Control of rice insect pests

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Overview

This course is composed of four modules concerning:

I. The Basics of Cultural Control of Rice Insect Pests
II. Single Field Cultural Control Practices
III. Community-Wide Cultural Control Practices
IV. Cultural Control Options Against Specific Insect Pests

Goals:
Upon completion of this course the user will:

I. Learn about cultural practices that affect rice insect pest populations.
II. Understand advantages and disadvantages of cultural control practices.
III. Explore different types of cultural control practices and the scale of adoption needed to derive benefit.
IV. Differentiate between cultural practices needed at the single field level vs. those requiring community-wide adoption.
V. Identify cultural control practices that can be adopted against specific pests.

Basics of Cultural Control of Rice Insect Pests

Lesson 1 - Definition of cultural control

Objective	Define cultural control, and understand its advantages and disadvantages, and scale of adoption required to derive benefit.

Cultural control is the modification of production practices to make the environment less favorable for pest invasion, reproduction, survival and dispersal. Its aim is to achieve reductions in pest numbers.

Most of the traditional agronomic practices have a dual purpose of crop production and pest suppression. Rice establishment through transplanting of seedlings is a good example, which effectively suppresses weeds and reduces the incidence of seedling pests. Farmers have developed these practices through observation and trial and error. These crop production practices are transferred from generation to generation, usually consisting of farm-based technology with little dependence on outside resources.

Modification of any crop production practice ultimately affects yield through complex interactions with the crop and environment. All crop production practices affect insect pest populations either positively or negatively. A single practice such as plant spacing or time of planting may produce opposite effects on different pest species. Often they counterbalance one another. The use of low fertilizer rates or draining the fields is highly effective in suppressing certain insect pests, but may result is lower yield.

The development of cultural control methods requires a thorough knowledge of the life history and habitats of the insect and its plant host. Farmers must decide which cultural practices are best for their location, such as direct seeding or transplanting seedlings in a wetland environment.

Lesson 2 - Advantages and disadvantages of cultural control

Objective	List the advantages and disadvantages of cultural control practices.

Advantages:

- Most cultural control practices are inexpensive or use resources available to farmers, such as labor or indigenous materials.
- Adoption of pests against a cultural control practice appears to be a much slower process than that of pesticides and resistant host plants.
- Cultural control practices are generally free from environmental pollution.
- Most cultural control practices are compatible with other pest management practices.

Disadvantages:

- Most methods suppress populations of some pests but can increase some others.
- Some practices decreases pests but also decreases yield.
- Many practices require community-wide adoption, which may be difficult to achieve.

Lesson 3 - Types of cultural control

Objective	Characterize two types of cultural control methods.

Cultural control practices can be characterized as **primary** and **secondary** cultural control:

Primary cultural control – Primary cultural control practices are those adopted specifically to control insect pests. Examples of primary cultural control practices include a) draining a rice field to suppress brown plant hopper populations and b) transplanting older seedlings to minimize whorl maggot damage.

Secondary cultural control – Secondary cultural control practices are those that are accomplished for crop husbandry such as land preparation, weeding, and fertilization. These practices can also minimize insect pest buildups. Examples of secondary cultural control practices include a) plowing to prepare the soil for planting while, at the same time, turning under the stubble which harbors stem borers and b) splitting nitrogenous fertilizer applications to increase nitrogen use efficiency while minimizing brown plant hopper population build-up.

Lesson 4 - Adoption scales of cultural control

Objective	Understand the balance of good vs. poor agronomic practice in assisting the adoption of cultural control practices by farmers.

When cultural control practices double as desirable agronomic practices, the farmers usually adopt them readily. However, when the cultural control practices are poor agronomic practices, adoption can be difficult. Some cultural practices offer direct benefits to the farmer if carried out at the farm level. However, some others require community-wide action to be effective. Depending on the scale of adoption required to derive pest suppression benefits, important **cultural control practices are divided into two categories:**

- Single field cultural practices
- Community-wide cultural practices

Single field cultural practices	Community-wide cultural practices
• Planting method • Seedling age • Pruning • Plant density • Crop background • Water management , and • Fertilizer management	• Crop rotation • Crop area • Rice cropping frequency • Plant maturity • Planting time • Synchronous planting/ flowering • Flooding stubble • Trap crop • Tillage • Weed control • Harvest methods • Straw and stubble destruction • Ratooning

Single Field Cultural Control Practices

Overview - Single Field Cultural Control Practices

Objective	Name the cultural control practices that are effective at the single field or farm level adoption.

Some cultural insect control practices offer direct benefits to the farmer if carried out at the single field or farm level. The following are several single field cultural control practices that are discussed in this course. You may access information on any of the practices by clicking the links below, or by selecting the appropriate links from the navigation bar on the right. Single field cultural control practices include:

1. Planting methods
2. Seedling age
3. Pruning
4. Plant density
5. Crop background
6. Water management
7. Fertilizer management

Planting Methods

Direct seeding onto dry or non-flooded soil is not advantageous to aquatic pests such as the rice water weevil. Dry seedbeds or dry fields do not attract rice caseworms and whorl maggots. Direct seeded rice suffers less stem borer damage than transplanted crops.

Transplanting into flooded fields suppresses dry land adapted pests such as white grubs, root aphids, termites, mole cricket, ants, and others.

