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Philippine Rice Production Training Manual

PHILRICE
PHILIPPINE RICE RESEARCH INSTITUTE
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PHILIPPINE RICE PRODUCTION TRAINING MANUAL

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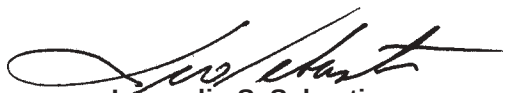
FOREWORD

Training is a major mandate of PhilRice. This training manual was developed to answer the need for courseware to support our training activities. To date, the Institute, has trained thousands, consisting of rice specialists, extension workers, seedgrowers, farmer leaders, and other key players in the rice industry.

This training manual is meant to serve as the "bible" in rice production. It contains the most recent and updated information in rice science and technology. With the manual as the reference, we hope to standardize the content of trainings conducted not only at the PhilRice Central Experiment Station (CES) but also those conducted at the branch stations, as well as the on-site trainings held at the regional and provincial levels.

With the content taken cared of by this manual, we hope that our trainers can be more innovative and cognitive-oriented in their approach to training. They will be able to focus more on the "whys" and the principles behind the recommended practices, thus promoting better understanding on the part of our trainees.

While this book is primarily intended for trainers and trainees, it may also be useful to all others who are interested to gain knowledge about our country's most important food crop. Furthermore, we hope that through our training efforts, we will be able to make a significant difference in the lives of our rice farmers.



Leocadio S. Sebastian
Executive Director

PREFACE

The production of this training manual is part of the Institute's continuing effort to improve the conduct of our training programs. One of the strategies chosen is to produce courseware that will support and standardize our training activities. With the use of this manual as a guide, we hope that the conduct of the training will be elevated to a higher level. The trainers will be able to focus more on the delivery of their presentations. They can use more experiential and participatory approaches, hence they will be more effective facilitators of learning.

The manual consists of 19 modules which cover the most updated cultural management information and practices in growing rice, from selection of varieties to post harvest practices. Other relevant information such as the situationer on the Philippine rice industry and the morphology of the rice plant are given as background information. Similarly, the most recent information on released rice seed varieties, pesticides, and fertilizers which are deemed useful are likewise appended.

Each module consists of an overview which introduces in brief the topic and its relevance. The content of the module is presented through statement of behavioral objectives followed by the key concepts and sentences that answer each objective. This gives the trainer or resource person the freedom to present the lesson in a manner he or she deems fit. Attempts were made to focus on the "whys" or the principles behind the technology being recommended.

Suggested methodology for handling the topics and the references consulted in the development of the module, which the users may refer to for further understanding and learning are given at the end of each module. It also contains sample evaluation questions that the readers may answer to check their own learning. Enrichment activities such as practicum, field visits, and other exercises to reinforce learning are likewise included.

All this information is suggestive at its best. It should be understood that the trainer's treatment of the topics given in each module would depend on the type of participants, their entry level, and the duration of the training program, among others.

In the production of this reference, we are indebted to many people and we would like to acknowledge them:

Dr. Virginia Duldulao, who developed the training manual "Let's Produce More Rice," which was the forerunner of this publication.

To the subject matter specialists who wrote/revised the different modules especially those who actively participated in the series of *in banc* consultations when we had to review each other's outputs. They conscientiously and painstakingly pored over the modules and argued over the accuracy of the contents making us realize how exacting agricultural science can be. They were: Annie Antonio, Cheryll Casiwan, Jovi de Dios, Willy Collado, Eden Gagelonia, Hermie Rapusas, Rolly San Gabriel, Dante Tabien, Artemio Vasallo, and Buddy Yabes.

Carlito N. Bibal, for the illustrations that gave this book "life".

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Andrei B. Lanuza, for his efforts in gathering and encoding the data, layout of the book, and for providing additional illustrations for this manual as it underwent numerous revisions.

Karen T. Barroga, Teresa P. de Leon, and Ruben A. Miranda, for administrative and moral support.

Dr. Edilberto D. Redoña for urging us to excel in everything that we do; Atty. Ronilo A. Beronio, for his warm and friendly accommodation.

Dr. Leocadio S. Sebastian, for giving me the opportunity to work with PhilRice while I am on sabbatical leave from the Central Luzon State University; it has been a most productive and enjoyable experience.

And to all others, who have contributed in one way or another to the successful completion of the project, our sincerest thanks.

Soledad S. Mina-Roguel
Project Coordinator and Editor

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MODULE 1

THE PHILIPPINE RICE SITUATION

Overview

This module presents a situationer on trends in production and hectarages for rice, demand for the commodity, imports and exports, requirement for national rice self-sufficiency and rice pricing policy.

Rice is the most important and dominant commodity in the country. According to the international rural sociologist, Gelia T. Castillo, rice is life, politics, and economics to the Filipino. It is survival itself.

Objectives and Topics

I. Recognize the importance of rice in the agriculture sector and in the economy.

   A. From 1990 to 2001, paddy contributed an average of 18% to GVA of agriculture and 3% to GNP.
   B. Rice is the staple food of 90% of our population.
   C. It accounts for 41% of total calorie intake and 31% of total protein intake.
   D. Rice carries the largest weight of a single commodity in the Consumer Price Index (CPI). Thus, rice prices are the best barometer for inflation in the whole economy.
   E. There are about 2.5 million farmers in the country whose major source of income is rice farming.
   F. The goal of every government administrator is self-sufficiency in rice.

II. Describe the areas planted to rice in the country.

   A. Rice is cultivated in 2.3 million hectares (M ha), 25% of total arable land.
   B. In 2001, the total area planted to rice is estimated at 4.1 M ha (irrigated-2.73 M mt; lowland rainfed-1.24 M mt; 0.1 M mt).
   C. Sixty-seven percent of this total rice area harvested is irrigated; 30% is lowland rainfed and 3% is upland.

D. Problem soils total to around 1.2 M ha which is about one-third of the total hectarage: 600,000 ha have adverse water and nutrient conditions; 100,000 ha are saline prone; 10,000 ha are alkaline; 15,000 ha have peat soil, and 500,000 ha are acid sulfate soils.

E. Rice areas are projected to further shrink due to their conversion to other uses such as subdivisions and residential areas, parks, and for other commercial/industrial purposes.

III. Explain the trend in rice area harvested, production, and yield during the period 1970-2001.

A. Rice Area Harvested

1. From 1970 to 2001, the total area harvested grew by 1% annually owing to increase in irrigated areas and increase in cropping intensity *(see figures 1.1)*.
2. Irrigated areas grew at an average of 2.9% annually; rainfed areas declined from the 1.7 M ha in 1975 to 1.24 M ha in 2001; and upland rice area declined by more than 75%.
3. In the last decade, the total area harvested increased from 3.3 M ha in 1990 to more than 4 M ha in 2001 despite some loss of agricultural land because of land conversion, urbanization and industrialization *(see figures 1.2)*.
4. This growth in area harvested is accounted for by the increase in irrigated areas which grew by an average of 3.2% per year in the last decade.

B. Palay Production

1. A growth rate of almost 4.6% in production was achieved in the 1965-1975 period, largely explained by high yield growth. During the 1985-1995 period, however, rice production grew only at an average rate of 1.6% per year.
2. From 1995 to 2001, total production increased from 10.5 M mt to almost 13 M mt with a slump in 1998 due to the El Niño that hit the country *(see figures 1.3)*.
3. Irrigated areas contributed about 76% of this total production.
4. This increase in production, however, cannot keep pace with consumption growth, thus resulting in rice importation averaging more than half M mt yearly.

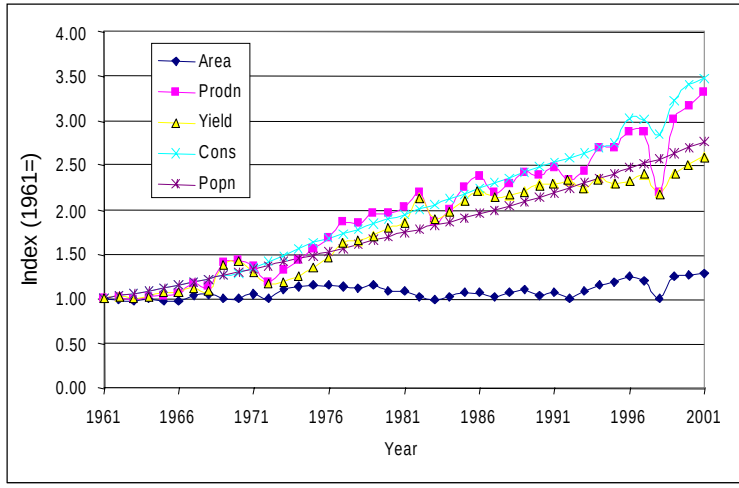


Figure 1.1 Trends in area, production, yield, consumption and population, Philippines, 1970-2001 (BAS-PhilRice, 2002)

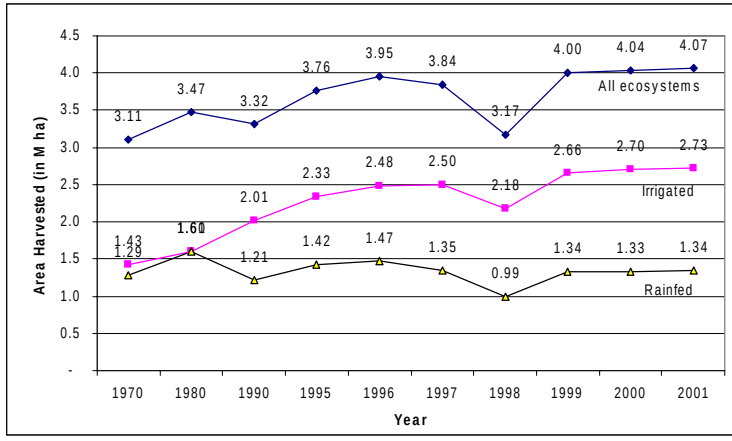


Figure 1.2 Estimated rice area harvested by ecosystem, Philippines, 1970-2001 (BAS-PhilRice, 2002)

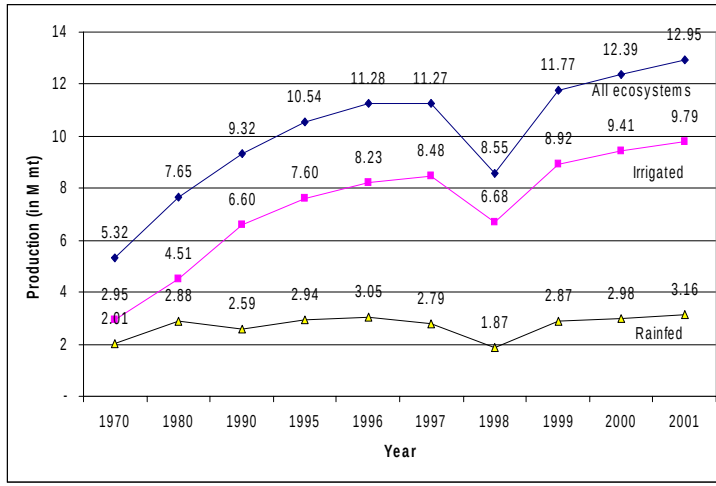


Figure 1.3 Estimated paddy production by ecosystem, Philippines, 1970-2001 (BAS-PhilRice, 2002)

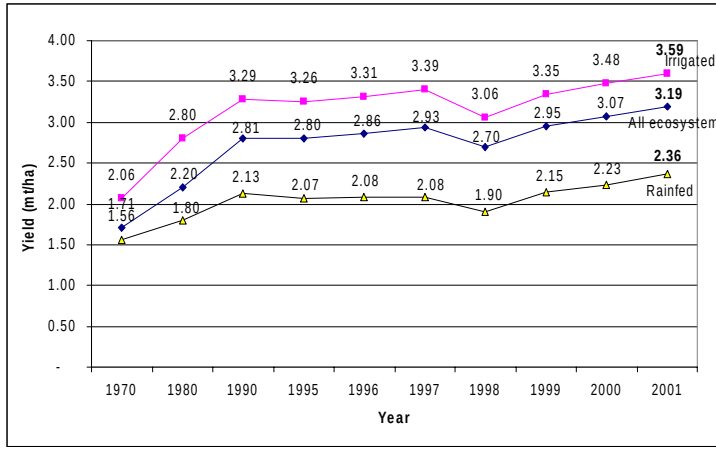


Figure 1.4 Estimated average yield by ecosystem, Philippines, 1970-2001 (BAS-PhilRice, 2002)

C. Yield per Hectare

1. Average paddy yield almost doubled from about 1.7 mt/ha in the 1970 to 3.19 mt/ha in 2001*(see figures 1.4)*.
2. During the period, yield in irrigated areas grew by an average of 1.8% per year, 1.4% in rainfed areas, and 1.9% in upland areas.
3. The growth rate in yield is declining, particularly in the irrigated areas. Average growth rate in yield decreased by half from an average of 2.4% per year during the 1970 to 1990 period to 1.2% during the last decade.
4. For irrigated areas, the average growth rate per year in the last decade is 0.9% only compared with the 2.8% annual growth rate in year during the 1970 to 1980 period.

IV. Show the trend in rice production (milled rice equivalent) relative to domestic consumption.

A. In the last three decades, the country has seen more deficits than surpluses in rice.
B. With a population close to 80 M in 2001 and per capita rice consumption of 102 kg, total rice requirement for food use only is more than 8 M mt per year.
C. Adding 1.1 M mt to account for seeds, feed and wastes, the total domestic rice requirement is about 9.1 M mt.
D. At a realizable total palay production of 12.95 M mt and at the current 65% milling recovery, this translates to 8.42 M mt milled rice or a deficit of 680,000 mt. The country, thus resort to rice importation to meet the total requirement (*see figure 1.5*).
E. The deficits are even more pronounced owing to the seasonal nature of rice production in the Philippines. Production during the dry season is not enough to cover the large deficits during the lean third quarter months, *e.g.* 0.77 M mt surplus dry season production was not enough to cover the 1.97 M mt deficit (*see figure 1.6*).

V. Compare rice prices and costs in the Philippines with other Asian countries.

A. Filipino consumers pay rice prices that are double to triple those borne by Thai or Vietnamese households (*see figure 1.7*).
B. As of August 2001, the wholesale price of regular-milled rice in Metro Manila wet markets averaged 16.53 per kg. For the same quality of rice, Vietnamese households pay whosesale for only P6.36 per kg while Thai consumers pay P7.54 per kg.

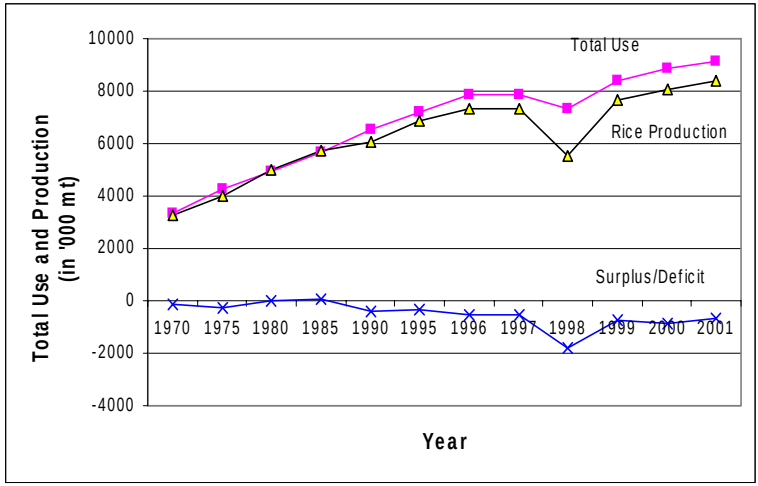


Figure 1.5 Estimated rice consumption and production, Philippines, 1970-2001 (BAS-PhilRice, 2002)

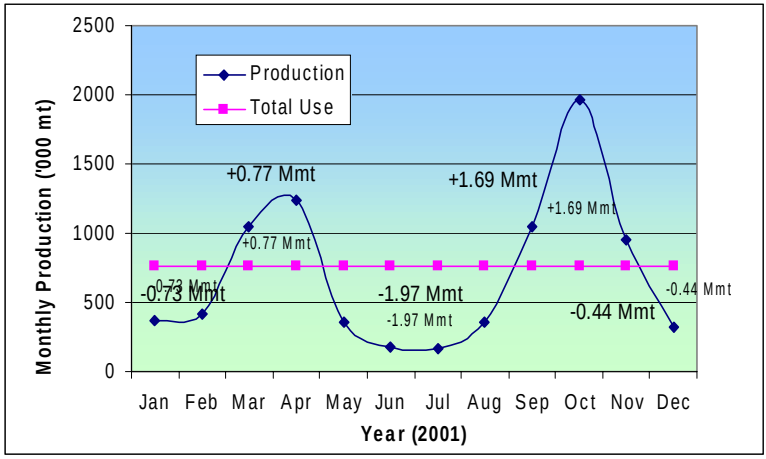
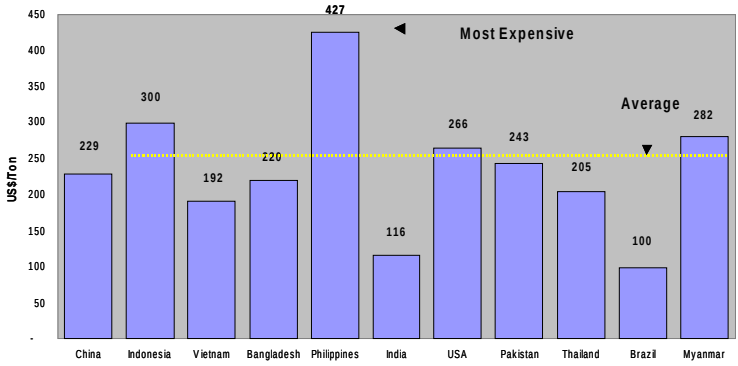


Figure 1.6 Monthly Production Inflow and Total Use of Rice, 2001

C. Similarly, Filipino rice farmers incur more expenses in growing rice compared with Thai and Vietnamese farmers.
D. Based on IRRI survey data in 1999, it costs Filipino farmers P4.82 to produce a kilo of paddy while Thai farmers spend only P2.94, Vietnamese, P3.45, and Chinese, P2.92.
E. The Philippines employs more hired labor in paddy production than other countries



Source: USDA FAS 2001, www.oryza.com, www.telmedpak.com, www.agrinet.org.gov, www.usda.gov, www.fao.org

Figure 1.7 Cross-country comparison of rice prices, 2001

VI. Discuss the status of farm-level production technology.

A. Nearly 100% of the farmers use high-yielding varieties, but only around 30% use high quality seeds. The average farmers' seeding rate is 2 bags with transplanting still the dominant method of crop establishment.
B. Farmers generally apply inorganic fertilizer 2-3 times in a cropping season. Average NPK application per hectare is 65-15-10 for all ecosystem.
D. Most farmers apply herbicide and molluscicide. The practice of IPM is increasing among farmers but most farmers still spray a certain level of insecticide.
E. Land preparation and threshing activities are largely mechanized.
F. Most farmers sell their paddy fresh compared with Thai and Vietnamese farmers.

