IRRI's TropRice:

- Principles of Insect Management - http://www.knowledgebank.irri.org/troprice/Principles_of_Insect_Management.htm
- List of Insecticides and Pests Reportedly Controlled -

http://www.knowledgebank.irri.org/troprice/List_of_Insecticides_and_Pests_Controlled_.htm
- IPM Levels - http://www.knowledgebank.irri.org/troprice/IPM_Levels.htm

Other sources:

- Managing tropical rice pests through conservation of generalist natural enemies and alternative prey - http://communityipm.org/docs/Ecol_settle.pdf
- Management of Rice Insect Pests - http://ipmworld.umn.edu/chapters/heinrich.htm
- Insect Pest Management in Tropical Asian Irrigated Rice - http://ento.annualreviews.org/cgi/content/full/45/1/549?ijkey=Y2krsyzMLm/RI&keytype=ref&siteid=arjournals
- Insect Management (Philippines) - http://www.philrice.gov.ph/prorice/insectmgmt.htm

Lesson 4.3: Natural Enemy Management

Conserving natural enemies is one of the foundations of FAO's approach. Based on their work in Asia, the members of FAO's IPM program were convinced that this was the most important limitation of traditional pest control strategies. They also felt that IPM concentrated on insect pests was a useful entry point for a broader approach to IPM.

Numerous studies and experience have since shown that conserving natural enemies is of tremendous importance in the safe and economical management of insect pests and doing so has to be a major component of a grower's management activities. In simple terms this involves:

- Minimizing the application of broad spectrum chemical and natural pesticides
- Allowing some pests to live in the field which will serve as food or host for natural enemies
- Establishing a diverse cropping system (e.g. mixed cropping)
- Including host plants providing food or shelter for natural enemies

Here is a list of some additional specific practices that have shown some success in helping to keep beneficial insect populations high.

- **Dust suppression**: some studies have shown that dusty conditions prevent many predators from being effective as dust interferes with their searching ability. Some of the steps that can be taken to manage dust include leaving groundcover vegetation and the planning of windbreaks. In rural areas oiling or paving roads has been shown to be effective.
- **Host/prey inoculation**: Host/prey insects can be inoculated into a field when the host is scarce.
- **Alternate hosts/prey**: Alternate hosts or prey have also been supplied to natural enemies.
- **Non-host foods**: Pollen and nectar or food sprays are most commonly involved but living sources of non-host foods can be other crops or non-crop plants. Some rice farmers have had success with Water chestnut, *Eleocharis* sp., can be planted in rice paddies to maintain populations of *Tetrastichus schoenobii* Ferriere (Hymenoptera: Eulophidae), an important parasite of the rice pest *Tryporyza incertulus* (Walker).
- **Intercropping**: A summary of intercropping studies (Andow 1986) found that herbivore populations were reduced in 56% of the cases examined. . In general, it is believed that intercropping reduces the advantages an herbivore gains in extensive monocultures and provides alternate resources for natural enemies, e.g. pollen as a food prior to host availability.
- **Sequential cropping**: It is also possible in some cases to plant crops sequentially to gain the advantage of maintaining food sources for natural enemies.
- **Food sprays**: Some growers have had success with spraying fields with a carbohydrate source (sugar or honey) or a protein and carbohydrate source (sugar or honey, plus yeast or casein hydrolyzate). In conservation, the food sprays serve primarily as arrestants, retaining the natural enemies in area, hopefully until the pest population begins to increase.
- **Refugia**: Hedgerows, windbreaks and other areas with perennial vegetation can harbor beneficials species that do not migrate long distances. Trees with grass around them are often best. These are most effective on small acreages because the natural enemies must disperse from the refugia. Thus, its impact will be less important on large farms than on small farms.
- **Cardboard wrapped trees**: Some studies have shown that banding trees with corrugated cardboard make good refugia. Such strips have been found to harbor large numbers of predaceous mites and insects and it was observed that 90% of the residents were entomophagous.