A seedbed offers certain advantages for crop protection. Use of a seedbed confines the crop to a small area where weeds can be removed easily by hand and insects can be removed by hand or sweep nets. The seedbed can also be covered with netting or plastic to protect it from vector insects, birds and rats. The longer the seedlings remain in the seedbed, the less time there is for vegetative stage pests such as the whorl maggot. Delayed transplanting is another management tactic to control vector-transmitted diseases as delayed infection reduces severity.

Seedling Age

Transplanting older seedlings reduces their time in the field which has an effect on the population buildup of pests that prefer or only attack during the vegetative stage. Use of older seedlings reduces damage from caseworms and whorl maggots and may help to avoid one generation of stem borers and brown planthoppers. Transplanting 21-day-old seedlings produces the highest yield. However, there is only minimal loss if up to 45-day-old seedlings are used and transplanted at higher numbers of seedlings per hill (3-4/hill).

Pruning

Clipping the tops of bundled tall seedlings prevents lodging and removes stem borer and hispa eggs, if present. This practice is not commonly used with modern rice varieties.

During the wet season, removal of the top third of a standing crop at the vegetative stage can remove leaf folders and stem borer egg masses, hispa eggs and grubs, and thrips.

During the vegetative stage, good hispa control can be achieved by clipping three-fourths of the leaves from severely infested fields that contain rice hispa eggs and grubs and burying the leaves in the soil.

Plant Density

The effect of plant density on insect pest abundance is varied and complex. Dense plantings change crop growth, development, and microclimate, which in turn has an effect on pests and their natural enemies. Sparse planting encourages weeds and indirectly has an effect on insect abundance. Low tiller numbers per unit area can result in a higher percentage of tillers damaged by stem borers.

On the other hand, closely spaced plants shade each other, making rice plants more vulnerable to brown planthopper due to increased humidity, greater plant surface area for oviposition, and less crowded feeding conditions. A field with a 10 x 10 cm hill spacing has greater chances of suffering hopperburn than a field with a 20 x 20 hill spacing. Dense planting increases populations of planthoppers, leafhoppers, leaffolders, gall midges, black bugs, and caseworms while whorl maggots, root aphids, root weevils and leaf beetles may become less abundant.

Crop Background

By covering the paddy water surface with Azolla (water fern) during the early vegetative stage, the incidence of whorl maggot is reduced. Such covering of paddy water is also suitable for natural enemies, especially predators, in assisting their movement from hill to hill in search of prey.

Water Management

Pests such as whorl maggots, root feeding midges, water weevils, caseworms, and others are suppressed when fields are drained for 1 or 2 days. This is mainly due to the effect that water absence has on their respiration.

The draining of fields is a common practice to suppress planthoppers and armyworms. Alternate flooding and draining, if carried out for 5-7 days, can minimize some semi-aquatic insect pests such as black bugs, planthoppers, gall midge, hispa, and most stem borers. Draining rice fields can reduce the threat of hopperburn. Draining stimulates calcium uptake, which hardens plant tissues and makes them more resistant to pests. However, draining may also stimulate weed growth. Frequency of action is important because alternative flooding and draining can cause high losses of nitrogen.

Pests adapted to dry land—such as armyworms, grasshoppers, thrips, ants, white grubs, mole crickets, root aphids, termites, root weevils, and seedling maggots—are highly vulnerable to flooding.

Fertilizer Management

High rates of **nitrogen** fertilizer will provide more plant nutrition, resulting in higher yield. However, high nitrogen fertilizer rates also:

- increase weed populations in the current and subsequent crops
- increase the incidence of fungal and bacterial diseases by increasing tissue susceptibility and tiller density and
- encourage the multiplication of brown planthopper, leaffolders, stem borers, leafhoppers, gall midge, armyworm, root weevil and leaf beetles. Under high nitrogen fertilizer conditions, insects generally grow larger, cause more damage, produce more offspring, grow faster, and complete more generations per crop.

The beneficial effect of nitrogen on plant growth outweighs the pest-controlling effects of entirely omitting its use. However, splitting the application, using sensible amounts, and using slow release forms (such as sulfur coated urea and urea super granules) helps to meet the dual goal of higher yields and lower pest incidence. On the other hand, thrips and whorl maggots become less abundant if nitrogenous fertilizer is applied.

Phosphorous tends to increase abundance of stem borers, but to a lesser degree than nitrogen. Phosphorous is important in root development, which allows the crop to tolerate weevil damage to its roots.

Potassium

- suppresses many insect pests—such as the whorl maggot, green leafhopper, yellow stem borer, brown planthopper, thrips, and leaffolder—by lowering the level of plant sugars and amino acids
- increases production of allelochemicals, thickening the cell wall and increasing the amount of silica uptake. Silica hardens the rice stem making the crop resistant to feeding by stem borer larva.

In summary, sensible and balanced used of fertilizers is important for insect pest management and higher yields.

Community-Wide Cultural Control Practices

Overview - Community-Wide Cultural Control Practices

Objective	Understand the cultural control practices that are effective only when practiced at a community level.

There are many cultural practices that may contribute to controlling pests but only if practiced on a community-wide scale. To reduce the effect of insect pest immigration from adjacent areas, community-wide measures are effective only if carried out over an area of 50 ha or more.

The following are several community-wide cultural control practices that are discussed in this course. You may access information on any of the practices by clicking the links below, or by selecting the appropriate links from the navigation bar on the right.