VII. Describe the status of rice marketing and international trade.

A. The government intervenes in the rice sector by maintaining a floor price for farm prices and a ceiling price for retail prices.

B. The National Food Authority (NFA) has the sole control of rice importation.
C. The average procurement of NFA is about 3-5% of the total palay production.
D. To improve market efficiency, the problems on poor condition of farm-to-market roads, and lack of grades and standards need to be addressed.
E. Net effective protection has been declining due to the higher protection on tradable inputs and overvaluation of exhange rates.

VIII. Infer how rice production can catch up with the ever increasing population.

A. Our population grows at an annual rate of 2.5%, one of the world's highest. The growth rate in productivity has to exceed the population growth rate in order to meet the total requirement.
B. By year 2004, the population is estimated to be about 83.9 M. This means that we have to increase production by at least 4.38 mt/ha in the irrigated areas through yield increase alone to achieve self-sufficiency.
C. The Philippines can catch up if adoption of improved technologies and strong institutional support are sustained.
D. In the next four decades, we have to double our rice yields to be able to feed the population without importation.

Suggested Methodology

- Lecture-Discussion
- Case analysis
- Experiential learning: participatory discussion groups using guide questions

Materials/Visuals

- Slides, slide projector
- Transparencies, OHP
- Powerpoint presentaion

References

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Tolentino, Bruce et.al. 101 Facts about rice in the Philippines.

Evaluation

Write true if the statement is correct. If false, change the underlined word or words to make it correct.

_____ 1. Rice is the staple food of more than 60% of Filipinos.

_____ 2. The goal of our government is to produce rice for export.

_____ 3. Due to decreasing hectarage, rice production is also decreasing.

_____ 4. Our problem soils for rice total to 1.2 M ha which is about 1/4 of the country's rice hectarage.

_____ 5. Across ecosystems, upland areas grew fastest.

_____ 6. The increase in production has kept pace with consumption.

_____ 7. The increase in total food use was largely attributed to the increasing population.

_____ 8. The Philippines has employed more hired labor in paddy production than any other country.

_____ 9. Improved varieties contributed 90% of the palay output.

_____ 10. The cost of rice production is lower in the Philippines compared to other Asian countries.

Questions to Answer

1. Why is rice the most important commodity in the Philipines?

2. Explain why, despite decrease in areas devoted to rice prodution, is still increasing?

3. Why do we import rice?

4. Compared with other ASEAN countries, rice is more expensive in the Philippines. Explain why.

MODULE 2

MORPHOLOGY OF THE RICE PLANT

Overview

This module introduces the terms associated with the different parts of the rice plant, their characteristics and functions. We should have common terms for all the parts for us to understand each other and be able to communicate more effectively.

The cultivated rice plant is an annual grass. Under favorable conditions and with the existence of early maturing varieties, rice can now be grown twice or even thrice a year.

Objectives and Topics

I. Identify and describe the parts of a rice grain.

A. The grain is the ripened ovary with the lemma, palea and their associated structures which now have become the husk or hull *(see figure 2.1)*.
B. The dehulled rice grain or caryopsis is called brown rice due to its brownish outer layer. It consists of the endosperm and embryo.
C. The endosperm provides nourishment to the germinating embryo.
D. The embryo consists of the leaves (plumule) and root (radicle).
E. When the grain absorbs water, the basal part of the lemma starts to swell. Germination has started when either the plumule or the radicle emerges *(see figure 2.2)*.
F. The plumule is enclosed by a cylinderlike protective covering, the coleoptile and the radicle is ensheathed by a mass of soft tissue, the coleorhiza.

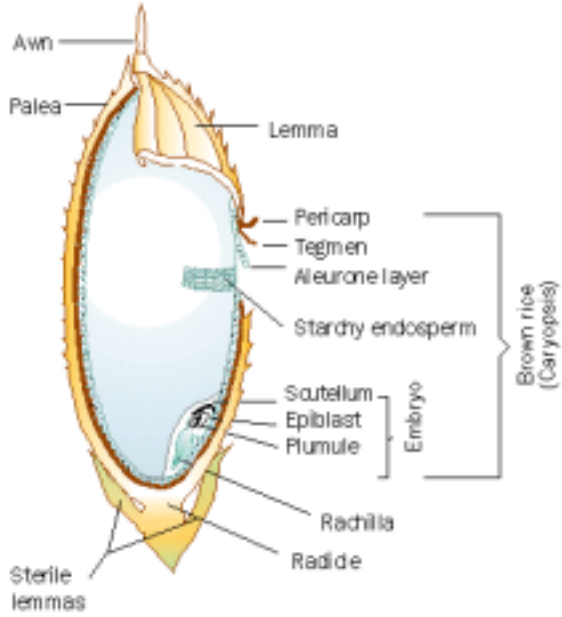
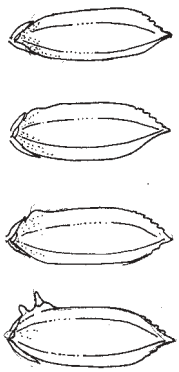


Figure 2.1. Parts of a rice grain



- Before water absorption

- Basal part of lemma starts to swell up after being pushed up from inside immediately before germination

- Emergence of plumule

- Emergence of radicle, *i.e.*, the so-called pigeon-breasted status in which germination can be considered to have already started

Figure 2.2 Process of germination of rice seed

II. Identify and describe the parts of a seed as it undergoes germination *(see figure 2.3)*.

A. Depending on where the seeds are germinated, either of the two emerges first: *coleorhiza* when germinated with light; or, *coleoptile* when germinated in soil or darkness.
B. *Coleorhiza* or the sheath envelops the radicle of the embryo. The *radicle* breaks through the coleorhiza shortly after the latter appears. This is followed by the formation of two or more *seminal roots,* all of which develop rootlets. The radicle is called *primary seminal root*.
C. *Coleoptile* encloses the young leaves and emerges as tapered cylinder. This later ruptures at the apex and the primary leaf emerges. It is either colorless, pale green, or pale purple to purple.

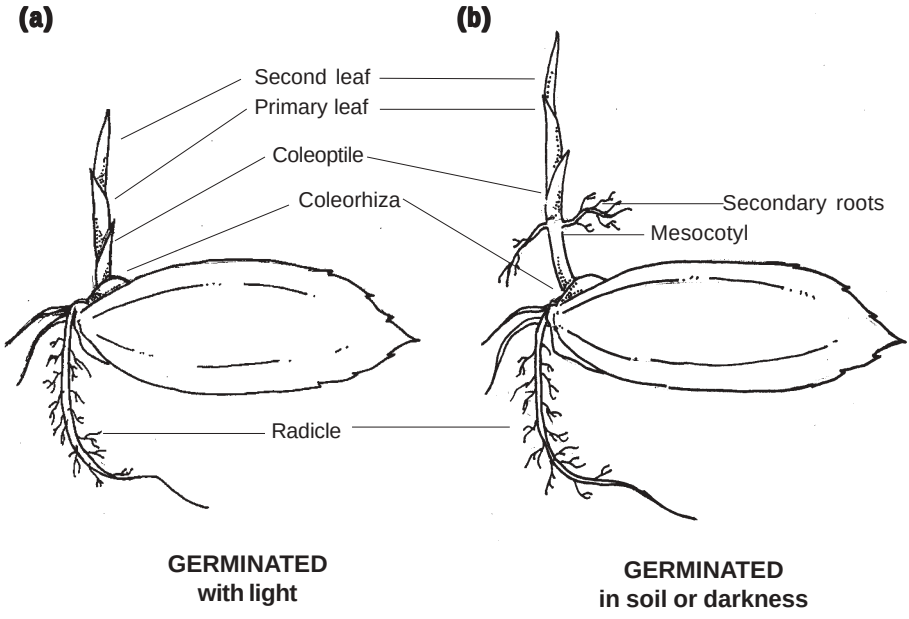


Figure 2.3. Parts of a young rice seedling when germinated with light (a) and in soil or darkness (b)

D. *Primary leaf* is the first seedling leaf. This is green and cylindrical and has no blade.
E. *Secondary leaf* is the next leaf that follows the primary leaf. It is differentiated into a sheath, blade, ligule and auricles.
F. *Mesocotyl* is the axis between the node of the coleoptile and the base of the radicle. The elongation of the mesocotyl elevates the coleoptile above the soil surface.

III. Characterize the vegetative parts of a rice plant.

A. The vegetative organs consist of *roots, culm,* and *leaves (see figure 2.4).*
B. A branch bearing the culm, leaves, and roots with or without a panicle is called *tiller* .

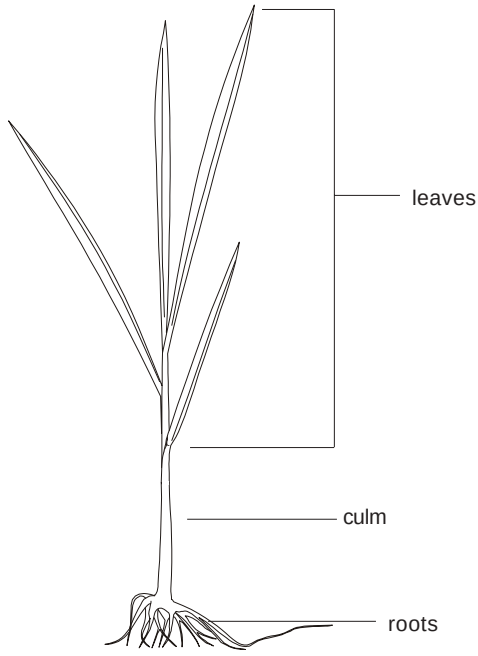


Figure 2.4. The rice tiller and its 3 vegetative parts

1. Roots

a. The roots are fibrous, possessing *rootlets* and root hairs.
b. The *seminal roots* are sparsely branched and persist only for a short time after germination.

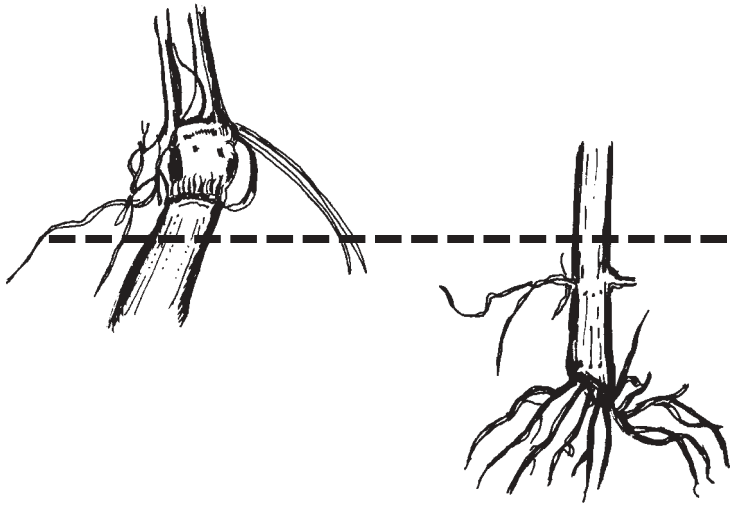
c. The *secondary adventitious roots* are produced from the *underground nodes* of the young culm and are freely branched *(see figure 2.5).*
d. As the plant grows, coarse *adventitious prop roots* often form in whorls from the nodes above ground level.

2. Culm

a. The stem of rice called *culm* is made up of a series of *nodes* and *internodes (see figure 2.6).*
b. The node (nodal region) bears a *leaf* and a *bud.*
c. The *internodes* are elongated and vary in dimension with the lower ones being larger in diameter and thicker than the upper ones.
d. *Primary tillers* arise from the *main culm* in an alternate pattern.
e. The *primary tillers* originate from the *lowermost nodes* and give rise to *secondary tillers*. *Tertiary tillers* grow out from secondary tillers.

3. Leaves

a. The *leaves* are borne on the culm in two directions, one at each node *(see figure 2.6).*
b. The leaf consists of the *sheath* and *blade.*



adventitious prop roots
(from nodes above the soil)

secondary adventitous roots
(from underground nodes)

Figure 2.5. Two types of roots of a rice tiller

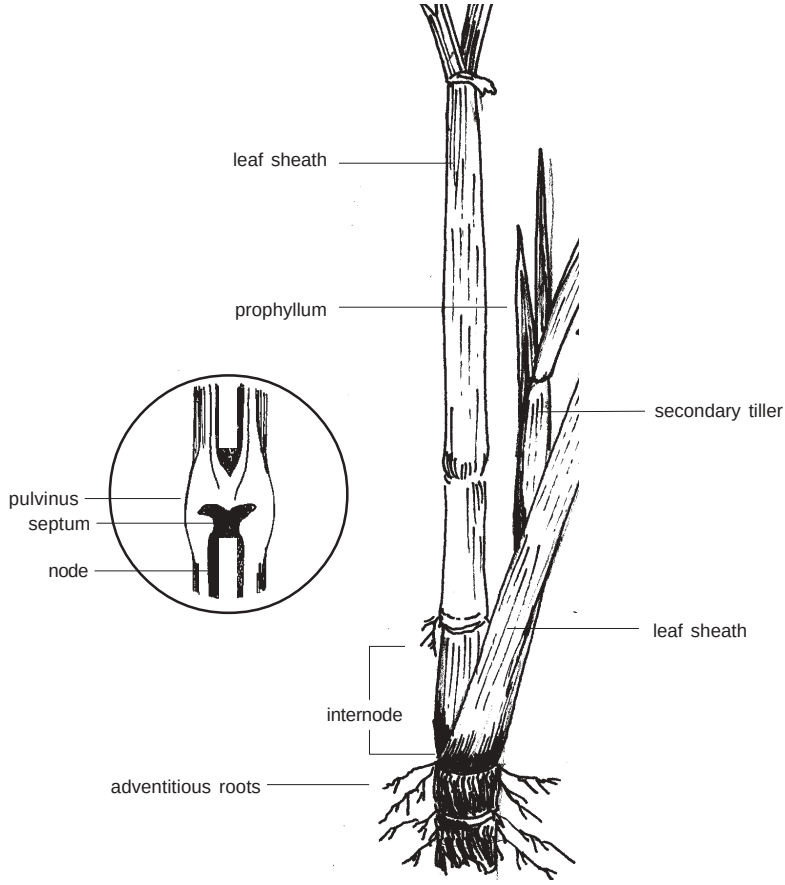


Figure 2.6. Parts of a primary tiller and its secondary tiller.
(Adapted from Chang and Bardenas, 1965)

c. The *leaf sheath* is the best part of the leaf. It envelops the culm above the node in varying length, form, and tightnes.
d. A swelling at the base of the leaf sheath just above the point of its attachment on the culm is the *sheath pulvinus.* This is frequently mistermed the node *(see figure 2.7.a).*
e. The *blades* are generally flat and attached directly to the collar. Varieties differ in blade length, width, area, shape, color, angle and pubescence.
f. The collar is the joint between the *leafsheath* and *leafblade (see figure 2.7.b)*.
g. The uppermost leaf below the panicle is the *flag leaf* (*see figure 2.7.c*).
h. Varieties differ in leaf number .
i. *Auricles* are small, paired, ear-like appendages borne on either side of the base of the blade.
j. The *ligule* is a thin upright membranous structure seated on the inside of the collar at its base.
k. Rice plants have both auricles and ligules. This characteristic is helpful in identifying grassy weeds in rice when the plants are young.
l. The *prophyllum* is the first rudimentary leaf at the base of the main culm. It is a bladeless, two-keeled bract also present between each secondary tiller and each tertiary tiller. It clasps the young tiller with its back against the culm.

IV. Describe the different parts of the floral organs.

A. The floral organs are modified shoots.
B. The terminal shoot of a rice plant is a determinate inflorescence, called the *panicle*.
C. A *spikelet* is the basic unit of the inflorescence.
D. The flower consists of six stamens and a pistil and two lodicules.