Here are a number of Websites you should visit with more information on conserving natural enemies.

- Recognize and Conserve Natural Enemies - http://sepaipm.cas.psu.edu/factsheets/chl-8.htm
- Biological Control: Utilizing Living Organisms to Control Living Organisms

- Biological Control: Utilizing Living Organisms to Control Living Organisms - http://www.mortonarb.org/plantinfo/plantclinic/phc/biological-control.PDF
- Beyond the Gene Horizon: sustaining agricultural productivity and enhancing livelihoods through optimization of crop and crop-associated biodiversity with emphasis on semi-arid tropical agroecosystems (workshop proceedings) - http://www.icrisat.org/gene_horizon/index.htm#i
- Vegetational diversity, arthropod response, and pest management - http://www.icrisat.org/gene_horizon/vegetational.htm
- Managing tropical rice pests through conservation of generalist natural enemies and alternative prey - http://www.communityipm.org/docs/Ecol_settle.pdf
- Conservation of Natural Enemies for Biological Control - http://www.agls.uidaho.edu/ent547biocontrol/Handouts/Conservation%20of%20Natural%20Enemies%20for%20Biological%20Control.doc

Lesson 4.4: Disease Management

The most effective strategy for disease management in rice involves actions before planting and trying to prevent disease problems from occurring in the first place. Once the rice is planted and infected there is usually not much that can be done. We've already talked about the importance of using resistant varieties and planting such varieties is probably the most important action to make. It is also important to be aware that resistance can "break down". If a grower notices serious infections on a variety that has been disease free for some years it is probably a good idea to switch to another resistant variety.

Infected seed is one of the main ways that diseases are spread and become established in fields and clean and high-quality seed with resistance to locally known diseases should be used as a first step in rice IPM of diseases. Farmers who do not have access to commercial seed sources should follow the practices outlined in the Clean Seed lesson of this course

Diversification (varietal mixture, varietal rotation, varietal deployment, crop rotation) has been shown to be particularly effective in managing some diseases and slowing the capacity of the pathogen to adapt to the resistance of the rice plant. For example, farmers in Yunnan province in China were able to reduce rice blast by 94% by interplanting one row of the incidence of a susceptible glutinous variety every four or six rows of the more resistant commercial variety. Intercropping and diversification work because a more disease-resistant crop, interplanted with a susceptible crop, can act as a physical barrier to the spread of disease spores. Multiple varieties in the field will tend to result in a more diverse array of pathogen populations, possibly resulting in induced resistance and a complex interaction that prevents the dominance of a single virulent strain of the pathogen. It has also been suggested that interplanting changes the microclimate, which may be less favourable to the pathogen.

Once the disease is detected it is important to remove and destroy any diseased plants seen. Pulling and deep burial is one approach used during the cropping season. At harvest, crop residues of infected fields should be plowed under and/or burned. Many farmers have success in breaking a disease cycle by growing a different crop for a season but this may not be feasible for all farmers.

Correct and balanced fertilization has also been shown to help prevent serious disease outbreaks.

Here are the sites that participants should visit for more detailed information on disease management in rice.

IRRI's TropRice:

- Principles of Disease Effects and Management - http://www.knowledgebank.irri.org/troprice/Principles_of_Disease_Effects_and_Management.htm
- Control Options - http://www.knowledgebank.irri.org/troprice/Control_Options.htm
- Products Commonly Used - http://www.knowledgebank.irri.org/troprice/What_to_Use.htm

Other sources:

- http://aes.missouri.edu/delta/muguide/ricdis.stm

Lesson 4.5: Management of Other Pests (Snails, Rats and Birds)

In addition to the pests already covered, there are many more. Rats and other rodents are very destructive in many areas. The golden apple snail is fast becoming a major pest throughout Asia and birds are a common pest. We will try to cover these on the next pages but unfortunately cannot cover some of the more localized pests like crabs, earthworms and crayfish that are also recognized as rice pests for various reasons. If your farmers are facing problems with a pest not covered please try to research the various management options yourself and share what you have learned.