1. Crop rotation
2. Crop area
3. Rice cropping frequency
4. Plant maturity
5. Planting time
6. Synchronous planting/flowering
7. Trap crop
8. Flooding stubble
9. Tillage
10. Weed control
11. Harvest methods
12. Straw and stubble destruction
13. Ratooning

Crop Rotation

As a method of insect pest control, breaking the rice cycle with other crops works best against species with limited host range, limited dispersal powers, and long life cycles. Rotating rice with a non-rice crop removes the pests' food source and reverses their population buildup. This method is effective against pests for which rice is the preferred host. Crop rotation is advocated to control gall midge, stem borers, white grubs, termites, planthoppers, seed bugs, and armyworms. Rotation must be practiced in synchronized plantings over a wide area, and should include a non-rice crop outside the grass family.

Crop Area

Most insect pests undergo aerial dispersal in their life cycle. However, some have a limited ability to locate a rice crop. The larger the area of rice grown, the greater the chance of dispersing insects as they descend on the crop. Larger crop areas are said to favor stem borers and brown plant hoppers. Studies show that continuously cropped rice gardens of less than a few ha escape some insect pest buildup. This is based on findings from corporate ventures of several hundred ha in the Solomon Islands and the southern Philippine island of Mindanao that succumb to increasing pest pressure.

It must be noted that the opposite may also happen. Rice areas that were decreased in Japan had an increase of green leafhoppers as grassy fallows favored its survival over winter. Dry season rice crops in small blocks, such as those found scattered along the coastal belt of Bangladesh, suffer severe damage from yellow stem borer due to the concentration of moths emerging from the huge diapausing area. However, polyphagous mobile pests are least affected by the amount of crop area.

Rice Cropping Frequency

The number of crops grown per year has a profound effect on insect pest abundance. The number of generations per year of monophagous insect pests increases with an increase in number of rice crops per year.

A dry season fallow, typical of rice growing areas in tropics, lowers pest incidence. Irrigated rice cropping in the dry season extends the availability of rice. Continuous cropping throughout the year allows exponential insect population growth and has been reported to increase abundance of whorl maggot, leaffolders, black bug, leafhoppers, planthoppers, thrips, and stem borers. Pests that are particularly favored are those that develop during all crop growth stages and are monophagous, such as the brown planthopper, green leafhopper, yellow stem borer, and gall midge.

On the other hand, continuous rice also sustains natural enemies and behaves as in perennial crops, which favors natural enemies. Their populations are sustained year-round because only a fraction at a time of their habitats are destroyed through cultural practices such as tillage, harvest, and flooding. Such situations always provide refuge for the natural enemies.

Plant Maturity

The early maturing cultivars have a shorter field duration, which limits the number of generations of the pests occurring on each crop. Since insect numbers increase exponentially with each generation, shortening crop maturation by only two weeks can have a profound effect on pest numbers and crop loss.

Early harvest has a negative impact on stem borers, armyworms, gall midge, leaffolders, white grubs, leafhoppers and plant hoppers. These insects colonize at the vegetative stage and can develop over succeeding growth stages. The use of early maturing varieties is effective if planted after a rice-free period, such as that induced by winter or dry season.

In general, early maturing cultivars are low yielding but provide greater flexibility for shifting planting times in an effort to avoid seasonal pest incidence. It must be noted that the shortened vegetative stage of early maturing varieties limits their capacity to compensate for pest damage.

Planting Time

Shifting the planting time is to the disadvantage of the pest, which is vulnerable to air or water temperature extremes, heavy rainfall, non-preferred crop growth stage, and an abundance of natural enemies. Both early and late plantings may miss peak abundance of the damaging pest stage. The effect of shifting the rice crop's planting time is highly site-specific.

Early planting may minimize gall midge, thrips, grasshoppers, leaf beetles, stem borers, root weevils, leafhoppers, planthoppers, seed bugs, and whorl maggots in some areas. Late planting can minimize the incidence of seedling maggots, leaffolders, armyworms, white grubs, root aphids and leaf miners in some areas.

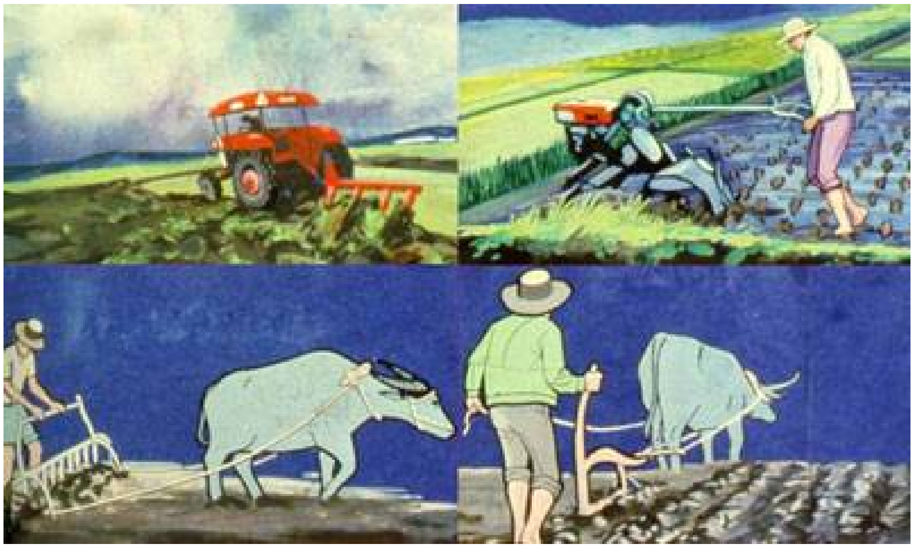
Shifting planting times has little effect in an asynchronous planting area. Shifting the planting date may reduce the number of crops that can be grown per year. An effective use of planting time is to strategically time area-wide rice plantings after a dry season. Delayed planting practiced in Java (Indonesia) in the 1920s and 1930s after the dry season (after the emergence of yellow and white stem borers from diapause) reduced borer problems.