1. Panicle

a. The *panicle* is borne on the uppermost internode of the culm. The extent to which the panicle and a portion of the uppermost internode extend beyond the flag leaf sheath determines the exsertion of the panicle *(see figure 2.8)*.
b. The *panicle base* is the nearly solid node between the uppermost internode of the culm and the axis of the panicle.
c. The region about the panicle base is called the *neck.*

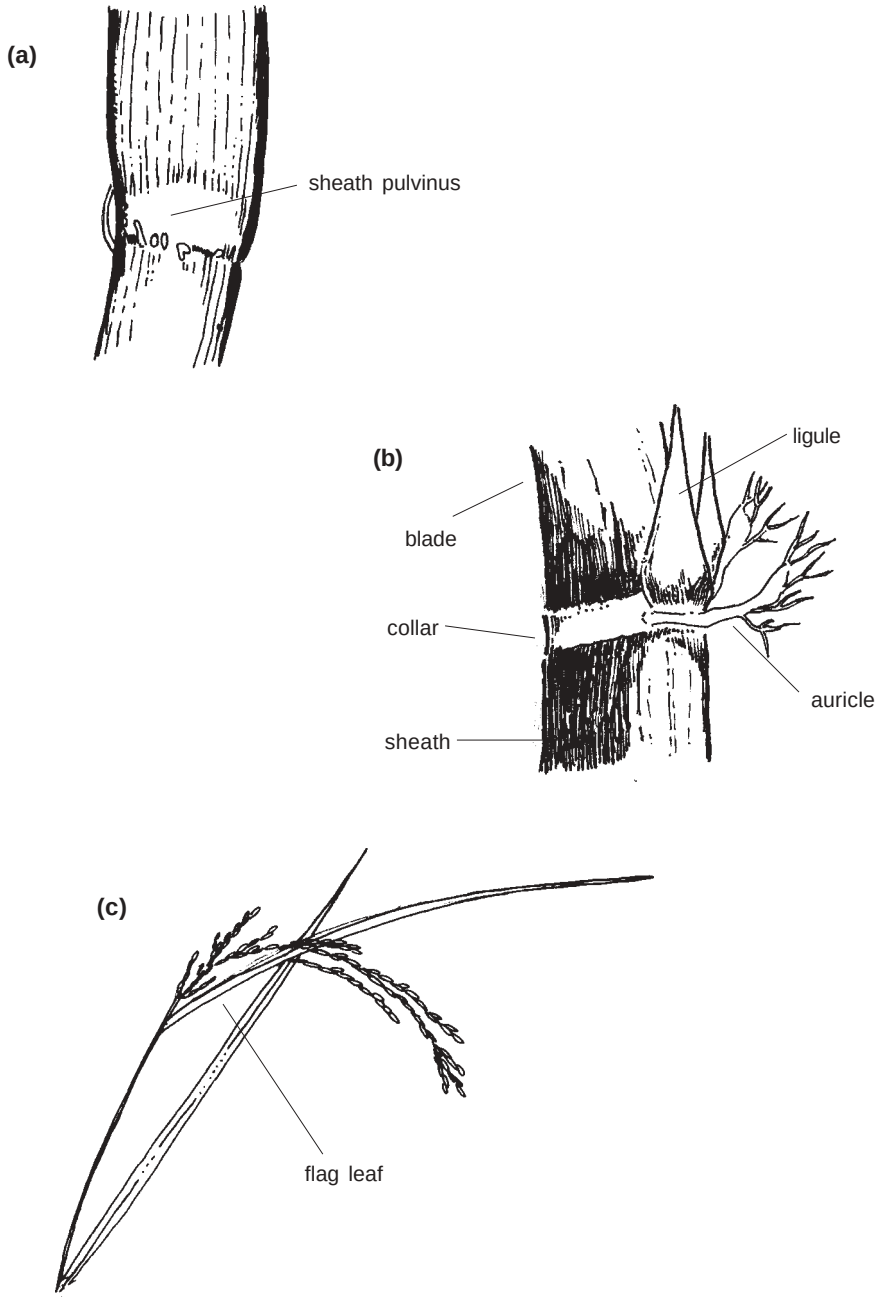


Figure 2.7. Parts of a leaf

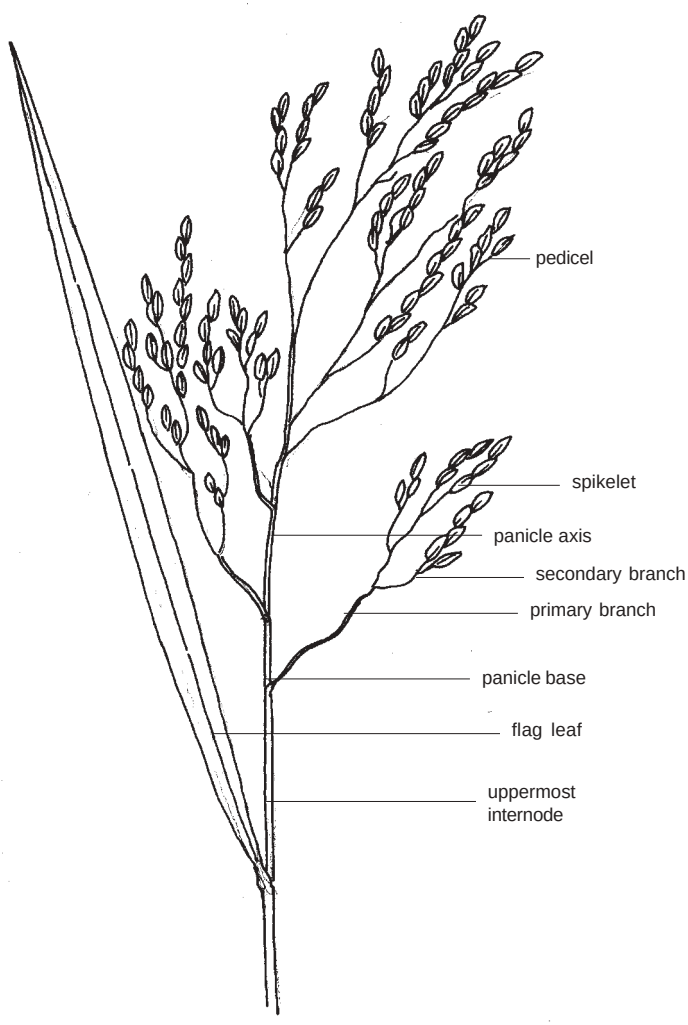


Figure 2.8. Component parts of a panicle *(Adapted from Chang and Bardenas, 1965)*

d. The *panicle axis* (rachis) is the main axis of the inflorescence, extending from the panicle base to the apex.
e. *Panicle pulvini* are the swellings in the panicle axis where the branches are borne.
f. Each node on the main axis gives rise to one or more *primary branches* and each of which in turn bears the *secondary branches*.
g. The second branches bear the *pediceled spikelets.*
h. The pedicel supports the spikelet on the secondary branches.

2. Spikelets

a. The enlarged cup-like apex of the pedicel is termed the *rudimentary glumes* (*see figure 2.9)*.
b. A spikelet consists of two sterile lemmas (outer glumes), the rachilla and floret.

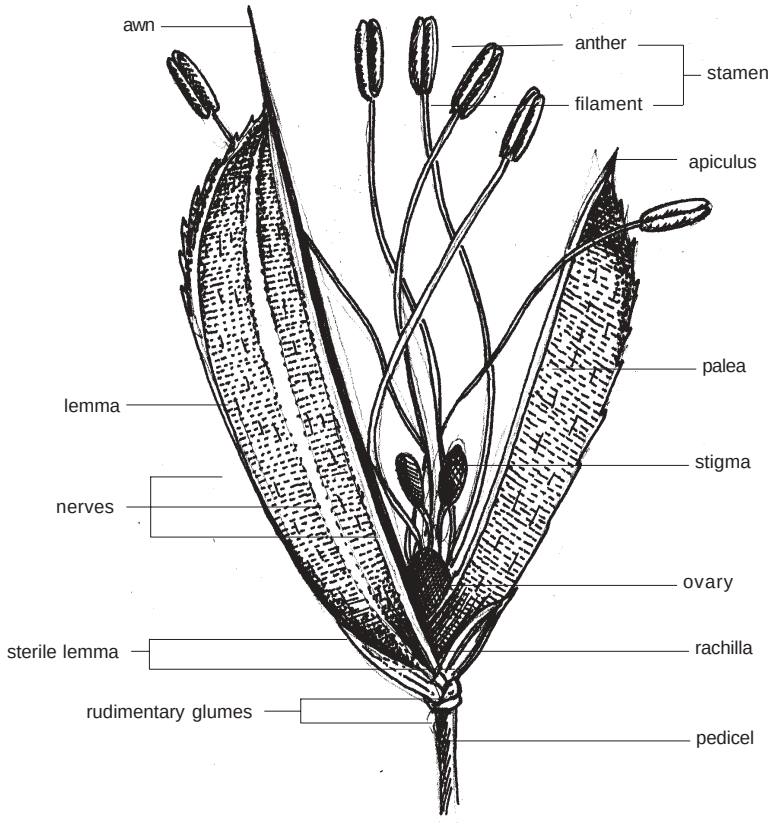


Figure 2.9 Parts of a spikelet (*Adapted from Chang and Bardenas 1965*)

c. The *upper bracts* or *flowering glumes* consist of the *lemma* (fertile lemma) and the *palea.*
d. The lemma, palea and the enclosed flower form the *floret*.
e. The extended tips of the lemma and palea are the *apiculi.*
f. The thin extension of the keel of the lemma is the *awn*.

3. Flower

a. The six stamens are composed of two-celled *anthers* borne on slender *filaments* (*see figure 2.10)*.
b. The pistil consists of a double plumed stigma, style, and ovary.
c. Two scale-like, transparent fleshy structures called *lodicules* are located at the base of the flower. At anthesis, these become turgid and thrust the lemma and palea apart allowing the elongating stamens to emerge above or outside the open floret.
d. The lemma and palea close after the pollen grains are shed from the *anther sacs.* They open and close only once on the same day.

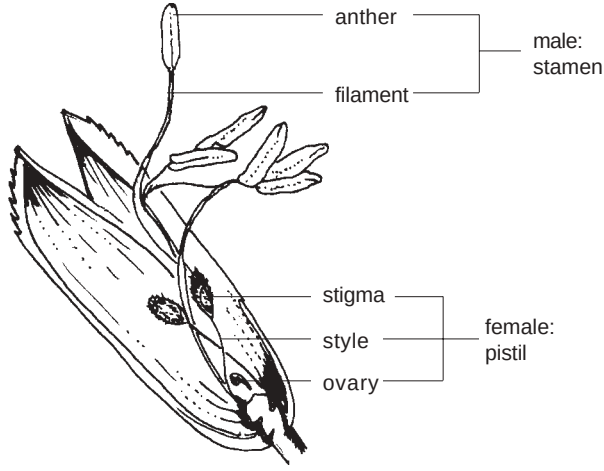


Figure 2.10 The male and female parts of a rice flower

Suggested Methodolgy

The method for this module can be a lecture cum demonstration method using actual specime, or through illustrations of the objects in transparencies or slides.

Materials/Visuals

- Pictures, slides, transparencies, OHP, slide projector
- Actual specimens
- Powerpoint presentation

References

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Evaluation

Performance Test

Given an actual specimen of a rice plant, identify the major parts and describe the main function of each:

1. Rice grain
2. Tiller
3. Leaf
4. Flower
5. Panicle

Enrichment Activity

1. Compare and note major differences of the rice plant with another species of grass.

2. Draw the major parts of a rice flower and discuss the functions of each part.

MODULE 3

THE GROWTH STAGES OF THE RICE PLANT

Overview

This module discusses the various growth stages of the rice plant from seed to maturity, and the changes in the plant at each stage. The rice plant is like any other living thing that undergoes different growth stages. A knowledge of these stages will allow the farmer to employ the appropriate management practice at the right time.

Objectives and Topics

I. Discuss the three growth phases of the rice plant and the corresponding duration of each.

A. There are three growth phases of the plant: vegetative, reproductive and ripening (*see figure 3.1)*.
B. The duration of the vegetative phase differs with the variety and growing season.
C. The reproductive and ripening phases are generally constant for most varieties. The reproductive phase is approximately 35 days, while the ripening phase is 30 days.
D. Differences in growth duration are determined mainly by the duration of the vegetative phase. For instance, we calculate the growth phases of a 115-day variety: the reproductive phase is 35 days and the ripening phase is 30 days so the vegetative phase is 50 days. For a 130-day variety; the vegetative phase is 65 days.

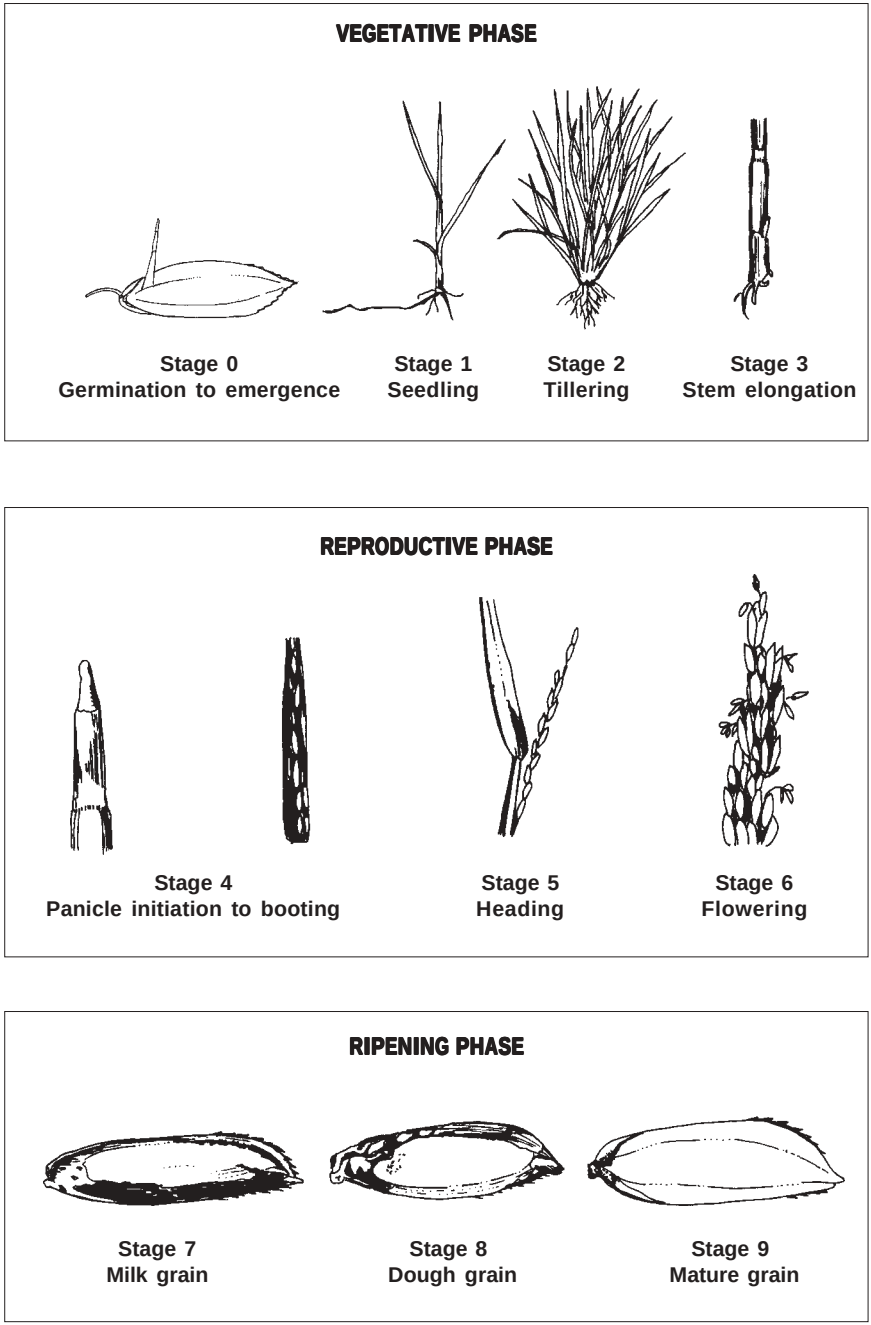

Figure 3.1. The 10 growth stages of the rice plant

II. List the 10 growth stages of the rice plant

Stage 0	Germination to emergence
Stage 1	Seedling
Stage 2	Tillering
Stage 3	Stem elongation
Stage 4	Panicle initiation to booting
Stage 5	Heading
Stage 6	Flowering
Stage 7	Milk grain
Stage 8	Dough grain
Stage 9	Mature grain

III. Describe the various growth stages of the rice plant during the vegetative phase.

Stage 0 - Germination to emergence

A. Germination is the development of the embryo into shoots and roots (*see figure 3.2)*.
B. Emergence is the time when the shoot tip sprouts from the soil or water surface.
C. Prior to germination, the seeds absorbs water from the surface of the hull. The water enters the open area between the caryopsis and the hull.
D. Embryo starts to germinate and develop. The coleoptile starts to grow in the embryo that has swollen after water absorption. The coleorhiza also becomes swollen.
E. The primordia for the first and then the second leaf start developing slightly inside the coleoptile.
F. The coleoptile tends to cease its growth at the length of 1-2 cm. When it has stopped growing, the first leaf emerges by breaking the coleoptile lengthwise.
G. The radicle comes out by breaking the coleorhiza.

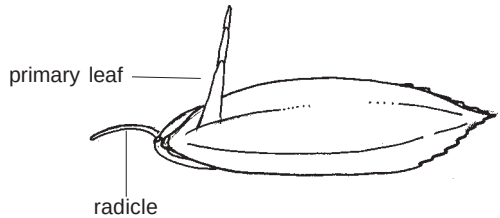

Figure 3.2 Germinated rice seed

H. Growth of the embryo varies with variety, temperature, and availability of water and air.
I. Extreme temperature and drought delay or prevent seed germination.
J. Uptake of water is the first requirement for seed germination.
K. Inside a germinating seed, starch, protein, and fats are digested and translocated to the embryo.

Stage 1 - Seedling

A. Seedling stage starts right after emergence and lasts until just before the first tiller appears (*see figure 3.3)*.
B. Seminal roots and up to 5 leaves develop.
C. The first leaf is incomplete because it lacks the leaf blade.
D. The second leaf, and succeeding leaves, have blades and develop every 3 - 4 days.
E. After producing 4 leaves at about 12 days old, the seedling grows from the food taken through the roots and manufactured in the leaves.
F. Secondary adventitious roots rapidly replace the radicle and seminal roots.