Lesson 4.5.1: Rats

Ask any rice farmer and you will soon learn that rats are one of the most serious pests of rice and also that they are extremely difficult to control. As in the control of insect pests

and also that they are extremely difficult to control. As in the control of insect pests, conservation of natural enemies is perhaps the most efficient approach. Unfortunately, the best natural enemy of rats are snakes and many farmers are reluctant to encourage large snake populations. Another good natural enemy is barn owls and encouraging owl populations has shown some encouraging results in Malaysia.

After natural enemies, a system of using traps-and-barriers with plastic has also achieved good results in rice fields but is not attractive for all farmers for a variety of reasons. Reasons for non-adoption include cost and maintenance requirements and in some countries, the traps and materials are very attractive to thieves and tend to disappear.

Beyond the strategies outlined above, the only examples of successful rat management involve the active participation of an entire community, preferably focused at the early season vegetative stage. Unfortunately organizing communities is a difficult task in itself at any time of the year.

Main community management practices include rat drives, baiting, digging, burning (flamethowers) and sanitation. All are effective if implemented on at least the level of a village. The most effective strategy seems to consist of determining the main species of rat present in order to ensure that baits are appropriate and then developing community-level mapping methods to plan and carry out continuous trapping along feeding routes, fumigation or digging of rat holes, modification of appropriate habitat and establishing early season bait stations using second-generation anticoagulant baits. First generation bait poisons like Zinc phosphide are no longer recommended. For one thing they are very dangerous to humans and livestock and they have been shown to be less effective in rat management because rats tend to eat too little of the poison to cause death. This leads to bait-shyness and poor control.

Here's one more interesting approach that you might want to evaluate. It is said to be practiced by farmers in Indonesia and is a new twist on the natural enemy approach. Farmers there evidently believe that a "cannibal rat" will keep other rats away from a rice field. Here is their recipe for making a cannibal rat.

- 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.
- Wait until there is only one rat left in the bucket. Keep water in the bottom for drinking.
- When only one rat is left, add one more rat and wait until there is only one rat left.
- Release the one remaining cannibal rat. It is claimed that other rats in the area will run away.

Additional sources:

- Rodent Management - http://pasture.ecn.purdue.edu/~schildre/health/pests/pest_rmgt.htm
- Rodent research publications - http://www.cse.csiro.au/research/VFP/rodents/rodent_pubs.htm
- Ridding rice of rats - http://www.cse.csiro.au/research/Program4/community_ecology/rodents/Ridding-Rice-of-Rats.pdf
- To catch a rat...- http://www.new-agri.co.uk/02-3/focuson/focuson2.html
- Pythons and parasites - http://www.new-agri.co.uk/02-3/focuson/focuson4.html
- A better rat trap - clean and safe - http://www.irri.org/irrc/Rodents/Reducing.asp
- Advances in IPM Rodent Control in Agriculture - http://www.sustdev.org/agriculture/articles/edition1/01.135.pdf

Lesson 4.5.2: Snails

The main mollusk pest of rice is the golden apple snail (GAS - *Pomacea canaliculata* (Lamarck)). This species originated in South America but was introduced into Asia in a misguided attempt to provide additional income and food to poor farmers. It has since found its way into Asia's rice fields and is a serious and growing problem throughout the region.

What makes this pest particularly difficult to manage is that is has virtually no natural enemies in its new home and is very mobile in its early stages. When small it is easily carried by the flow of irrigation water and spreads rapidly throughout communities.