On the other hand, timely planting with the onset of monsoon rains can allow the crop to pass the early growth stage before pests can colonize it. Shifting planting times also results in growing the crop under different weather conditions.

Synchronous Planting/Flowering

Insects readily disperse from field to field. They can maintain high population levels and cause great losses in farm communities where planting times of neighboring fields are staggered beyond an interval of 3 to 4 weeks (the generation time of most pests). Staggered planting ensures greater survival of rice pests throughout the year by extending the temporal availability of the host plant. However, asynchrony also maximizes populations of natural enemies.

On the other hand, monophagous pests are most affected by synchronous planting. Synchronous planting and the creation of a rice-free period of at least one month between successive rice crops can greatly reduce pest abundance. If synchronous planting is impractical in large rice-growing areas, the whole area can be divided into 3 to 5 kilometers in diameter blocks (beyond the effective dispersal range of most pests). Adjacent blocks should be out of phase with each other by about 3 to 4 weeks. Synchronous planting is advocated for management of planthoppers, leafhoppers, stem borers, gall midge, leaf beetles, caseworms, and root weevils.



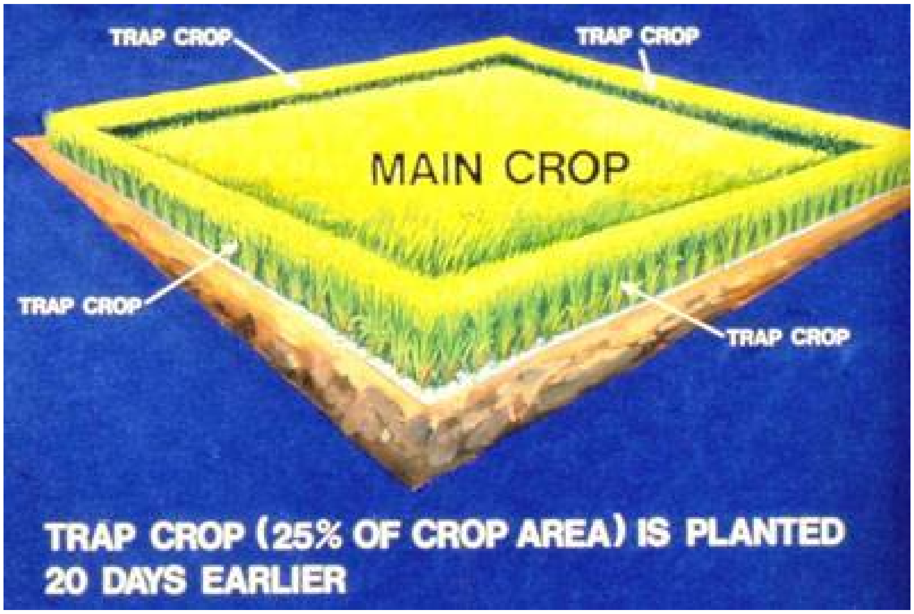
Planting cultivars of similar maturity or different maturities with ensured synchronous flowering reduces damage by panicle-feeding pests such as the seed bug, birds and rats.

Trap Crop

The trap crop technique relies on the attraction of insect pests to plantings other than the main crop. Timing is important in utilizing a trap crop. The pests should not be allowed to reproduce on the trap crop and the crop itself should not sacrifice much of field area. However, it is important to plant a trap crop over an area large enough to attract the resident pests.

To control stem borers, a trap crop technique was used in China during the 1960s and 1970s that called for planting 0.7 to 5.0% of the rice area in small fields ahead of the main crop. To increase pest attraction, this technique was enhanced by using susceptible cultivars, high amounts of nitrogen, and lights. Later, manual removal of the egg masses from the trap crop or the application of insecticides assisted in controlling stem borer infestations. Trap crops were also used in Java in 1960s to attract the highly synchronized emergence of white stem borer moths. Another successful method is used in Japan that calls for delaying land preparation in the Spring until the emerging green leafhopper and smaller brown planthopper adults complete their egg lying on grassy weeds in the field. The following land preparation crushes their population.

A trap cropping method that is under experimentation calls for the planting of highly susceptible varieties in 2-3 border rows of a field ahead of the main crop to attract stem borers, brown planthoppers, or green leafhoppers. The border areas are then sprayed regularly. Also, leaving small patches of weeds will attract seed bugs, which may by eliminated by frequent insecticide sprayings.



Flooding Stubble

In areas with sufficient water, harvested fields can be submerged to drown stem borers, armyworms, and grasshoppers. Flooding the field after harvest has been mainly used to control stem borers. Flooding, followed by tillage, is more effective for suppressing stem borer populations, and prolonged flooding is often required as some of the larvae can survive inside the stem for quite sometime. This method is particularly effective if conducted in a community-wide effort. Flooding has a strong effect on most soil pests including white grubs, mole crickets, termites, and ants.