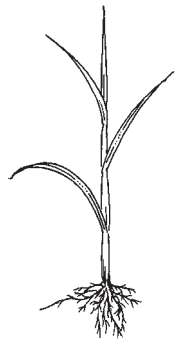

Figure 3.3 The rice seedling

Stage 2 - Tillering

A. This stage extends from the appearance of the first tiller until maximum tiller number is reached.
B. Primary tiller grows from the main culm or stem from auxillary primordia or basal nodes *(see figure 3.4.a).*
C. Secondary tiller grows from the primary tiller and the tertiary tiller from the secondary tiller *(see figure 3.4.b)*.
D. The lower the point of origin on the main stem, the older the tiller is.

E. Tillers displace a leaf as they grow and develop.
F. The increase of tertiary tiller continue up to a certain point designated as the maximum tiller number stage. After this stage, some tillers die as the number of the tillers decline and level off *(see figure 3.4.c)*.

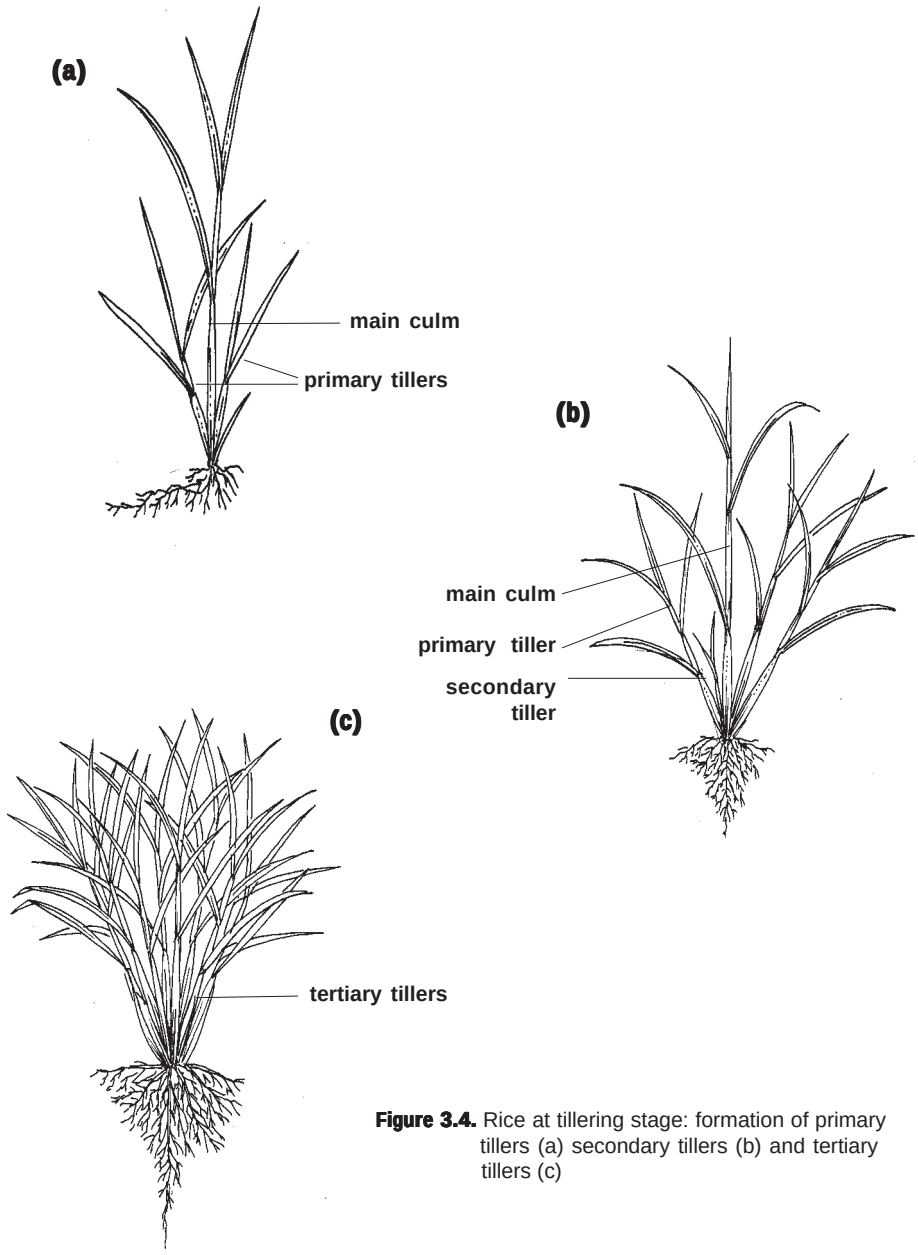

Figure 3.4. Rice at tillering stage: formation of primary tillers (a) secondary tillers (b) and tertiary tillers (c)

Stage 3 - Stem elongation

A. This stage begins before panicle initiation in late maturing varieties; it may occur during the later part of the tillering stage.
B. In short-duration varieties, stem elongation and panicle initiation occur almost simultaneously (*see figure 3.5*).

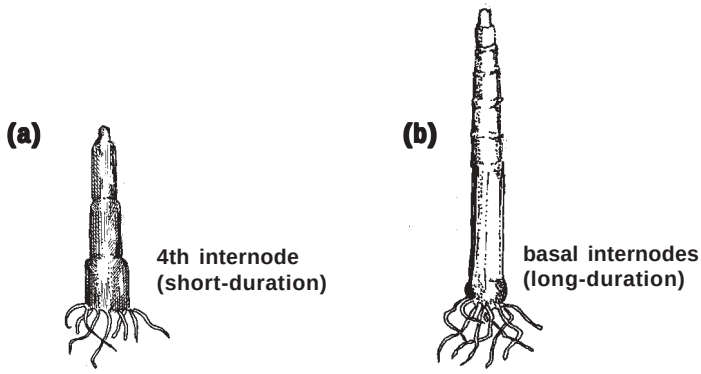

Figure 3.5 Short-duration (a) and long-duration (b) elongation of the stem

III. Describe the various growth stages of the rice plant during the reproductive phase.

Stage 4 - Panicle initiation to booting

A. This stage begins with the initiation of the panicle primordium at the tip of the growing shoot and end when the young panicle is about to emerge.
B. The panicle becomes visible to the naked eye about 7-10 days after initiation as a white feathery cone.
C. Panicle initiation occurs first in the main culm and follows in the other tillers in an uneven pattern.
D. As the panicle develops, the spikelets become distinguishable and the panicle extends upward inside the flag leaf sheath.
E. Booting is the final part of the panicle development stage. About 16 days after visual panicle initiation, the sheath of the flagleaf swells. This swelling is called booting.
F. Senescence of leaves and unproductive (non-panicle bearing) tillers are noticeable at the base of the plant.

Stage 5 - Heading

A. Heading stage is defined as the time when 50% of the panicles have exerted.
B. Heading starts when the panicle emerges from the flagleaf sheath and ends when it completely protrudes from the sheath.
C. The topmost internode elongates rapidly and pushes up the panicle.
D. It usually takes 10 - 14 days for all plants in the field to complete heading.

Stage 6 - Flowering

A. Anthesis (blooming or flowering) follows after heading and refers to the series of events between the opening and closing of the spikelets.
B. At the time of anthesis, the panicle is erect and the following events take place; the florets are open, mostly in the morning (between 9 am-12 nn); the stamens elongate and the anthers move out of the flowering glumes as pollen is shed; pollen grains fall out of the stigma; the florets then close.
C. The panicles flower beginning at the top, middle, and lower thirds.
D. Flowering occurs about 25 days after visual panicle initiation regardless of variety.
E. The plant is most sensitive to stress such as drought and temperature extremes during this stage.

IV. Describe the various growth stages of the rice plant during the ripening stage.

Stage 7 - Milk grain

A. The grain starts to fill with a white milky liquid that can be squeezed out.
B. The top of the panicle bends gently in an arc (*see figure 3.6.a*).
C. The panicle and the 3 uppermost leaves are green.

Stage 8 - Dough grain

A. The milky portion of the grain turns into a soft then a hard dough (*see figure 3.6.b*).
B. The panicles arches about 180 degrees at the tip and 90 degrees at the middle. The grain turns yellow and the whole field looks yellowish.

C. The last two remaining leaves of each tiller begins to dry at the tips.

Stage 9 - Mature grain

A. The grains are fully developed, mature, hard and yellow .
B. A greater portion of the upper leaves are dry and the panicles bend down (*see figure 3.6.c*).

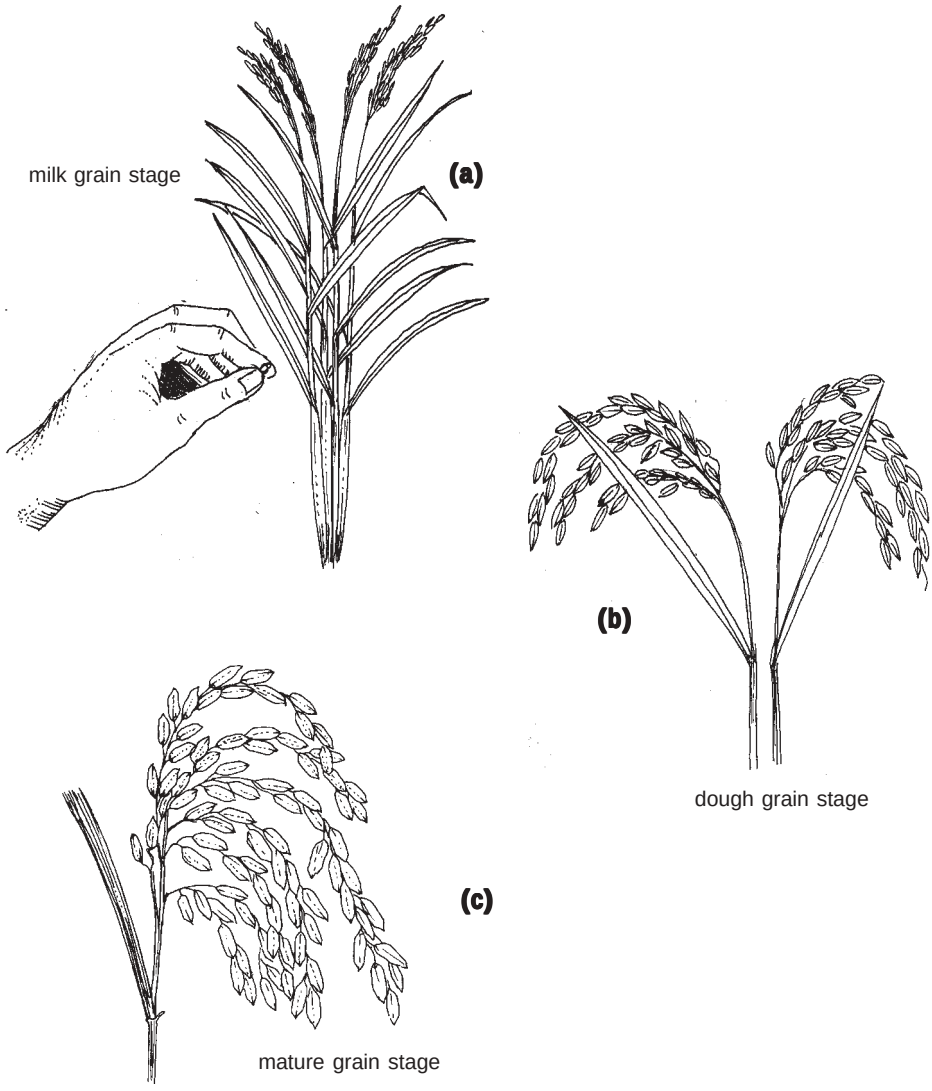

Figure 3.6. The 3 stages under the ripening phase

Suggested Methodology

- Lecture-discussion
- A visit to the farm to show the growth stages of the rice plant would be an advantage.

Materials/Visuals

- Actual specimens (rice plant at various growth stages).
- Slide, slide projector, transparencies, OHP
- Powerpoint presentation

References

De Datta, SK. 1981. Principles and practices of rice production, John Wiley & Sons, Inc., New York, USA.

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Evaluation

I. Write true if the statement is correct and false if the statement is wrong.

_____1. A 125-day variety of rice has a vegetative growth of 60 days

_____2. Maximum number of leaves at seedling stage is 3.

_____3. Tillers are produced at the seedling stage.

_____4. Panicle initiation occurs first in the main culm.

_____5. The rice florets open any time of the day.

_____6. The duration of the reproductive phase is the same in most rice varieties.

_____7. The initiation of the panicle primordium marks the start of the reproductive phase.

_____8. In early maturing varieties, maximum tillering, stem elongation, and panicle initiation occur almost at the same time.

_____9. Rice is ready to harvest when the grains are at the dough grain stage.

_____10. Anthesis refers to the development stages after pollination and fertilization.

Enrichment Activity

1. Describe the characteristics and needs of the rice plant for each stage.

STAGE	CHARACTERISTICS	CULTURAL PRACTICES

2. Compare and contrast modern and traditional varieties in terms of growth stages.

MODULE 4

CHOOSING THE APPROPRIATE VARIETY

Overview

This module specifies the factors to be considered in choosing a variety, the characteristics of varieties released by the Philippine Seed Board (PSB), and the National Seed Industry Council (NSIC) for different agroecosystems.

Farmers can choose the variety they are going to plant, but they should be guided by many factors in their decision. Foremost, among them are yield potential, resistance to pests, maturity, grain quality, and the appropriateness of the variety to the ecosystem.

Objectives and Topics

I. Discuss fthe factors to consider when choosing a variety.

A. There is an approriate variety for different agro-ecosystem practices such as: rainfed, upland irrigated, saline-prone, cool-elevated, and direct-seeded. Check the list of varieties recommended for different rice fields (*see Appendix 1, Characteristics of Popular Philippine Rice Varieties*).
B. Varieties that are resistant to pests in your locality to reduce pesticide use.
C. A higher PSB number does not mean that the variety is higher yielding.
D. Rices with high quality grain have higher selling value and demands a higher market price. IR64 is not the only variety with this characteristic. PSB Rc14, Rc18, Rc28, Rc78, Rc80, and Rc82 have qualities similar to IR64.

II. Explain high grain yield potential as a factor in choosing a variety.

A. There are factors that affect high grain yield potential of a variety: structure of the plant, lodging characteristics, type of leaves and

tillering characteristics. These characteristics differ with each variety for the different agroecosystems.

B. High-yielding varieties have erect and narrow leaves, semi-dwarf, and medium to high tillering.
C. Improved varieties have greater yield potential than traditional varieties.
D. Even under the best conditions, the traditional varieties can not yield more than the improved varieties.
E. Use of fertilizers and improved farming practices increase grain yield more in improved varieties than in traditional varieties.

III. Explain why grain quality is a factor in choosing a variety.

A. Good eating quality variety commands higher price.
B. Consumer demand good eating quality rice.
C. Some PSB varieties have grain quality similar to IR64 (*i.e.* PSB Rc28 and PSB Rc72H).
D. High milling recovery.

IV. Cite reasons why resistance to insects and diseases should be considered in choosing a variety.

A. Varieties differ in reactions to different pests.
B. Use of resistant varieties is the most practical and economical method of control against insect pests and diseases.
C. A variety should be resistant to the major pests common in the locality.
D. Not all pests significantly reduce rice yields

V. Discuss maturity and growth duration as a factor in the choice of a variety.

A. Growth duration affects the cropping pattern.Shorter crop duration is desirable to increase crop intensity thereby increasing income.
B. Rice crops with shorter growth duration can escape biotic and abiotic stresses.
C. Longer maturing varieties generally have higher yield potential.

VI. Discuss other factors to be considered in the choice of a variety.

A. *Resistance to lodging*. There are factors that affect lodging: plant

height, light intensity, spacing, amount of soil fertility, the method of crop establishment, wind velocity and rain, type of leaf sheath, stem thickness, and root structure.

B. *Resistance to drought*. Varieties that can thrive under dry conditions for sometime are advantageous especially when the crop is dry-seeded or when irrigation water is delayed or inadequate.

C. *Tolerance to problem soils*. There are varieties that can grow even in adverse soil conditions such as saline soils, zinc-deficient soils, phosphorous and iron-deficient soils, excess manganese and aluminum, and toxic soils.

Suggested Methodology

- Experiential learning. Let the participants talk about the factors to consider selecting a particular variety in small groups. Present the result of the group discussion in class. This can then be followed by a lecture discussion.

Materials/Visuals

- Slides, transparencies of the different PSB and NSIC varieties for the different ecosystems.
- Samples of the different varieties.
- Powerpoint presentation.

References

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Evaluation

True or False: Write true if the statement is correct and false if the statement is not.

_____ 1. It is not necessary for a variety to possess all the desirable characteristics as long as it meets the requirements of the locality.

_____ 2. Varieties that have short growth duration need more care.

_____ 3. The traditional varieties have better eating qualities than the modern varieties.

_____ 4. The use of resistant varieties contributes to the preservation of the environment.

_____ 5. At present, the country does not have varieties for adverse conditions.

Answer the following questions.

1. Why is high grain yield potential the primary consideration in choosing a variety?

2. Which is better, a short maturing variety or a long maturing one? Why?

3. What are the factors that affect lodging in rice?

4. Given the many factors in choosing a variety, what are the 3 major factors that you will have to consider. Explain your answer.

5. Develop a matrix of factors to be used in selecting a variety. Each determinant should have a relative weight.

MODULE 5

LAND PREPARATION

Overview

This module describes the methods and techniques in preparing the field for growing rice, their advantages as well as disadvantages.