There are several control measures recommended against the golden apple snail. One recommended management practice for irrigated rice is to place mesh screens at water inlets. This helps to reduce the numbers of snails entering the field with irrigation water. If populations are not too high and labor is not a constraint, many farmers get acceptable levels of control by hand picking or crushing. Farmers can sometimes take advantage of the habit of the Golden Apple Snail to lay eggs on wooden posts inserted in the rice field. When posts are full of egg masses (but before they hatch) simply remove the stakes and destroy the attached eggs. Some other practices include planting older seedlings and periodically draining the field and letting it dry. Draining fields that have several shallow ditches where the snails congregate allows for faster collection and facilitates herding ducks in fields to eat the snails.

Perhaps the most promising approach to snail management involves the use of some unusual natural enemies. Herding ducks through the rice field seems to be particularly effective but some farmers are also having success with fish. Humans make particularly good natural enemies if the incentive is high enough. In Viet Nam, snails provide a valuable and inexpensive source of food for fish farms. Farmers collect, chop, cook and feed so many snails that, in many areas, snail populations are on the decline.

Molluscicides such as metaldehyde should only be used when all else fails.

Additional information sources:

- Fish-farming in Vietnamese rice fields fights golden apple snail pest - http://www.fao.org/news/1998/980410-e.htm
- Snail Damage to Rice Plants - http://www.ricecrc.org/reader/damage1.htm
- The IRRI "Salaan" Snail and Egg Collector - http://www.irri.org/Aed/aedsal.html
- Snail, Rat, Earthworm, and Bird Management - http://www.philrice.gov.ph/prorice/sreb_mgnt.htm

Lesson 4.5.3: Birds

Birds are known to be very damaging to rice and another difficult pest to manage. In some areas farmers use large nets to catch birds and then either sell them for a profit or eat them themselves. Some farmers in Asia also use fine mesh nets to protect their crops by spreading them over the crop canopy. Many farmers use a variety of methods to scare birds including shouting, throwing dirt clods, sound cannons and scarecrows. Reflective ribbons or used video or cassette tapes strung among the plants is reported to be a particularly effective way to scare birds an some success has been reported with using owl or hawk models. However, these scare tactics are not usually effective for long unless backed up by people moving about the fields and contributing to the effort. Some success has also been reported in destroying nesting habitats but this may not be a very good approach unless farmers are sure that they are only managing the nesting of pest species.

Module 5. The Fourth Rule of Rice IPM - Unlocking Farmers' IPM Expertise

Module overview

You must be aware by now that an awful lot is known about IPM for rice. We know the rules, we know the underlying concepts, we know the organisms and we know the management practices needed to effectively manage pests in the rice ecosystem. Unfortunately, **we** does not necessarily include the billions of farmers in developing countries who desperately need to know these things as well. The real challenge in IPM is to develop and implement cost-effective farmer education and knowledge dissemination programs that give farmers the knowledge and skills they need to become IPM experts. If this doesn't happen, all the knowledge that **we** possess is worthless.

A key goal for IPM is to empower farmers and give them the knowledge and skills they need to be confident managers and decision-makers, eager for new ideasand information and able to evaluate the information they receive and adapt it to local circumstances. Sadly, achieving this goal has been elusive.

In this module we will focus on Rule 4: Unlock farmers' IPM expertise. What can you as an agricultural professional do to empower farmers and improve their abilities to make sound crop and pest management decisions based on their personalcircumstances and the ecological balance in their fields. We will present some traditional and innovative approaches that are being implemented and evaluated around the world. You will notice that many of these draw heavily on social science expertise and the incorporation of techniques developed in other fields of endeavor such as commercial advertising, participatory nonformal education, and community organizing.

Lesson 5.1: Farmer Support and Empowerment Approaches

Government, non-government, development agency and private farmer education efforts have been using a range of techniques over the years. Much of this is what has traditionally been known as **Agricultural Extension** - essentially a means of introducing new knowledge and ideas into rural areas in order to bring about change and improve the lives of farmers and their families. Extension is a process that occurs over a period of time and, through educational activities, works with rural people, supports them and empowers them to confront their problems more successfully.