Tillage

Turning the soil over can crush insects, bury them, destroy their nests, and/or expose them to desiccation and predators. Insect predatory birds tend to concentrate in the field at tillage for predation of exposed insects.

Dry season cultivation in the dry lands is less beneficial when compared to puddling as the insects can tunnel deep into the soil. Populations of soil-dwelling pests of dry land rice (such as white grubs, mole crickets, termites, ants, and root bugs) can be reduced by increasing the number of tillage operations. Tillage after rice harvest kills stem borers, armyworm pupae, grasshopper eggs, black bugs and root weevils. Such tillage prevents unwanted crop growth (ratooning), which may affect insect populations by breaking their life cycle (e.g., gall midge, leafhoppers and plant hoppers). Agronomically, Plowing down stubble after the harvest is a preferred method as it increases soil organic matter and recycles nutrients. For best results, plowing down stubble needs to be combined with synchronous planting.

Weed Control

Some rice insect pests will develop on common rice field weeds—mostly grasses—that occur in fallow fields, border areas, or in association with rice. Weed hosts act as a bridge between rice crops or preferred stages of rice crops to sustain pest populations. Weed control is suggested to control leaffolders, leafhoppers, planthoppers, seed bugs, leaf beetles, black bug, mealy bug, armyworms, caseworms, root aphids, root bugs, root weevils, leaf miners, and seedling maggot. Good weed control in the field allows the rice crop to tolerate more pest damage. Cutting weeds from areas bordering paddies and removing weeds from rice fields reduces potential nesting sites and shelter for rats and alternate hosts of insects.

However, these alternate hosts not only support pest insects but also support their arthropod predator and parasitoids. An example concerns predatory crickets. During the day, they live in the grassy vegetation adjacent to rice fields and then move to the field at night for predation on leaffolder eggs.

Harvest Methods

The cutting height of the crop at harvest influences the control of stem borers. Stem borer larvae descend to the base of the plants to pupate or to pass an unfavorable season in larval diapause. How far they descend depends on the species and water level. Panicle harvesting allows 98% of the stem borer populations to carry over to the next rice crop. The greatest degree of control occurs when the stubble is cut at a level of 15 cm or below. However, if the stem borer larvae are in diapause, harvesting at the ground level will only remove less than 15% of them with the straw.

Straw and Stubble Destruction

Management of post harvest crop residues is mainly directed toward the control of stem borers, ear-cutting caterpillars, disease pathogens, and weed management. Traditionally, burning straw and stubble was a common practice that claimed to control stem borers, armyworms, plant hoppers, and leaffolders.

The threshing process and sun drying is very effective in killing the larvae and pupae of stem borers and the eggs of leafhoppers and planthoppers in the straw. Deepwater rice stubble can be burned easily but it is difficult to burn short stubble. Before the 1970s, the burning of long deepwater stubble was a common practice in many countries. However, due to the reduction in deepwater rice cropping and an acute fuel crisis, this practice has almost been abandoned. There is also concern that straw and stubble burning in the field can affect populations of natural enemies and other non-target organisms.

Ratooning

A ratoon extends the crop availability for additional pest generations. The higher the main crop is cut, the sooner the ratoon appears. Stem borers survive in the stubble and leaffolders thrive in the ratoon crop. Gall midge is favored by tillering while plant hoppers and leafhoppers will multiply on ratoons. Rice seed bugs also increase on ratoons as they are long-lived and survive between the two crops. The presence of rice pests and other similar arthropods on rice ratoons also encourages natural enemy populations to build-up. The most serious pest problems caused by ratoon crops are insect-vectored viral diseases such as yellow dwarf and tungro. However, ratooning does not favor vegetative stage pests such as the whorl maggot, caseworm, green semilooper, or green hairy caterpillar due to the very short duration of the vegetative stage.

Cultural Control Options Against Specific Insect Pests

Overview - Cultural Control Options Against Specific Insect Pests

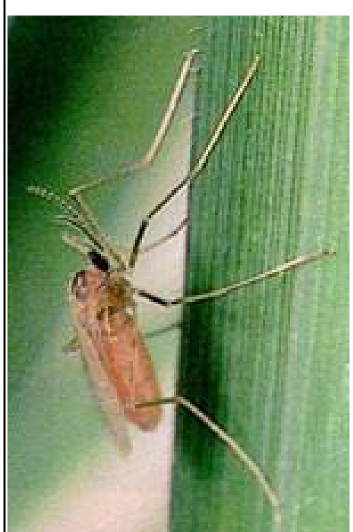
Objective	Learn cultural control options available for suppression of specific rice insect pest populations.

The following links highlight several cultural control options against specific insect pests that are discussed in this course. You may access information on any of the options by clicking the links below, or by selecting the appropriate links from the navigation bar on the right.