It is not enough for the farmer to plant the recommended variety; it is equally important to have good field preparation. A well-prepared field provides good physical, chemical, and biological conditions of the soil for optimum crop growth. Adequate knowledge on field preparation is, therefore, important in rice production.

Objectives and Topics

I. Differentiate land preparation from tillage.

A. Land preparation is the process of preparing the soil to provide a favorable soil environment for plant germination and growth. Land preparation is accomplished through tillage.
C. Tillage is the process of mechanically altering some physical characteristics of the soil for it to be ideal for growing crops.

II. Enumerate the two types of tillage and the purposes of each.

A. *Primary tillage* involves the initial cutting of the soil where a crop has been grown and harvested, or when the ground is simply barren. This can be performed by using either an animal or tractor drawn or mounted implement.
B. *Secondary tillage* is the subsequent cultivation of the soil after primary tillage. This operation breaks the soil clods and incorporates materials thoroughly into the soil. The implement used is the harrow which is either comb-toothed or spike-toothed.

III. Discuss the two ways of preparing rice fields.

A. *Wetland tillage* is the usual way of preparing lowland fields for planting. The soil is tilled in a saturated or flooded condition.

B. *Dryland tillage* is the other method of preparing rice fields. This is for both lowland and upland fields where the soil is dry during land preparation. This is done to obtain a mellow, firm seedbed for sown seeds to germinate in, control weeds, and incorporate organic materials into the soil.

IV. Enumerate the factors that influence the method of land preparation.

A. Method of crop establishment
B. Water supply
C. Power resources
D. Cost and sustainability
E. Characteristic of the soil

V. List the advantages and disadvantages of wet and dryland tillage.

Wet tillage	Dryland tillage
Advantages	
- Improves weed control - Facilitates incorporation of organic materials and soil ammendments - Provides good soil condition for crop establishment	- Requires less water - Helps control golden snail - Soil aeration
Disadvantages	
- Needs high water requirement - Soil structure is destroyed - Unfavorable for subsequent establishment of rice-based crops	- High power requirement - Lack of suitable equipement

VI. Describe the steps in wetland tillage.

A. Repair the dike to impound water particularly where water supply is not reliable.
B. Irrigate the field until soft enough and suitable to the equipment to be used.
C. Perform primary tillage operations. Use any of the following moldboard plow, disc plow, rotavator or floating tiller.
D. Keep the field submerged for 5-7 days to soften the clods and to

decompose organic materials. Let the water drain naturally to allow volunteer/drop seeds and weed seeds to germinate.

E. Harrow the field 2-3 times at 5-7 days interval. The first harrowing is done along the plowing pattern to break the soil clods. The second harrowing is done crosswise to incorporate crop residues and to eradicate newly emerged weeds. Third and final harrowing aim to do initial land leveling, final incorporation of crop residues and to provide proper soil tilth for crop growth. It is normally done a day before crop establishment.
F. Level the field using a wooden plank. A leveled field can contribute to proper water, nutrient and pest management, as in golden apple snail and weeds. Even maturity of the rice crop can also be attained if the field is leveled.

VII. Discuss the steps in dryland tillage.

A. The field is plowed whenever the residual moisture permits the operation. Sometimes, rain is necessary to do the plowing.
B. In some cases, a disc harrow semi-mounted to a 4-wheel tractor is used.
C. A rotavator mounted to a 4-wheel tractor is also used especially for light soil.
D. Harrowing in the dry condition can be done with the use of spike-tooth harrow. On the other hand, some fields were initially prepared in dryland condition but the succeeding operations will be used for wetland condition.

VIII. Enumerate the implements used in wetland tillage.

A. Moldboard plow
B. Disc plow
C. Floating tiller
D. Rotavator
E. Combed-tooth harrow

IX. Enumerate the implements used in dryland tillage.

A. Disc plow
B. Moldboard plow
C. Rotavator
D. Disc harrow
E. Spiked-tooth harrow

X. Identify the factors that affect the selection of implement to be used.

A. Soil type
B. Soil condition
C. Topography
D. Presence of stubble, trash and weeds

XI. List the advantages and disadvantages of tractor and animal power.

Tractor	Animal Power
Advantages	
- Faster - More efficient - Can perform more variety of work	- Locally available - Can reproduce; source of meat, milk, and organic fertilizer - No spare parts needed
Disadvantages	
- High initial cost - Not suitable to all types of field - Needs fuel and breaks down mechanically	- Limited work output - Prone to illness, poisoning, and rustling - Requires daily attention

XII. Explain why field preparations should be done 21 days before transplanting.

A. To protect seedlings from effects of high concentration of harmful substances generated by decomposing organic matter.
B. To allow plants to utilize nutrients released during decomposition of organic matters.
C. To allow volunteer or drop seeds and weed seeds to germinate and eventually destroyed to avoid plant mixtures and competitors.

XIII. Discuss the characteristics of a well-prepared field.

A. Weeds, rice straw, and stubbles are thoroughly decayed and incorporated into the soil.
B. Soil is well puddled and leveled.

Suggested Methodology

- Lecture and field demonstration
- Experiential / participatory

Materials/Visuals

- Slides/Slide projector
- Transparencies/OHP
- Farm implements (in the field)
- Powerpoint presentation

References

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Evaluation

Multiple Choice. Select the best answer from the among the choices given.

1. Land preparation is the process of
   _____ a) breaking the clods into smaller particles
   _____ b) initially cutting the soil where a crop has grown
   _____ c) preparing the soil for planting to provide favorable soil environment for plant germination and growth
   _____ d) plowing, harrowing and leveling
   _____ e) tilling the soil in preparation for transplanting

2. Before plowing the field, it has to be:
   _____ a) measured
   _____ b) irrigated with enough water
   _____ c) tilled with tractor
   _____ d) leveled with a wooden plank
   _____ e) partitioned by levees

3. In harrowing the field,
   _____ a) the soil has to be puddled
   _____ b) the harrow is passed lengthwise then crosswise
   _____ c) use a rotary weeder
   _____ d) it must be irrigated first
   _____ e) it must first be leveled

4. Which does not belong in the group?
   _____ a) disc plow
   _____ b) floating tiller
   _____ c) rotavator
   _____ d) moldboard plow
   _____ e) spiked-tooth harrow

5. Land for transplanting rice should be plowed and harrowed
   _____ a) 1 month before transplanting
   _____ b) a week before transplanting
   _____ c) a day before transplanting
   _____ d) 3 weeks before transplanting
   _____ e) 15 days before transplanting

Discussion. Answer briefly the following questions:

1. Differentiate land preparation from tillage.

2. Differentiate wetland tillage from dryland tillage. Cite advantage and disadvantages of each.

3. What are the factors that affect the kind of method used in preparing rice fields?

4. How many days should land be plowed and harrowed before transplanting? Why?

5. Why is it important to level the field?

6. What are the characteristics of a well-prepared field?

MODULE 6

METHODS OF CROP ESTABLISHMENT

Overview

This module describes the two main methods of rice crop establishment, transplanting and direct seeding, and the practices associated with them.

Crop establishment depends on the farmer's resources, type of farm, and management capabilities. In turn, the method of crop management influences equipment, input and labor requirements and management practices.

Objectives and Topics

I. Describe the two methods of growing rice.

A. *Transplanting*. Seedlings are first raised in seedbeds before they are planted in the field
B. *Direct seeding*. Seeds are sown directly in the field.

II. Identify the factors that are considered in the choice of methods.

A. Objective/preference of farmer
B. Ecosystem
C. Resources available
D. Management capability of the farmer
E. Cropping season

III. Describe the steps in germinating seeds.

A. Soak seeds for 24 hours in running or clean water (*see figure 6.1*).
B. Incubate the seeds for 24-36 hours (or until a white dot appears, which is the emerging root) by placing them in sacks filled to one-

half capacity then tied securely. This keeps the seeds warm and increases the growth of the embryo for uniform germination.

C. Provide adequate aeration during incubation by placing seeds on top of a slotted palette (*see figure 6.2*).

D. Avoid piling the sacks on top of each other to prevent the build-up of heat. A very high incubation temperature decreases germination rate and may even kill the germinated seeds.

Figure 6.1 Soak the seeds in a drum with clean water or preferably in running water

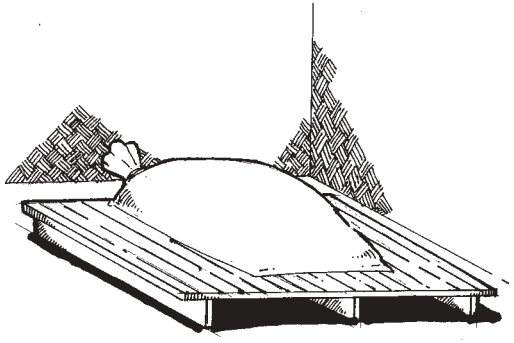

Figure 6.2 Wooden pallet promotes aeration

IV. Discuss the requirements in the selection of seedbeds.

A. It should be far from fields infected with tungro, grassy stunt, and other diseases.

B. It should be away from sources of light to avoid attracting adult stem borers, brown planthoppers, and green leafhoppers.

C. It should be near a water source

D. Good soil condition.

E. Good drainage.

V. Compare the two methods of raising seedlings for transplanting.

	Method	
Criterion	Wetbed	Dapog
Seeding rate (kg/ha)	20-40	45-65
Seedbed area (m^2/ha)	400	60
Soaking time (hr)	24	24
Incubation time (hr)	24-36	36-48
Sowing to transplanting (days)	20-25	9-14

VI. Discuss the steps in raising seedlings by wetbed method.

A. Prepare 1-1.5 m wide seedbed plots of any convenient length one day before sowing.
B. Provide a 40 cm space between beds to facilitate management of the seedbeds.
C. Raise the seedbed about 4-5 cm.
D. Apply 5 bags of organic fertilizer.
E. Level the seedbed surface for uniform water distribution and to facilitate drainage.
F. For a one-hectare field, sow 20-40 kg in a 400 m^2 seedbed.
G. Sow seeds at 50-100 g/m^2 (about a handful).
H. Water the seedbed 2-3 days after sowing (DAS). Gradually increase 1-2 cm depending on the height of the seedlings.
I. Monitor the seedbed regularly for proper management.

VII. Discuss the steps in raising seedlings by the dapog method.

A. Construct seedbeds in the same way as in the wetbed but cover the beds with either banana leaves, plastic sheets, or heavy coarse paper. This prevent the roots of the seedlings from getting in contact with the soil to facilitate removal of seedlings from the seedbed.
B. Surround the seedbed with banana bracts, course paper, or other suitable materials. Overlap the leaves to prevent holes or breakage.
C. Aside from the field, concrete floors can be used as dapog seedbed.
D. Sow the seeds uniformly.
E. Water the germinating seeds regularly and occasionally press them with a pressing board or the palm of the hand.
F. Roll the seedlings like a mat with the leaves turned inward.
G. Cut the roll into convenient sizes.

VIII. Cite the advantages and disadvantages of the dapog over the wetbed method.

Advantages	Disadvantages
- Smaller seedbed area. - Seedlings are ready for transplanting in a shorter period. - Seedlings recover faster after transplanting. - Less expensive.	- Needs intensive water management. - More difficult to transplant. - Seedlings are less competitive against weeds. - More susceptible to golden kuhol.

X. Describe the requirements of good seedlings.

A. Uniform height and growth.
B. Short leaf sheaths.
C. Free from pests and diseases.
D. More roots that are long and sturdy.

XI. Compare the two methods of transplanting.

A. *Random planting*. This is done without definite distance or spacing between seedlings.
B. *Straight row planting***.** A definite spacing is maintained between plants. This is done through the use of planting guides, markers, and mechanical transplanter.

X. Enumerate the guidelines in pulling and transplanting seedlings.

A. Pull out seedlings a day before or immediately before transplanting.
B. Pull seedlings gently to prevent root injury.
C. Bundle the seedlings in convenient sizes for easy handling during transplanting.
D. Plant seedlings as indicated by the guides or marker. Hold seedlings between the thumb and the fore and middle fingers and insert gently into the soil.
E. After planting a row, move backwards to the next row and resume planting.
F. Replant missing hills within 5-7 days after transplanting.

XI. Enumerate the advantages of straight row planting method.

A. Enhances the attainment of an optimum plant spacing and population.
B. Facilitates the application of fertilizers and pesticides.
C. Facilitates weeding and roguing.
D. Off-types can be easily identified.

XII. Explain the importance of right spacing in transplanting.

A. Proper spacing increases potential yield by 25-30%.
B Closer spacing enhances suppression of weeds but results in mutual shading thus, reducing the maximum use of sunlight by the plants. It also increases lodging and cost of transplanting.
C. Spacing the plant too far apart lessens the plant population needed in obtaining maximum yield per unit area, thereby resulting to low yield.

XIII. Cite the importance of transplanting the right number of seedlings at the right depth.

A. Transplant 1-3 wetbed seedlings per hill at a depth of 2-3 cm and 5-10 seedlings at less than 2 cm depth for seedlings raised from dapog.
B. Tillers normally develop 5-10 days after transplanting. Deep planting delays tillering.

XIV. Explain what to do with extra seedlings and missing hills.

A. After transplanting, place extra seedlings along the alleyway of the field to be used for replanting.
B. Replant missing hills within 5-7 days after transplanting to avoid uneven maturity.

XV. List the requirements of direct seeding.

A. Use a suitable variety.
B. Practice good land preparation.
C. Effective water management.
D. Proper seed preparation and seeding.
E. Integrated nutrient management (INM)
F. Integrated pest management (IPM)

XVI. Enumerate advantages of wet seeding over transplanting.

A. Reduce labor cost by doing away with seedbed preparation, seedbed care, pulling of seedlings and transplanting.
B. Shorter duration of maturity. Generally, direct seeded rice matures 7-10 days earlier than transplanted rice because seedlings are not pulled.

XVII. Discuss the steps in wet seeding method.

A. Use a variety that is suitable for wet seeding.
B. Prepare the field thoroughly for the crop to have an initial head start over weeds. Weeds are more competitive in direct seeding since they grow simultaneously with the crop.
C. After soaking for 24 hours and incubating for 24-36 hours, air dry the seeds before seeding for easier broadcasting. Use a rate of 40-80 kg/ha.
D. At the time of broadcasting, saturate the field but do not allow any standing water.
E. Flash irrigate the field 3 days after broadcasting to resaturate the soil.
F. Herbicides may be applied 5-6 days after broadcatsing the seeds for more effective weed control.
G. Apply pre-emergence herbicide based on manufacturers for more effective weed control.
H. When necessary, hand-weed 20-25 DAS to eliminate weeds that survived herbicide treatment or use post-emergence herbicides.

XVIII. Discuss the steps in dry seeding method.

A. Prepare the field thoroughly.
B. Repair dikes during land paration to impound water in the paddies.
C. Sow the seeds immediately after the final land preparation by drum seeding or broadcasting. Cover the seeds by harrowing. Use 60-80 kg/ha.
D. Apply herbicide immediately after a rainfall following seeding. Repeat application of the following rainfall to ensure success if the field is weedy.
E. Apply 1/2 of the recommended fertilizer rate 15-20 DAS and the remaining 1/2 at 40-45 DAS.

XIX. Discuss the steps in using drum seeding method.

A. Prepare the field thoroughly.
B. Level the soil one day before seeding.
C. Soak seeds for 24 hours in clean or running water.
D. Incubate the seeds for 24 hours by placing them in sacks filled to one half capacity then tied securely. This keeps the seeds warm and increases the growth of the embryo for uniform germination. Over incubation will normally result to longer radicle which limits the seeding rate and precession of the machine.
E. Avoid using incubated seeds that are still dripping wet. Wet seeds tend to stick and this affects the metering accuracy of the machine.
F. Saturate the field during seeding but do not allow standing water.
G. Construct canalets along the side of the paddy to facilitate draining of water.
H. Place the seeds into the drum cylinders up to the level in which the shafting is just slightly covered. At this level, the seeds can still roll inside the cylinder when the drum rotates.
I. For manually drawn seeder, positon the seeder in a corner with straight levees and along the longest side of the paddy. For hand tractor drawn seeder, leave space at the sides enough for one pass (this will be seeded last at the end of every paddy).
J. Adjust the seeder to the desired seeding rate (40 or 80 kg/ha). This can be adjusted by covering one line of rows in the drum cylinders with a rubber band provided on the cylinder.
K. Reposition the seeder for the return pass by setting the first row annexed to the row of the first pass (usually at a space of 20 cm) and continue the headlands of the field.
L. Seed filling can be done during the break of the operation at the headlands.
M. Do not irrigate the field after seeding. Flash irrigation can be done when the field is about to crack.
N. Follow the recommended procedure for pre and post emergence herbicides for direct seeding or use rotary weeder if desired at 20-25 DAS.
O. Apply fertilizer at 10 DAS with minimal floodwater or before using the weeder to incorporate the fertilizer and ensure maximum efficiency.

Suggested Methodology

- Lecture-discussion
- Lecture-demonstration
- Field visit

Materials/Visuals

- Slides/transparencies, slide projector, OHP
- Powerpoint presentation

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Evaluation

Self-Check Test. Answer the following questions.

1. What are the factors to be considered in selecting method of crop establishment?

2. What are the requirements of a good seedbed?

3. Why should we select an area away from light sources for our seedbed?

4. What are the advantages and disadvantages of using the dapog method?

5. Differentiate random planting from straight row planting.

6. Why should the replanting of missing hills be performed in 5-7 days?

7. Why is observing the recommended spacing important in transplanted rice?

8. Discuss the advantages of wet-seeding over transplanting.

MODULE 7

IRRIGATION WATER MANAGEMENT

Overview

This module discusses the functions and importance of water management in the growing of a successful rice crop. It also describes the growth stages of rice in relation to water use, types of irrigation and water management practices commonly adopted.