In the promotion of IPM, some of the most recent success stories have come from strategic extension campaigns, farmer field schools, and now, community IPM approaches. Traditional Extension approaches can also be used and, more and more, development professionals are looking at ways to use modern information and communication technologies (ICTs) to facilitate rural access to knowledge and information.

Lesson 5.1.1: Strategic Extension Campaigns

Strategic extension campaigns (SECs) use mass media convey research findings and recommendations in a simplified form in order to motivate attitude change. SECs have been shown to achieve rapid impact because they reach large numbers of farmers in an area all at once, including remote locations normally not visited by extension trainers. One of the most effective SECs used to promote IPM practice is IRRI's "Forty Days" SEC. Forty Days SECs are being fielded in several countries in order to reduce unnecessary insecticide use in early-season rice. Their main objective is to rectify farmers' mistaken belief that leaf-feeding insects, particularly leaffolders, cause severe yield loss. This belief leads them to apply insecticides during the early stages of the crop even though they are not necessary. These applications may even trigger outbreaks of BPH and other secondary pests.

Additional references on SECs

- Strategic Extension Campaign: Increasing Cost-Effectiveness and Farmers' Participation in Applying Agricultural Technologies - http://www.fao.org/sd/EXdirect/EXan0003.htm
- Strategic extension campaign - A participatory-oriented method of agricultural extension- http://www.fao.org/docrep/u8955e/u8955e00.htm#Contents

Lesson 5.1.2: Farmer Field Schools

The IPM Field School is a field based programme that provides learning experiences usually for groups of up to 25 farmers. The Field School lasts for a full cropping season and meets at least 12 times for about four to five hours per meeting. At each meeting, farmers are guided through several activities: agroecosystem field observation, analysis and presentations; special topics; and group dynamics. Participants are given the opportunity to observe and analyse the

dynamics of the rice field ecology across a full season. Schools are based on FAO's four IPM implementation principles previously discussed:

1. Grow a healthy crop.
2. Observe fields weekly.
3. Conserve natural enemies.
4. Farmers are IPM experts.

Lesson 5.1.3: Community IPM

Community IPM takes the farmer field school approach to a broader level and attempts to empower farm communities to organize and implement their own IPM activities. Instead of using trained facilitators to teach farmer field schools, farmer leaders become the main instigators of IPM training and promotion. Farmer groups are encouraged to analyze problems, design field studies and carry out experiments.

For additional information on IPM training you might want to also check out these sites.

- Understanding natural enemies; a review of training and information in the practical use of biological control - http://pest.cabweb.org/PDF/BNI/Control/BNIRA44.PDF
- From pest control to ecosystem management: how IPM training can help - http://www.eseap.cipotato.org/MF-ESEAP/FI-Library/97-ICEA.pdf

Lesson 5.2: Traditional Extension Techniques

Although the Training and Visit system of Extension has largely been discredited as an effective way to promote IPM, good ideas can be found by looking at some of the tried and true Extension methodologies developed over the years. Below are links to two excellent resource sites with extensive information on various Extension methods and Extension training.

- Improving agricultural extension. A reference manual - http://www.fao.org/docrep/W5830E/W5830E00.htm
- Guide to extension training - http://www.fao.org/docrep/T0060E/T0060E00.htm

Lesson 5.3: Information and Communication Technologies

A major problem rural populations have traditionally faced has been their inability to access needed information and knowledge. This has been the driving force behind both traditional Extension activities as well as the newer, more participatory approaches like the farmer field school and Community IPM programme.

But now, with the explosion of new information services, even remote areas in many developing countries are able to take advantage of global information sources. Information and Communication Technologies (ICTs) are increasingly proving their value in addressing the information and knowledge needs of rural people. While reaching farmers with these tools is still not widespread, they are being successfully used to deliver information to and from intermediary information providers such as universities, government offices, telecenters, NGOs and libraries.

25F, Rasa Tower, 555 Phaholyothin Rd., Chatuchak, Bangkok, 10900. Thailand.
Telephone: +66 2 937 0487 ; Fax: +66 2 937 0491