1. Early vegetative pests
2. General defoliators
3. Stem borers
4. Plant sucking pests
5. Grain sucking pests
6. Soil pests

Early Vegetative Pests

Pest	Cultural Control Options
Rice caseworm - *Nymphula depunctalis* (Guenee), Pyralidae, Lepidoptera. 	• Rice fields with wider hill spacing (30 x 20 cm) usually suffers less damage from caseworm. • Early planting may escape the peak caseworm moth activity period. • Draining of fields for 5-7 days kills caseworm larvae. • Use of older seedlings reduces the duration of the susceptible stage of the crop. • Nitrogen fertilizer use at optimal dosages and split applications reduce the rice caseworm's abundance.
Rice whorl maggot - *Hydrellia philippina* Ferino, Ephyridae, Diptera.	• Adult flies are more attracted to standing water. Therefore, by draining the water at 3-4 days intervals during the first 30 days after transplanting, egg lying is reduced. • Covering the water surface with Azolla and Salvinia molesta prevents rice whorl maggot infestation. • Direct-seeded rice is not as attractive to adults as a transplanted rice crop is. • Fields with higher plant density suffers less damage. • Close planting decreases oviposition and subsequent damage.

	
Rice seedling maggot - *Atherigona oryzae* Malloch, Muscidae, Diptera. 	• Sowing early or very late when the weather is relatively dry will reduce the incidence of fly development. • Avoiding rice planting during the period of seedling maggot abundance. • Flooding the rice crop occasionally or on a weekly basis may reduce incidence. • In infested fields, fertilizer can be used to stimulate the formation of new shoots. • Intercropping maize with rice (sowing maize 2-weeks before rice harvest in every 5th row of the rice field) suppress populations.
Asian rice gall midge – *Orseolia oryzae* (Wood-Mason), Cecidomyiidae, Diptera. 	• Plowing under the ratoon of previous crops can reduce infestation. • Control of grassy weeds and wild rice (alternate hosts) from surrounding areas can reduce gall midge incidence. • Draining of rice fields for 5-7 days affects midge populations. • Planting of early and using early maturing varieties may help to avoid high infestations. • Using only moderate amounts of nitrogen and potassium fertilizers and adopting split applications to reduce population growth rates. • Avoiding staggered planting (complete planting in an area within 3 weeks) to reduce infestation.
Rice green semilooper - *Naranga aenescens* (Moore, Noctuidae, Lepidoptera.	• Planting closely or at high seedling rates to give the crop a better opportunity to tolerate defoliation. • Avoiding staggered planting, which favors population buildups. • Planting early (first few weeks of each planting

	season) may help to avoid damage from the green semilooper. • Heavily fertilized crops result in high semilooper incidences. Therefore, optimal amounts and split applications are recommended.

General Defoliators

Pest	Cultural Control Options
Rice hispa - *Dicladispa armigera* (Olivier), Chrysomelidae, Coleoptera. 	• Clipping and destruction of the top three-fourths of the leaves of highly infested crops with eggs and grubs at the early vegetative stage can suppress populations. • Sustained collection of adults by sweep net and destruction suppress populations and reduces damage. • The removal of rice ratoons and volunteer rice during the crop-free season affects the rice hispa's survival and multiplication of over-wintering populations. • In situations of high hispa incidence, skip nitrogen fertilizer top-dressing. Note that top-dressing after the pest is controlled can enhance recovery.
Rice ear-cutting caterpillar - *Mythimna separata* (Walker), Noctuidae, Lepidoptera.  **African armyworm** - *Spodoptera exempt*a (Walker), Noctuidae, Lepidoptera.	• When attack is noticed on seedbed, raise water level to drown the larvae. • In endemic areas, rotating host crops, such as wheat or maize, after rice should be avoided. • If these pests are causing problems, regularly avoid rice-wheat cropping patterns. • Populations can build on grassy weeds in and around the fields. Therefore, weeds should be kept under control. • Use nitrogen fertilizer sensibly. Higher doses of nitrogen will cause greater fecundity, higher survival, increased larval feeding, and damage. • Water levels can be raised when the population is in the pupal stage. This will drown them in the soil cracks and between tillers at the base of rice hill. • Planting of sunflower and castor plants (attract Spodoptera) as trap crops around and within the fields reduces damage to the main crop.

 **Rice swarming caterpillar** - *Spodoptera mauritia acronyctoides* (Guenee), Noctuidae, Lepidoptera.  **Fall armyworm, grass worm** - *Spodoptera frugiperda* (J.E. Smith), Noctuidae, Lepidoptera. **Common cutworm** - *Spodoptera litura* (Fabricius), Noctuidae, Lepidoptera.	
Rice leaffolders – *Cnaphalocrocis medinalis* (Guenee), Pyralidae, Lepidoptera	• Early planting may help to avoid greater degrees of leaf damage. • Wider spacing (22.5 x 20 cm and 30 x 20 cm) and low usage of nitrogenous fertilizers decreases leaf damage. • Highly fertilized plots seem to attract females for oviposition. Therefore, it is advisable to avoid over-fertilization. • Egg predators (crickets) inhabit surrounding grass habitats and move to the field at night for predation. Maintenance of non-rice habitats might be worthwhile. • Higher damages will occur in shaded areas. Therefore, remove the causes of shading within the field.