Efficient water supply is one of the most important factors in successful and sustainable rice production. Since water is continuously becoming a scarce resource it has to be properly managed. Water greatly affects the rice plant, the soil nutrients, the physical status of the soil, the insect pests and diseases, the weed population.

Objectives and Topics

I. Discuss the role of water to the soil-plant system and its importance.

A. Plants absorb water from the soil through roots, transport it via conducting vessels, and release it to the atmosphere through their stomata. Along these processes, nutrient absorption, photosynthesis, metabolism, and transport of materials concurrently occur.
B. When water absorbed is lesser than transpired, plants close their stomata and curl their leaves to lessen water loss. Thus, carbon dioxide (CO_2) intake and leaf area exposed to sunlight is greatly reduced leading to reduction of photosynthetic rate.

II. Cite functions of water in rice production.

A. Helps control weeds and aids in land preparation.
B. Cools the soil to be favorable for plant growth.
C. Dissolves and carries mineral nutrients from the soil to the plants and distributes photosynthetic product to the different parts of the plant.

D. Serves as medium for physico-chemical processes in the soil to support plant growth and development.
E. Cools the plant, helps regulates stomatal openings and make the plant erect and leaves fully expanded for better sunlight exposure and carbon dioxide intake.

III. Determine the total water requirements of the rice crop.

A. The total irrigation water requirement for the whole cropping season varies depending on soil type, topography, proximity to drainage, depth of water table, sub soil profile characteristics, crop duration, area of contiguous fields and cultural management practices.
B. Medium to heavy textured soils requires around 700 - 1,500 mm of water per cropping season under traditional practices at 100 days growing period.

IV. Enumerate the sources of water for rice production.

A. Surface waters (rivers, lakes, surface drainage, creeks, and ponds).
B. Groundwater (can be obtained through pump to lift the water from subsurface to the ground level and to the farms.
C. Precipitation (rain and drizzle).

V. Describe the common water management practices being employed.

A. Continuous flooding with stagnant water – Irrigation to a maximum pond water depth before floodwater subsides.
B. Continuous flooding with flowing water – Non-stop application of water.
C. Rainfed water management - Impounding rain water in the paddy. Thus, water use efficiency is greatly influenced by skill of the farmer, the sequence of paddies, amount of rainfall, mutual consent among neighboring farmers, the rate of seepage and percolation and the slope of the land.

VI. Explain how water is lost from the rice field.

A. *Evaporation* is the moisture lost in vapor form from the free water surface. This is affected by solar radiation, temperature, wind, relative humidity and plant cover.
B. *Percolation* is the downward movement of water through soil due to

gravity, hydrostatic pressure or both. The finer the soil, the lower the percolation rate. The presence of deep cracks can increase percolation. Puddling, presence of hard pan, soil compact layer or nonporous subsoil greatly reduce percolation. Ideal percolation rate is around 5 mm per day for lowland rice.

C. *Seepage* is the horizontal movement of water through a levee and normally flows into the soil surface or into streams, rivers, or drainage. Sometimes, seepage water can be used in other farms.

D. *Runoff or surface drainage loss* is the movement of water over a levee. It occurs when water is not controlled or it is impossible to control like in the case of strong rains or floods.

VII. Explain when and how irrigation water is being applied in transplanted rice field.

A. In the seedbed, when all seedlings had immerged, maintain around 2 - 3 cm pond water depth to prevent soil from becoming hard during seedling pulling.

B. Within one week after transplanting, maintain soil saturation to control snail infestation and establish better soil-root contact.

C. During the tillering up to booting stage, occasional soil aeration stimulates deeper root growth, tiller production, firm root anchorage, correction of micronutrient imbalances, and removal of toxic substances from the soil.

D. During ripening period, stop irrigation and if there is still any standing water one week before the expected harvest time, drain it for more uniform grain maturity. This also facilitates harvest and post-harvest operations.

E. During the rest of the growing period, apply around 5-7 cm water depth.

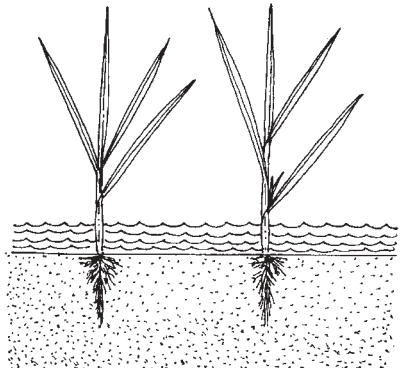

Figure 7.1 Maintain 2-3 cm water depth to promote tillering

VIII. Discuss the use of water in weed management.

A. Weeds can be effectively controlled with the aid of water, not by how much the volume used but by when and how it was used.
B. A uniform thin water blanket can control more weeds than deep and non uniform pond water depths in the paddy.
C. Some herbicides require the presence of flood water during application while some do not require to be most effective.
D. Weeds must be controlled as early as possible for maximum benefits and before water saving activities starts.
E. Water-saving options can be applied starting 3-4 weeks after crop establishment.

IX. Cite general ways of minimizing water loss.

A. Shallow dry tillage soon after harvesting can minimize the formation of deep cracks and occurrence of bypass flow. Tilled layer acts as mulch that reduces soil drying and cracking while small soil aggregates block big cracks.
B. Construct and maintain farm ditches and dikes that are necessary for efficient water conveyance and distribution among rice paddies.
C. Reduce percolation during land preparation and crop growth by plowing the field immediately after initial irrigation to seal big cracks.
D. Shorten land preparation to not more than 4 weeks but puddle the soil very well to increase water-holding capacity.
E. Practice synchronous farm operation (variation of around 2 weeks) within a considerable area and within 2 weeks starting land preparation.

X. List some condition-specific water-saving options

A. Application of 3-5 cm water every time water subsides. This technique minimizes percolation rate due to hydrostatic pressure and prevent runoffs. Applicable to all types of soils intended for lowland rice production. Ideal for canal irrigation system.
B. Minimal irrigation to maintain soil saturation. This can be applied in areas with less weed pressure and having heavy to lighter soils. This technique also minimizes percolation rate and runoff. Can be used in canal irrigation and pump irrigation systems.
C. Application of 5-7 cm water during irrigation after 5-7 days of no water on the paddy. Applicable to heavy clay soils. Ideal for canal irrigation systems, pump irrigation systems and soils with micronutrient imbalances.

D. Application of 5-7 cm pond water every 10-14 days interval. This can be applied in soils with shallow water table, high water holding capacity, do not develop deep cracks and more rigid hard pan. Irrigation frequency can be further reduced depending on water availability. Suited for pump irrigation systems.
E. Reduction of pond water depth of around 20-40% less than the usual practice every irrigation time. Applicable to all types of soils and ideal for pump irrigation systems and tail ends of gravity irrigation.

XI. Explain why water-saving techniques reduce water use during the growing period without reducing yield.

A. Water saving techniques does not necessarily reduce yield despite significant reduction on irrigation water applied because only the excess water is removed. Thus, much water is being saved. It can be done by decreasing the frequency of irrigation and/or reducing the water volume per irrigation. This practice also provides some degree of aeration for better root and tiller development and to correct some soil nutrient imbalances.
B. Water-saving techniques can be done starting 15-30 days after transplanting or seeding. During this time, seedlings have recovered from transplanting stress and crop canopy is already closed to be more competitive against weeds.

Suggested Methodology

- Lecture/Discussion
- Participatory Discussion

Materials/Visuals

- Slides/slide projector
- Transparencies/OHP
- Powerpoint presentation

References

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Evaluation

True or False. Write true if the statement is correct and false if it is wrong.

_____ 1. Rice thrives better with less water.

_____ 2. Shallow water depth at the tillering stage faciliates tiller production and firm root anchorage.

_____ 3. During the last phase of the growth period, plenty of water is still needed.

_____ 4. A hectare of rice plants uses about 10 million liters of water per growing period.

_____ 5. The rice plant is most sensitive to water deficit from booting to flowering stage.

_____ 6. By repairing the levees, water loss is minimized.

_____ 7. Seedlings need plenty of water because they are rapidly growing.

_____ 8. If prolonged drought occurs after root establishment, there will be a reduction in yield.

_____ 9. Drought at the beginning of the reproductive stage greatly reduces yield.

_____ 10. Sandy loam holds water longer than clay loam.

Participatory Discussion

1. What are the functions of water in rice production.

2. Describe the common water management practice being employed by farmers.

3. How can water management be used as a weed control?

4. Enumerate the ways by which we can conserve water in rice production.

5. What are the ways by which water is lost in rice fields? Explain each.

6. Explain when and how irrigation water is applied in transplanted rice fields

Enrichment Activity

List the different growth stages of the rice plant. Give the appropriate water management technique for each stage for more effective use of water.

MODULE 8

Integrated Nutrient Management

Overview

This module explains the concept of integrated nutrient management (INM). It discusses the nutrients (macronutrients and micronutrients) needed by the rice plant and the factors needed to increase fertilizer use efficiency. This module also discusses proper nutrient management techniques, identifying symptoms of nutrient deficiency, and how to avoid them.

The rice plant requires an adequate supply of nutrients from various sources for optimal growth. These nutrients are supplied by indigenous sources such as soil minerals, soil organic matter, rice straw, manure, and water (rain and irrigation), but the amount supplied is usually insufficient to achieve high and sustainable yields.

Objectives and Topics

I. Define what is INM.

A. Integrated nutrient management is basically the skillful handling of organic and inorganic fertilizers or a combination of these fertilizers, accompanied by sound cultural management practices. These include the use of appropriate varieties, good water management, effective pest management and crop rotation.
B. Likewise, assessment of soil fertility and crop yields is an important consideration.
C. INM is very important in rice production. It ranges from the nutrient needed by the rice plant, factors to consider in applying fertilizers to the nutrient deficiencies, and how to manage them
D. There are 17 elements needed by the rice plant to complete a healthy life cycle. They are generally grouped into macronutrients and micronutrients.

E. The rice plant requires relatively high amount of macronutrients and small amount of micronutrients (*see table 9.1*).
F. The most common limiting nutrients are nitrogen (N), phosphorus (P), potassium (K), sulfur (S), and Zinc (Zn).

II. Describe the primary concerns of INM.

A. Sustenance of soil fertility through the use of inorganic and organic fertilizers, where nitrogen, phosphorus, potassium, sulfur and zinc are provided by commercial inorganic fertilizers, the other macro and microelements are provided by organic fertilizers taking into consideration the indigenous nutrient-supplying capacity of the soil.
B. Increased fertilizer-use efficiency through the use of appropriate cultural management practices to reduce nutrient losses, appropriate fertilizer management such as proper time and method of application, and correct source and rate of fertilizers.

III. Enumerate the nutrients needed by the rice plant.

A. Rice and other crops need nutrients (both macronutrients and micronutrients) for their growths and yields. Macronutrients are those elements needed by the crops in large quantities, while micronutrients are elements needed in relatively small amounts.
B. In addition to carbon (C), hydrogen (H), and oxygen (O), the macronutrients also include nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S).
C. The micronutrients are iron (Fe), zinc (Zn), manganese (Mn), copper (Cu), boron (B), and silicon (Si).
D. The average amount of nutrient removed by modern rice varieties for every ton of grain yield is given on *Table 8.1*.

IV. Discuss the factors that should be considered to increase fertilizer-use efficiency.

A. Soil

1. There are protocols that may be used to fully characterize the fertilizer requirement of the crop. This avoids over-fertilization that predisposes the plant to fungal and bacterial diseases, reduces cost of inputs, and enhances the physical and chemical properties of the soil.

2. Determine the soil physical (type, texture), chemical, and biological properties contributing to soil fertility.
3 Use effective ways for diagnosing nutrient limitation of the soil such as laboratory analysis, soil test kit, or the minus-one element technique (MOET).

ELEMENT	Kg
N	17.5
P	3
K	17
Zn	0.05
S	1.8
Si	3.5
Mg	4.0
Ca	0.5
Fe	0.5
Mn	0.5
Cu	0.012
B	0.015

Table 8.1 Average amount of nutrient removed by modern rice varieties for every ton of grain yield.

B. Variety and crop management.

1. Use high-quality seeds of varieties that are efficient users of nutrients and tolerant to pests and diseases.
2. Level the soil properly and maintain a water level of 2-5 cm until 3-4 weeks after transplanting.
3. Irrigate only after 5-6 days of no standing water to save 16-35% water without reducing yield. This is also a good practice to manage Zn-deficient soils, control lodging, and correct some other soil related nutrient problems.
4. Transplant young seedlings at (10-21 day-old).
5. Choose a suitable planting density. Hills spaced 20 x 15 cm apart during dry season (DS) and 20 x 20 cm during wet season (WS) with 1-3 plants per hill in transplanted rice and 40-60 kg of seeds per ha in broadcast, wet-seeded rice.
6. Remove weeds, especially at the early vegetative stage and before applying fertilizers. Weeds complete with the rice plants for nutrients. They grow faster when fertilized. The more vigorous the weed growth is, the greater the competition.

C. Planting time

1. Follow the appropriate planting season and time in the locality. During the WS, plants are leafy and shade each other so that the food manufactured in the leaves is low. This means that the nutrient requirement is lower than during the DS.
2. Apply higher rates of NPK during the DS because growing conditions are more favorable.
3. Observe synchronous planting to minimize concentrated damage caused by rice pests such as green leafhoppers, stem borers, rats, and birds.

D. Organic fertilizer management.

1. Organic nutrient sources such as rice straw, azolla, sesbania, indigo, ipil-ipil leaves, and animal manure can supply substantial amounts of nutrients.
2. The use of organic nutrient sources can reduce inorganic fertilizer needs.
3. Rice straw, stubble or undecomposed organic material should be incorporated 2-3 weeks before crop establishment to avoid negative effects (toxicities, immobilization).
4. Burning of straw results in losses of N (100%), P (25%), and K (20% due to leaching). If straw is burned, it should be spread in the field and not burned in heaps.
5. Seedlings can be pulled easily if organic fertilizers are applied in the seedbed.
6. Incorporation of organic materials can also improve the water holding capacity and structure of the soil so that roots have better access and use of available nutrients. It also increases microbial biomass, nitrogen-fixing bacteria, and other organisms that control the transformation of fertilizer materials into plant available forms.

V. Discuss N management.

A. N is commonly the most limiting nutrient in rice because it is not supplied in sufficient amounts by the soil and other indigenous sources. The cheapest common N source is urea (46% N), which can be incorporated into the soil or topdressed during the season. Currently, only about 30-40% of the N applied with fertilizer is taken up by the crop in farmers' fields, but the recovery can be greatly increased with good management:

1. Basal application

   a. Apply basal N fertilizer only in transplanted rice and only if soil fertility is low (< 3 t of grain yield per ha in an unfertilized plot). Avoid large basal applications of more than 40 kg N/ha.
   b. Broadcast the fertilizer onto the mud before the final harrowing (*see figure 8.1*). There should be no standing flood water. Keep the field saturated until 5-6 days after transplanting and keep a 2-5 cm water level until 3-4 weeks after transplanting. This practice minimizes gaseous N losses to the atmosphere.

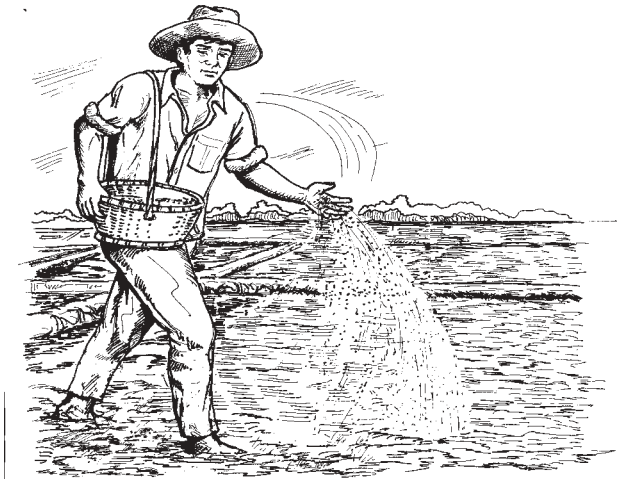

Figure 8.1 Broadcast the fertilizer into the mud before the final harrowing

   c. To minimize losses, avoid N application in direct-seeded rice because (1) seedlings are too small for the large N supply; (2) seedlings still have food up to 15 days after sowing; and (3) field water will be drained up to 10 days after seeding, thus, avoiding large N losses. Also, basal application is not recommended if indigenous N supply (INS) is greater than 40 kg/ha.

2. Topdressing

   a. Use the leaf color chart (LCC) to determine the plant's requirement for N.
   b. Apply more N (or more often) when the crop demand for N is large, which is between mid tillering and panicle initiation.

c. Use more splits, especially with long duration varieties, coarse textured soils, and in the DS when yields are higher. Divide the total fertilizer N recommendations into 2-3 (WS) or 3-4 (DS).
d. Do not apply more than 40 kg N/ha per topdressing.
e. Do not topdress N when leaves are wet because fertilizer will stick to wet leaves and may cause leaf burn.
f. Do not topdress N if heavy rain is expected because the fertilizer could be washed out or lost through runoff.
g. A late topdressing of urea at heading to flowering stage is only recommended in the DS and only when crop stand is good and pest pressure is low.
h. Do not apply urea during the hottest time of the day or when it is windy to avoid gaseous N losses to the atmosphere (volatilization).