 *Marasmia exigua* (Butler), Pyralidae, Lepidoptera *M. patnalis* (Bradley), Pyralidae, Lepidoptera	

Stem borers

Pest	Cultural Control Options
Golden-fringed stem borer – *Chilo auricilius* Dudgeon, Pyralidae, Lepidoptera	• Avoid applying nitrogenous fertilizers at high doses, which favors population buildup. • Rice planted in sugarcane (another host) dominant areas may suffer high infestation. Healthy sugarcane setts should be used. Infested setts should be planted in furrows under a 5-7 cm layer of soil to prevent the emergence of adults.
Dark-headed stem borer - *Chilo polychrysus* (Meyrick), Pyralidae, Lepidoptera.  **Striped stem borer** - *Chilo suppressalis* (Walker), Pyralidae, Lepidoptera.	• Flooding and harrowing and plowing to turn in stubble and/or straw after harvest destroys larvae and pupae. • Destruction of rice ratoons and volunteer rice plants also reduces season to season carryover. • Depending on the local condition, time of planting can be adjusted to avoid periods of peak adult activity. • The use of early-maturing varieties limits the crop's development period; therefore, affecting population size. • Synchronization of plantings and harvesting close to the ground (removes some larvae and pupae with the straw) can affect populations.

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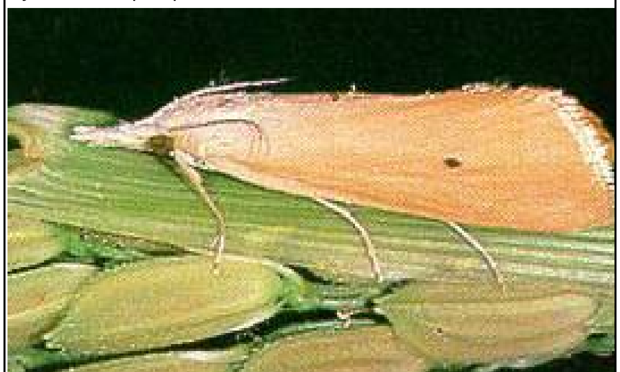
<tr><td>Yellow stem borer - Scirpophaga incertulas (Walker), Pyralidae, Lepidoptera

White stem borer - Scirpophaga innotata (Walker), Pyralidae, Lepidoptera.
</td><td>
Rice varieties with short stature and shorter growth duration periods suffer less damage than long growth duration varieties.
Rice – rice patterns with shorter growth duration varieties suffer less damage than single rice patterns with long duration varieties. This may be because of stem-borer mortality due to harvests occurring twice in the double cropping system.
Community-wide destruction of diapausing larvae (in stubble) through tillage after harvest, followed by flooding, reduces stem borer populations resulting in low incidence in the next crop.
Planting or seeding times may be delayed to avoid the peak emergence of moths from the diapausing populations.
Rice seedbeds may be used as a trap crop for moths emerging from diapause.
</td></tr>
<tr><td>Pink stem borer - Sesamia inferens (Walker), Noctuidae, Lepidoptera.
</td><td>
Planting cultivars with the same maturity class and planting synchronously in an area reduces infestation.
Early planting will usually cause the crop to escape the period of peak population buildup.
Early maturity is a mechanism to avoid population build-up.
In rice-rice patterns with a non-host crop (such as a field legume) reduces incidence.
Harvesting has a devastating effect particularly if the straw is destroyed and the remaining stubble is plowed under the soil.
Well timed and balanced fertilization aids a crop to compensate from damage.
</td></tr>
</table>

Plant Sucking Pests

Pest	Cultural Control Options
Green leafhoppers - *Nephotettix cincticeps* (Uhler), Cicadellidae, Hemiptera.	• **Reducing the number of rice crops to two per year and synchronized**

<table>
<tr>
<td>N. malayanus (Ishihara & Kawase), Cicadellidae, Hemiptera
N. nigropictus (Stal), Cicadellidae, Hemiptera

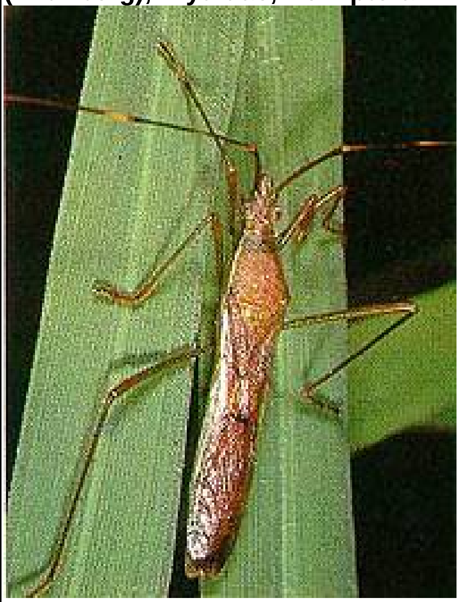
N. virescens (Distant), Cicadellidae, Hemiptera
</td>
<td>establishment across farms reduces leafhoppers and other insect vectors of rice virus or phytoplasma diseases.
• Transplanting older seedlings (>3 weeks) also reduces viral disease susceptibility transmitted by leafhoppers.
• Avoid planting at peak activity (shown by historical records) period to avoid infestation.
• Early planting within a given planting period, particularly in the dry season, reduces the risk of insect-vector disease.
• Nitrogen should be applied at an optimal level to discourage population build-up and influence plant recovery.
• Good weed control in the field and on the bunds removes the preferred grassy hosts and promotes crop vigor.
• Crop rotation with a non-rice crop during the dry season decreases disease reservoirs.
• Upland rice intercropped with soybean reduces the incidence of leafhoppers on rice compared to rice alone.</td>
</tr>
<tr>
<td>Brown planthopper - Nilaparvata lugens (Stal), Delphacidae, Hemiptera.