B. Fertilizers applied before transplanting should be incorporated into the soil to prevent N losses into the air and to keep the fertilizer nearer the roots.
C. N fertilizer application at tillering and early panicle initiation (EPI) stages increases the number of panicles per square meter, number of spikelets per panicle, and dry matter production.
D. The best time to apply N fertilizer is at transplanting and EPI. Fertilizer application after flowering increases spikelet sterility and causes late production of tillers.
E. When N fertilizer is broadcast onto floodwater under hot and windy conditions, especially when the rice canopy is still small, N is lost rapidly.
F. The rice plant highly responds to N fertilizer right after transplanting and just before the reproductive stage (5-6 days before visible panicle initiation).
G. If the INS is 50 kg/ha, recovery efficiency of applied N is 45%, and 17 kg N/ha is taken up per hectare, apply 153 kg N/ha for a target yield of 7 tons/ha in the DS. However, real time crop need for N can be assessed with the use of the LCC.
H. Too much nitrogen fertilizer use allows much vegetative growth, resulting in poor light distribution under the rice canopy. As a consequence, the rice plant is prone to lodging and has poor filling of grains because of intensive mutual shading.
I. For medium-textured soils (sandy loam, silt loam, and loam), apply N 3-4 times:

1. during the final harrowing (basal);
2. during mid-tillering: 30-35 days after transplanting (DAT);

3. during panicle initiation;
4. during early flowering.

J. For fine-textured soils (silty clay loam, sandy clay loam, sandy clay, silty clay, and clay), apply N fertilizer 2-3 times:

1. during final harrowing (basal);
2. during mid-tillering;
3. during early panicle initiation (EPI).

K. Long-maturing varieties have long vegetative phases, hence requiring more split applications for N fertilizer.

1. For 115-day varieties, split N into 2 doses: apply 2/3 to 1/2 of the N as basal and remaining 1/3 to 1/2 N at EPI.
2. For 120-130 varieties, split N into 3 doses: 1/3 basal; 1/3 at tillering; and 1/3 at EPI.

L. For transplanted rice, apply N fertilizer as basal (if INS is 40 kg/ha or lower) just before the final harrowing. Succeeding fertilizer applications should be based on the LCC.
M. For direct-seeded rice, determine when to topdress N using the LCC.
N. If the amount of the fertilizer available is small (*e.g.*, 30 kg/ha), apply all of it in a single dose at EPI or 65 days before maturity.

VI. Enumerate the symptoms and causes of N deficiency.

A. Symptoms

1. Stunted plant growth.
2. Reduced tiller number.
3. Leaves are small, narrow, and erect (they turn yellow-green and brown).
4. Older leaves become light straw-colored and then wither.

B. Causes of N deficiency

1. Low soil N supply.
2. Insufficient application of N fertilizer.
3. N loss due to heavy rainfall (leaching and seepage).

C. How to prevent N deficiency

1. Apply nitrogen fertilizer as needed based on LCC reading.

2. Apply nitrogen in splits to increase efficiency.

VII. Discuss the proper and efficent P management.

A. P requires a long-term management strategy because P is not easily lost or added to the root zone by the biological and chemical processes.
B. P management should be considered as a long-term investment in soil fertility.
C. Prevent P deficiency than to treat P deficiency symptoms.
D. If P is limiting yield, apply sufficient P to overcome the limitation. Otherwise, apply only a smaller maintenance dose as insurance where required.
E. Apply P fertilizer as basal as it is essential for root development and production of tillers. P fertilizer would not be effective if applied later in the season.
F. P fertilizer application provides a residual after-effect that can persist for several years, but it is most effective to apply a smaller amount every season than applying a large amount, yet less frequently.
G. Incorporate rice straw. Although the total amount of P contained in the straw is small (1 kg P per ton straw), it will contribute to maintaining a positive P balance in the long term.
H. If 20% of rice straw is removed at harvest, 15 kg P/ha is taken up per ton of grain, indigenous P supply (IPS) is 15 kg P/ha and recovery efficiency of applied P is 20%, apply 69 kg P_2O_5/ha to get a yield of 7 t/ha in the DS. This could give a positive P balance in the soil.
I. P deficiency results in poor growth (small leaves, slow recovery) of green manure crops, delayed maturity (often by 1 week or more), large proportion of empty grains, low grain weight and poor grain quality, and absence of algae in floodwater.

VIII. Describe the symptoms and causes of P deficiency.

A. Symptoms

1. Stunted plant growth.
2. Reduced tiller number.
3. Erect stem with small narrow, erect leaves.
4. Young leaves look normal but old ones turn brown and wither.

B. Causes of P deficiency

1. Low soil P supply.
2. Insufficient application of mineral P fertilizer.
3. Low efficiency of applied P fertilizer owing to high P-fixation capacity or erosion losses (in upland rice fields only).
4. P immobilization in calcium phosphate due to excessive liming.

C. How to prevent P deficiency

1. Irrigate or flood the field to reduced ferric phosphate.
2. Apply P fertilizer as basal or at early tillering stage.

IX. Discuss the proper and efficent K management.

A. K provides general strength to plants and contributes to generating energy and crop growth.
B. Unlike N and P, K does not have a pronounced effect on tillering, but it increases leaf area, spikelet number, percentage filled grain, and grain weight.
C. The amount of K to apply is determined by the soil type, cropping intensity, straw management, and target rice yield.
D. Broadcast or incorporate 50-75% K fertilizer into the soil during the final harrowing (basal). Topdress the remaining 50% or 25% at EPI stage to increase panicle growth and development. In non K-fixing soils, apply all K as basal.
E. In clay soil, apply K as basal along with N and P fertilizers.
F. In medium-textured soils, topdress K fertilizer at the rapid tillering stage to avoid leaching.
G. Alternate wetting and drying of the soil may increase K in the soil solution.
H. Like P, K management should also be considered as a part of a long-term soil fertility management because K is not easily lost from or added to the root zone by the short-term biological and chemical processes.
I. If K is limiting, apply sufficient K to overcome the limitation. Otherwise, apply only a smaller maintenance dose as insurance where required.
J. If 20% of the rice straw is removed from the field at harvest, 17 kg K/ha is taken up per ton of grain, indigenous K supply (IKS) is 85 kg/ha and recovery efficiency of applied K is 50%, apply 82 kg K_2O/ha for a target yield of 7 t/ha in the DS. This can give a positive K balance in the soil.
K. Do not burn rice straw but return threshed materials to the field to increase K supply. Returning straw can save on K fertilizer be-

cause the straw contains 80% of the K in plants.

L. Soil types, particularly prone to K deficiency, include medium textured soils and highly weathered acid soils (*e.g.*, acid upland soils).

X. Describe the symptoms and causes of K deficiency.

A. Symptoms

1. Stunted plant growth.
2. Slightly reduced tillering.
3. Yellowing of interveinal areas of lower leaves starting from the tip then the leaves turn brown and wither.
4. Older leaves with brown spots.

B. Causes of K deficiency

1. Low soil K supply.
2. Low amount of K fertilizer applied.
3. Rice straw burned and not returned to the field.
4. Excessive use of N or N + P fertilizers with insufficient K application.

C. How to prevent K deficiency

1. Apply K fertilizer.
2. Avoid burning rice straws if possible.

XI. Discuss the proper and efficent Zn management.

A. Zn deficiency problem must be corrected to attain high yields. In Zn-deficient soils, nitrogen, phosphorus, and potassium (NPK) fertilizers alone cannot provide good yield unless Zn deficiency is corrected. For example, it was observed that in Agusan del Norte, where most rice fields are deficient in Zn, application of NPK fertilizers alone decreased lowland rice grain yield, whereas application of Zn as zinc oxide with NPK dramatically increased yield.

B. Several Zn sources such as $ZnSO_4$, ZnO, $ZnCO_3$, Zn frits (silicate), $Zn_3(PO_4)$, and Zn chelates have been used for ameliorating Zn deficiency in soils. The water soluble salts of Zn and its natural and synthetic chelates generally are more efficient than low solubility salts. The order of effectiveness of the various Zn carriers is as follows: Zn-DTPA > Zn-EDTA > Zn-fulvate > Zn-citrate > $ZnSO_4$ > ZnO > Zn frits.

C. High phosphorus levels in rice soils induce Zn deficiency by immobilizing Zn in the roots. Avoid mixing phosphate fertilizer with Zn compounds in one application to rice.

E. Crop response to Zn application is modified to a large extent by the environment. Zinc deficiency symptoms in rice can be acute in cold weather while mild or absent in warm weather. The response of rice to Zn application decreases with an increase in soil temperature.

D. Though the rice plant requires only 300 grams of Zn to produce a ton of grain yield, zinc deficiency will result in low yield (<4 t/ha) no matter how much nitrogen, phosphorus, and potassium fertilizer is applied. Results of our field experiments in Zn-deficient soils have shown that an increase of 0.5 t/ha to more than 1.0 t/ha is obtained with application of $ZnSO_4$ or ZnO even without NPK fertilization. Combining $ZnSO_4$ fertilizer with NPK fertilizer will improve fertilizer use efficiency in Zn-deficient lowland soils.

XII. Describe the symptoms and causes of Zn deficiency.

A. Symptoms

1. Stunted plant growth.
2. Slightly reduced tillering.
3. Base and midrib of young leaves are yellowish.
4. Old leaves are rusty brown.
5. Reduced size of leaf blades.
6. Uneven growth of the plants.
7. Delayed maturity.

C. How to prevent Zn deficiency

1. Apply 10-15 kg (1 bag) of zinc sulfate/ha within 10 days after transplanting or;
2. Dip seedlings in 2% Zn Oxide (ZnO) suspension.
3 Practice intermittent irrigation.

XIII. Discuss the proper and efficient S management.

A. Sulfur (S) is an essential nutrient that is needed by the rice plant to form chlorophyll, the green pigment. It is also needed to activate certain enzymes and synthesize vitamins such as biotin, thiamin, and vitamin B that are needed for plant growth.

B. In recent years, sulfur deficiency in lowland ricefields has become widespread and could be contributing to declining yields in some

rice growing areas especially where heavy doses of nitrogen (N), phosphorus (P), and potassium (K) have been applied regularly.

C. Descalsota et al. (1999) reported that sulfur deficiency is observed in some soils of Ilocos Norte, Cagayan, Isabela, La Union, Nueva Ecija, Nueva Vizcaya, Pangasinan, Tarlac, Pampanga, Zambales, Cavite, Batangas, Laguna, and Iloilo. They reported that the levels of available sulfur, *i.e.* sulfate sulfur, on the sites studied ranged from 0 to 9 parts per million (ppm). The critical level of sulfate sulfur in flooded rice soils is 9 ppm.

XIV. Describe the symptoms and causes of S deficiency.

A. Symptoms

1. Stunted plant growth.
2. Reduced tiller and leaves (especially the youngest).
3. Leaves become yellow-whitish and brown.

B. Preventive measures

1. Use ammonium sulfate instead of urea.
2. Incorporate straw instead of burning it. About 40-60% of S contained in straw is lost during burning.

XV. Explain the procedures used in determining the nutrient needs of rice.

A. Determine the soil physical (type, texture), chemical, and biological properties contributing to soil fertility.
B. Use effective ways for diagnosing nutrient limitation of the soil such as laboratory analysis, soil test kit, or the minus-one element technique (MOET).
C. Collect soil from the field at least two months before transplanting.
D. Conduct the MOET following guidelines from PhilRice.
E. In moderate to severe cases where some symptoms are manifested by the standing crop, use LCC to determine N deficiency.

XVI. Discuss the fertilizer recommendation for hybrid rice.

A. As a rule of thumb, relatively little N, all P, 50% of the K, and S should be applied basal or early in the season.
B. Conduct a MOET for nutrients other than N, and if deficiencies are observed, apply fertilizer as given in Table 9.2.

C. If a MOET cannot be conducted, follow rules for applying P, K, and S given in earlier sections. Succeeding N applications will be based on the LCC (*see table 8.3*), and the remaining 50% K should be applied at early PI.
D. It is not recommended to apply combined fertilizers after the tillering stage unless they contain only N and K.
E. Apply 10-25 kg (1 bag) of zinc sulfate/ha within 10 days after transplanting even MOET is conducted or not, or dip seedlings in 2% ZnO suspension.

Table 8.2 Quick fertilizer nutrient calculator for basal or early applications

Deficient nutrient other than N	Fertilizer requirement	Recommended basal application (Choose any of the following, depending on the availability and cost of the fertilizer materials)
P	20-25 kg N + 20-30 kg P_2O_3	[1 bag urea + 3 bags 0-18-0] or [3 bags 16-20-0] or [2 bags 20-10-0 + 2 bags 0-18-0] + [3 bags 17-7-17 + 2 bags 0-18-0]
K	20-25 kg N + 20-30 kg K_2O	[1 bag urea + 1 bag 0-0-60] or [3 bags 17-0-17]
S	20-25 kg N + 20+24 kg S	[2 bags of ammonium sulfate (AS)]
PK	20-25 kg N + 20-30 kg P_2O_3 + 20-30 kg K_2O	[1 bag urea + 3 bags 0-18-0 + 1 bag 0-0-60] [4 bags 10-15-15] or [4 bags 10-15-20] or [4 bags 12-12-12] or [3 bags 14-14-14]
PS	20-25 kg N + 20-30 kg P_2O_3 + 20-24 kg S	[3 bags 16-20-0]
KS	20-25 kg N + 20-30 kg K_2O + 20-24 kg S	[2 bags of AS + 1 bag 0-0-60]
PKS	20-25 kg N + 20-30 kg P_2O_3 20-30 kg K_2O +20-24 kg S	[3 bags 16-20-0 + 1 bag 0-0-60]

Table 8.3 Fertilizers to topdress when LCC is less than 4

Time of application	Amount of fertilizer per hectare	
	Dry Season (DS)	Wet Season (WS)
Early growth stage, 14 to 30 DAT	1.5 bag urea or 3 bags AS	1 bag urea or 2 bags AS
Rapid growth stage, 34 to 50 DAT	[2 bags urea[a] or 4 bags AS] + 0.75 bag 0-0-60[b]	[1.5 bag urea[a] or 3 bags AS] + 0.75 bag 0-0-60[b]
Late growth stage, around 54 DAT	1.5 bag or 3 bags AS	1 bag urea or 2 bags AS
10% heading (only if crop stand is excellent and pest pressure low)	0.5 bag urea or 1 bag AS	---

a) Apply only once
b) About 50% of the total K rate should be applied at early PI together with urea

Note: 1 bag 0-0-60 contains 300 kg K_20

Suggested Methodology

- Lecture-discussion with the use of transparencies and slides to show samples of nutritional deficiencies
- Case discussions of rice nutritional problems met in the fields
- Participatory discussion

Materials/Visuals

- Slides, slide projector
- Transparencies, OHP
- Powerpoint presentation

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Evaluation

True or False. Write true if the statement is correct and false if it is not.

_____ 1. If the rice plants have stunted growth, it is enough to apply nitrogen fertilizer.

_____ 2. Integrated nutrient management is primarily knowing the right kind of fertilizer then applying it to the plants.

_____ 3. There are 13 essential elements for rice, 6 macronutrients and 7 micronutrients.

_____ 4. The more fertilizers you apply to the plants, the more robust they grow.

_____ 5. P fertilizer is more effective if applied in splits later in the season.

_____ 6. Sound cultural management is part of INM.

_____ 7. To have a rational fertilizer application, one must know the nutrients available in the soil and the nutritional status of the plant.

_____ 8. The need for nutrient by the plant is the same at all stages of the plant.

_____ 9. It is not important that all the essential elements are present in available form for the plant.

_____ 10. It is only in the Philippines where rice plants have nutritional disorders.

Participatory Discussion

1. What are the factors to consider to increase fertilizer efficiency?

2. Discuss the advantages of using organic fertilizer. Give examples of organic nutrient sources.

3. Why is excessive nitrogen not good for the rice plant?

4. Identify the 5 most common limiting nutrients in rice soils. Describe the deficiency symptoms caused by these nutrients.

5. Discuss the management of N,P,K,S, and Zn fertilizers.

MODULE 9

Integrated Pest Management

A. Understanding the Integrated Pest Management (IPM) Concept

Overview

This module discusses the definition, objectives, basic concepts, principles, and the practical applications of integrated pest management (IPM). IPM is the selection, integration, and implementation of pest management that will ensure favorable, economical, ecological, and sociological consequences. IPM is not a packaged technology for pest control. It is a philosophy embodying a design and evaluation process for decision making in managing ecosystems to maintain pest population below damaging level.

Objectives and Topics

I. Explain the objectives of IPM.

A. The main objetcive of IPM is to **improve decision-making.**
B. It is the concern of IPM to provide the necessary knowledge and tools to the different groups of decision makers to improve their capability in making sound decision needed in the development and implementation of pest management programs.
C. Pest management is people-oriented and, in order for it to be put into general practice, the management specialist must use and demonstrate the pest management technology and successfully teach it to others.
D. IPM has enabled farmers to save unnecessary insecticide inputs, prevent exposure to health hazards due to pesticides, and reduce environmental pollution.
E. With the successful implementation of IPM, it is expected that:

1. Ecological disruption and unexpected pest outbreaks are minimized.
2. Natural control is maximized.
3. Better pest management decisions are made.

II. DIscuss the different concepts and principles of IPM.

A. A species is not considered a pest if it occurs below damaging levels.

1. Insects may occur in all fields but only in small numbers.When species population become and remain, for some reason, higher than normal, then they can be considered pests.
2. Remember that no two pest situations are the same; often there will be a significant difference in pest populations even between neighboring fields.
3. Pest situation of the same field will vary from season to season or year to year in the character or severity of its pest problems
4. In other words, a management program that worked last year may entirely be inappropriate for the next year.

B. The ecosystem is the management unit.

1. The individual organism, the population, the community and the physical factors are the building blocks of the ecosystem.
2. It includes the farmer and his family, his work animals and other livestock and his surroundings.
3. The value of the ecosystem concept is that it emphasizes the interaction of all factors in a given area, and that it forces us to look further than studies in isolated areas or aspects of biological activity.
4. Diversifying the ecosystem can be important in encouraging the role of natural enemies.