Whitebacked planthopper - Sogatella furcifera (Horvath), Delphacidae, Hemiptera.</td>
<td>• High dosages of nitrogenous fertilizers, close spacing, and high relative humidity increases planthopper populations.
• Draining rice fields can be effective in reducing initial infestation levels. The field should be drained for 3 - 4 days when heavy infestations occur.
• Growing no more than two crops per year and using early-maturing varieties reduces planthopper abundance and damage.
• Sensible use of fertilizer by splitting nitrogen applications can also reduce chances of plant hopper outbreaks.
• Synchronous planting (planting neighboring fields within 3 weeks) and maintaining a rice-free period may be effective.</td>
</tr>
<tr>
<td>Rice black bugs or Malaysian black bug - Scotinophara coarctata (Fabricius), Pentatomidae, Hemiptera.</td>
<td>• Selecting early-maturing cultivars can reduce population build-up.
• After harvest, all stages of the black bug remains on rice stubble. Therefore, incorporation of the stubble into the soil by plowing destroys their breeding/hiding habitat.</td>
</tr>
</table>

	• Clean cultivation removes alternate hosts that serve as breeding sites and allows more sunlight to reach to the base of the rice plants. • Synchronous planting over large contiguous areas, preferably over a 1 km radius, can evade damaging population levels and break their life cycle.
Rice mealybug - *Brevennia rehi* (Lindinger) Pseudococcidae, Hemiptera. 	• Removal of alternate hosts in the vicinity of the field considerably reduces their multiplication. • Mechanical and physical control methods, such as removal of infested plants and burying them in the soil then re-planting, are good to stop spreading.

Grain Sucking Pests

Pest	Cultural Control Options
Green stinkbug - *Nezara viridula* (Linnaeus), Pentatomidae, Hemiptera. 	• Early-maturing varieties can be used as trap crops to protect the late maturing main crop. However, insecticides need to be applied to the trap crop for the stinikbug's control. • The green-manuring crop, ***Sesbania rostrata***, can also be used as a trap crop. Intercropping of soybean with rice can also be effective. • Adjusting the planting date allows a degree of manipulation of ***N. viridula*** numbers.
Slender rice bug - *Leptocorisa acuta*	• Simultaneous crop maturity in all fields

(Thunberg), Alydidae, Hemiptera  *L. oratorius* (Fabricius), Alydidae, Hemiptera *L. chinensis* (Dallas), Alydidae, Hemiptera.	in an area dilutes rice bug damage. • Staggered planting should be avoided. Rice maturing in a few fields later than that, which is maturing in other areas, may suffer severe damage because of its concentration. • Rice bugs are capable of surviving on other vegetation during the off-season. Control of bugs on other vegetation, especially in the off-season, can be beneficial.

Soil Pests

Pest	Cultural Control Options
Rice water weevil - *Lissorhoptrus oryzophilus* (Kuschel), Curculionidae, Coleoptera	• Drainage of rice fields is effective in controlling larval population and damage under specific field conditions. • Delaying permanent flooding by 2 to 3 weeks than normal also affects larval population and reduces damage. • Planting rice early usually does not affect larva population build-up. Nevertheless, the rice plants are able to tolerate infestations without yield loss.
Mole cricket - *Gryllotalpa orientalis* (Burmeister), Gryllotalpidae, Orthoptera 	• In a prone area, late sowing of rice seeds between rows of wheat in late May suffer less damage than those sown earlier. • Use of higher seed rates reduce the percentage of seedling loss. • Flooding of rice fields for a few days prevents mole cricket damage.
White grubs - *Holotrichia spp.*, Scarabaeidae, Coleoptera	• Different tillage operations such as plowing, harrowing, and hoeing affect various stages of white grubs. Plowing in 3-4 week intervals during off-season expose grubs to harsh weather and predators.

Leucopholis irrorata **(Chevrolat), Scarabaeidae, Coleoptera**

- **Flooding for a long period reduces grub activity.**
- **Sugarcane-paddy-sugarcane patterns in endemic areas are an effective control measure.**
- **Rotation of resistant crops such as sunflower with rice also controls its buildup.**
- **Use of sorghum, maize, and onions as trap crops can reduce white grub infestation.**
- **Allowing the land to lie fallow for 2 consecutive years helps to reduce pest numbers.**

Selected References

Format	Reference
Hard Copy	**Litsinger JA., 1994.** *Cultural, mechanical and physical control of rice insects.* Pp. 549-584 In: EA Heinrichs (ed.) *Biology and Management of Rice Insects*. International Rice Research Institute, Philippines, 779p. **Reissig WH, Heinrichs EA, Litsinger JA, Moody K, Fiedler L, Mew TW and Barrion AT., 1986.** *Illustrated Guide to Integrated Pest Management in Rice in Tropical Asia*. International Rice Research Institute, Philippines, 411p.
Compact Disk/ On-line	**Crop Protection Compendium (2001 edition)** - CAB international (UK), CD and On-line. **RiceIPM (version 1)** - International Rice Research Institute (Philippines) and The University of Queensland (Australia), CD.
Author	Zahirul Islam - IRRI Training Center, Los Banos, Philippines
Programmer, editor	Albert Dean Atkinson - IRRI Training Center, Los Banos, Philippines