C. Natural control must be maximized.

1. IPM is an ecologically based pest control strategy that relies heavily on natural mortality factors such as natural enemies (predators, parasitoids, and microorganisms), and weather.
2. Control by natural enemies (biological control) is cheap, effective, permanent, and non-disruptive of other element of the ecosystem.
3. In rice ecosystems, plant feeding and beneficial arthropods are predominant. In most cases, the beneficial ones are more in number and species than the pest they contol.
4. In pest management, natural enemies need to be conserved and augmented or improve their effectiveness.

D. Control procedures must not produce unexpected undesirable effects.

1. Artificial controls must be looked on as tools to be fitted into the environment with little disruption as possible.
2. The effects of the various actions both on each other and on the rest of the environment must be considered to prevent the negation of one pest control factor by another.
3. Actions should be made to restore and preserve natural balances in the system and not eliminate species.

III. Identify other information needed for better pest management decision making.

A. IPM programs do not include eradication methods. The concept is to suppress a pest and not to annihilate it.
B. IPM uses pesticides, but only after natural control factors operating in the ecosystem have been carefully considered.
C. Pesticides become useful when other carefully planned control management options have failed and emergency intervention is necessary (see Appendix 2.1-2.7).
D. The crucial problem however for pesticide use to become an integral part of a successful pest management program is the proper timing of pesticide treatments.
E. Furthermore, any person working with pesticides in the field should be aware of:

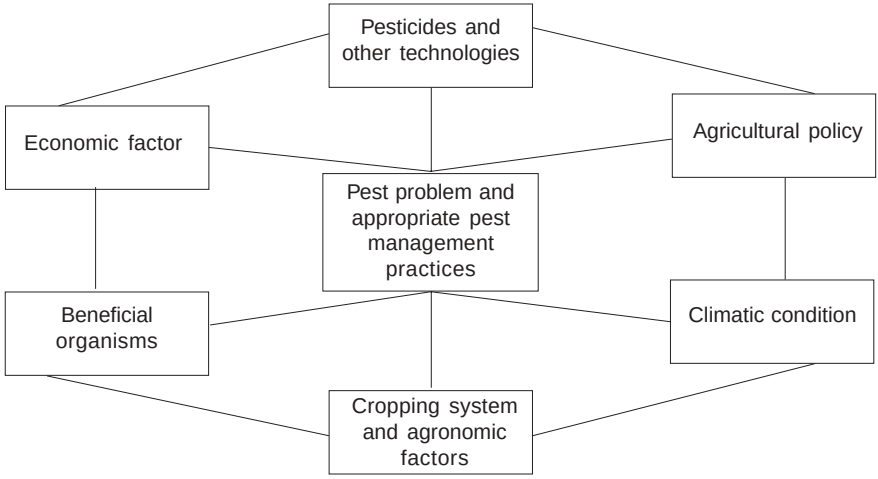
1. The identity of the chemicals being used
2. How it should be used or applied
3 How much to use
4. When to apply
5. How often it should be applied
6. The potential human, livestock, and environmental toxicity of the material
7. Safety precautions that may be needed
8. What to do in case of an emergency (poisoning)

F. It is equally important in pest management point of view to know:

1. The identity of the target pest(s) for each application.
2. What non-target species are in the field especially natural enemies and pollinators that might be affected by the application.
3. What alternative methods or materials may be available for management of the target pest(s).

G. It is the responsibility of the person who prescribes or recommends the use of any insecticide to equip the user with these information. It is only then that pesticide use can be a successful component of pest management programs.
H. Remember that many species of rice pests are highly mobile, hence, individual management efforts by farmers may not suffice.
I. Spray activities in individual fields often make pest population unpredictable and encourage patches of extremely high densities.
J. The average pest densities recover more rapidly than predator/parasitoid densities. Therefore, an individual farmer's effort to decrease pests may in fact result in an increase of insect pests and the farmer will have to pay an "ecological cost" and "health cost" in addition to the cost of insecticides and labor.

IV. Identify the factors that affect pest status, pest damage and pest management.



V. Discuss the guidelines in the effective implementation of IPM in the rice farm.

A. Explain the crop's biology and how it is influenced by the immediate environment.
B. Identify key pests and their biology, behavior, and distribution as influenced by the environment, then pinpoint weak links in their life cycle.

C. Identify existing biological control agents of major pests and understand their biology and distribution.
D. Develop management methods that conserve and augment existing biological control agents.
E. Practice a sound monitoring system.
F. Practice field sanitation and crop diversification.
G. Practice synchronous planting.

VI. Discuss the practical application of the IPM concept.

A Be sure of the cause of the damage by checking the following:

1. Characteristic damage**.** How does the crop look when damaged by a certain insect pest?
2. Symptoms. How does the crop look when damaged by a certain disease?
3. Growth phase affected. Most pests damage rice only at certain growth stages. If you are not sure of the pest that damaged the crop, observe the damage and the growth phase that it matches. For instance, whorl maggots attack during the early vegetative phase while rice bugs attack during the grain filling phase.

B. Check the pest for the following:

1. Distinguishing characteristics. Know how the pest looks like and where it lives. For instance, brown planthoppers inhabit the plant base while green leafhoppers inhabit the upper portion and the plant.
2. Stage of the pest causing the damage**.** Insects undergo different growth stages but not all growth stages of a pest are destructive to the crop. Know the destructive stage of a pest so that you can devise the best management strategy. For instance, stemborers and other lepidopterous pests are destructive only during the larval stage while planthoppers and leafhoppers are destructive at the nymphal and adult stages.

C. Combine all possible methods of pest management:

1. Use resistant varieties. Plant a variety resistant to as many pests as possible. Know what insect pests and diseases a variety is resistant to. You do not need to apply pesticides against these pests.

2. Practice cultural control. Synchronous planting is highly desirable to prevent the transfer of pests to other fields. This means planting within 3 weeks by all farmers within the area.
3. Harvest at ground level or incorporate residues to the soil to eliminate hosts of pests and diseases.
4. If possible, leave the field fallow for at least four weeks or plant crops other than rice to disrupt the life cycle of the pests.
5. Use recommended fertilizer rates, especially nitrogen, as this can make the plant susceptible to some pests.
6. Prepare the land thoroughly to maintain water level uniformly for weed and snail management.
7. Use the right seeding rate.
8. Keep paddy dikes as small as possible, narrow and low so that rats can not burrow in them.

D. Conserve biological control agents or friendly organisms. There are more friendly insects than insect pests. Keep the friendly insects alive. Use insecticides only when the result of the agroecosystem analysis (AESA) indicates that there are not enough biological control agents and there are enough pests to damage the crop. Biological control agents are the best insurance against insect pest population explosion without additional expense.
E. Use chemical control only when no alternative methods or a combination of measures are applicable or available

VII. Gain insights into insecticides as a control measure for rice pests.

A. The use of chemical insecticides is decreasing with the advent of IPM, an ecologically sound approach to pest control.
B. The proper use of insecticides involves a thorough understanding of insect population dynamics and the infestation/yield loss relationships and the economics of insecticide use.
C. The proper use of insecticides requires the farmers to have training and there must be readily available advice.
D. Application equipment needs to be reliable and simple in design so that it requires little maintenance.
E. Chemical insecticides are often a hazard because users are not aware of the pesticide hazards. Besides, they pay too little attention to the instructions written in the package.
F. Avoid indiscriminate use of pesticides.

Methodology

- Lecture
- Use of slides and other visuals
- Powerpoint presentation

Materials/Visuals

- Pictures/slides showing unpolluted rivers, polluted/silted river; field with healthy rice plants, field attacked by insect pests/diseases; effect of indiscriminate use of insecticides; IPM application (FFS-TOT pictures)

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Evaluation

True or False. Write true if the statement if correct and false if it is not.

_____ 1. The practice of IPM ensures higher yield from the rice farm.

_____ 2. Synchronous planting should be practiced by farmers to get the full benefit of IPM.

_____ 3. Rice pests damage the crop at all stages.

_____ 4. All insects in the farm are pests to the rice crop.

_____ 5. To be effective in the practice of IPM, there is a need to know the crop's biology and the pest's growth cycle.

_____ 6. IPM utilizes various control methods in a harmonious way.

_____ 7. IPM is a packaged technology for pest control.

_____ 8. In the long run, it is more economical to spray insecticides.

_____ 9. The use of resistant varieties can be a control measure.

_____ 10. There are more insect pest than natural enemies hence relying on biological control is not advisable.

MODULE 10

Integrated Pest Management

B. Integrated Insect Pest Management

Overview

This module describes the most common species of insects observed on the rice plant, their characteristic damage, destructive stage,life cycle and stage of the plant that they damage. Management practices/options for each species are also suggested and discussed.

Not all insects that feed on the rice plants are pests. A species is only considered a pest if the damage it caused will result in a significant reduction of yield. Neither are they destructive throughout their life cycle. It is therefore important to know the life cycle of the insect for a better management strategy.

Objectives and Topics

I. Identify and describe the different groups of insects feeding on the rice plant.

   A. Several insects feed on the rice plant at all stages of crop growth. Some feed from seedling to maturity while others feed only during certain stages.
   B. Some are defoliators (feed on the leaves), sucking insects (suck plant sap on leaves, leafsheaths, stems, flowers or grains), stem borers (feed on the stems), and root feeders (feed on the roots).
   C. Most species of insects feeding on the rice plant in the field do not necessarily constitute a pest. This is because the damage they inflict can easily be compensated by the plant itself, hence, no significant reduction in grain yield.

II. Discuss the ways on how the rice plant can compensate for damage inflicted by the pest. The rice plant has the ability to compensate for damage through:

   A. Regrowth of damaged tissues.

B. Production of new or additional leaves and tillers.
C. Increased size of new leaves.
D. Increased photosynthesis in undamaged leaf.
E. Increased chlorophyll content of subsequently produced leaves.
F. Increased nutrient uptake by new or remaining tissues.
G. Delayed senescence in remaining tissues.

III. Describe the different species, their life cycle, destructive stage, their characteristic damage and susceptible stage of the plant.

A. **Defoliators**

1. *Whorl maggot* – flies; adult flies are grayish; 2mm long, 1/3 size of housefly.

   a. Destructive stage – maggot or larva
   b. Susceptible stage of plant – seedling to early tillering stage
   c. Characteristic damage- distortions on the sides of emerging leaves due to larval feeding before leaves unfold
   d. Life cycle – 4 weeks

2. *Rice caseworm* – moth; white; 6 mm long.

   a. Destructive stage – larva
   b. Susceptible stage of plant – seedling to early tillering
   c. Characteristic damage – ladder-like appearance of white or green portions; leaf tips appear as if cut by scissors; presence of larval cases attached to the plant or floating on the water
   d. Life cycle – 35 days

3. *Leaffolder* – moth; light brown with horizontal black markings on wings, attracted to shady areas).

   a. Destructive stage – larva
   b. Susceptible stage of plant – tillering to flowering
   c. Characteristic damage – longitudinal white and transparent streaks on leaf blades caused by removal of leaf tissues by larval feeding; leaf blade folded into tubular structures
   d. Life cycle – 25-35 days

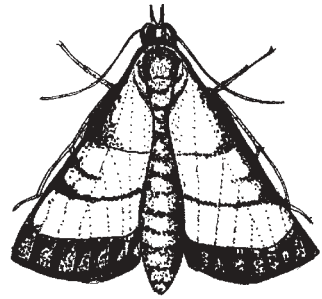

Figure 10.1 Leaffolder moth

4. *Cutworm and army worm* – moth; color of larva varies with color of leaves where they feed; cutworm larva has prominent black spots on thorax; curls into C-shaped when disturbed; pupates in the soil, feeds also on grasses.

    a. Destructive stage – larva/caterpillar
    b. Susceptible stage of plant – seedling to panicle stage
    c. Characteristic damage – young larva eats the leaves, older cutworm larva may eat the whole plant; armyworm larva may cut panicles; feed also on grasses
    d. Life cycle – 34-42 days

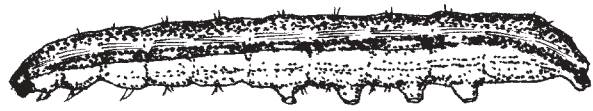

Figure 10.2 Armyworm larva

B. **Sap Suckers** (Leafhoppers and Planthoppers)

1. *Green Leafhoppers* (GLH) – nymphs are green and adults are bright green with variable black markings on the wings; suck plant sap and transmit the rice tungro virus; found mostly on leaves or upper portion of plant.

    a. Destructive stage – nymphs and adults
    b. Susceptible stage of plant – seedling to tillering
    c. Characteristic damage – vector of tungro virus
    d. Life cycle – 22-26 days

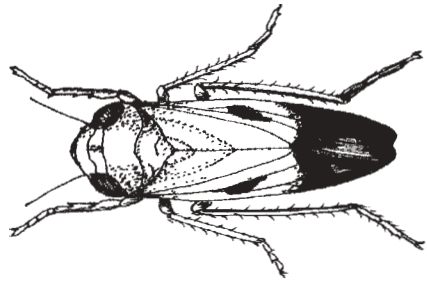

Figure 10.3 Green Leafhopper

2. *Brown planthopper* (BPH) – adults are brown, short- or long-winged; 2.5 – 3 mm long; nymphs are whitish; found at base of plant; transmits grassy stunt and ragged stunt virus.

    a. Destructive stage - nymphs and adults
    b. Susceptible stage of plant –early tillering to flowering
    c. Characteristic damage – wilting and eventually death resulting in hopperburn due to excessive feeding; drying of plants progresses in a circular manner
    d. Life cycle – 20-24 days

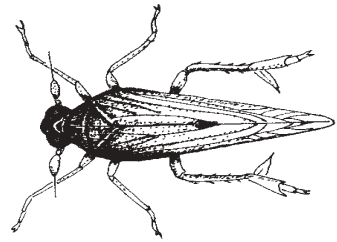

Figure 10.4 Brown Planthopper (long winged)

3. *Whitebacked planthopper* (WBPH) – nymphs are white to a strongly mottled dark gray or black and white; adults have white strip on their back; females are short-winged and males are long-winged.

    a. Destructive stage – nymphs and adults.
    b. Susceptible stage of plant – tillering to flowering.
    c. Characteristic damage – heavy infestations may cause outer leaves of a hill to show burn symptoms but rarely causes hopperburn
    d. Life cycle – 19 -24 days

4. Rice Black Bug (*RBB*) - nymphs are grayish to black, adults are black and are weak fliers but can be transported over long distances by wind, ships, or other means of transportation; strongly attracted to light.

    a. Destructive stage – nymphs and adults
    b. Susceptible stage of plant – vegetative stage onwards
    c. Characteristic damage – at the vegetative stage, central leaf may roll resembling a deadheart; dead panicles or whiteheads; heavy infestation results in bugburn
    d. Life cycle – 26-37 days

C. **Stem borers**

1. *Yellow stem borer* (YSB) – female moth is straw colored, with very distinct black spot on each forewing; larva with hairless yellowish body; eggs laid on the upper surface of leaf in oval batches and covered with mat of anal hairs of female moth.
2. *White stem borer* (WSB) – moth is white and no black spot on wings; larva like YSB but white in color; eggs similar to YSB.
3. *Striped stem borer* (SSB) – moth straw color to light brown with silvery scales and a row of black dots at the tip of forewings; larva with five longitudinal purplish brown stripes; eggs are scale-like, laid near the base of leaf, not covered with hair.

    a. Destructive stage – larva
    b. Susceptible stage of plant – seedling to panicle stages
    c. Characteristic damage – deadheart at tillering stage and whiteheads at reproductive stage
    d. Life cycle – 30 - 45 days

IV. Describe the management options applicable to each species.

A. Whorl Maggot and caseworm

1. Drain the field since adults of whorl maggots are attracted to fields with standing water and to kill caseworm larvae.
2. Conserve and enhance natural enemies as a biological control method.
3. Practice synchronous planting.

B. Leaffolder

1. Avoid excessive use of fertilizer.

2. Conserve and enhance natural enemies as a biological control method.
3. After careful evaluation on the severity of damage on the flag leaves, insecticide application may be considerd.
4. Practice synchronous planting.

C. Cutworm and armyworm

1. Maximize natural/biological control. Eggs and larvae are attacked by several species of parasitoids and predators.
2. Keep fields free of weeds to remove alternate hosts.
3. If population is high especially at early instars, insecticide application may be needed.
4. Practice synchronous planting.

D. Brown planthoppers

1. Plant resistant varieties.
2. Practice synchronous planting.
3. Maximize natural control. Eggs, nymphs and adults are attacked by several species of parasitoids and predators. Several species of fungi also infect the nymphs and adults.
4. If population becomes high, insecticide application may be needed especially in hybrid rice seed production.

E. Whitebacked planthoppers

1. Practice synchronous planting.
2. Maximize biological control. Eggs, nymphs and adults are attacked by several species of parasitoids and predators. Several species of fungi also infect the nymphs and adults.
3. If population becomes high, insecticide application may be needed especially in hybrid rice seed production.

F. Green leafhoppers:

1. Plant resistant varieties.
2. Practice synchronous planting.
3. Maximize natural/biological control. Eggs, nymphs and adults are attacked by several species of parasitoids and predators. Several species of fungi also infect the nymphs and adults.
4. Chemical control. The use of insecticides is not necessary when tungro infected plants are not present around the area and if tungro infection occurs after 45 days after transplanting.
5. Spray applications based on tungro symptoms will be too late

and unnecessary because the hoppers would have transmitted the virus about 7-14 days earlier. Hence, in areas where tungro is endemic, do not wait for symptoms to appear.

6. Spray appropriate insecticides as soon as green leafhoppers are observed.

G. Rice Black Bug

1. Practice synchronous planting.
2. Grow tolerant varieties.
3. Avoid alternate hosts like gabi, corn, and several species of weeds.
4. Biological control – conserve naturally occurring parasitoids and predators; nymphs and adults are infected with *Metarhizium* fungus.
5. In case of heavy infestation, chemical control may be necessary.

H. Stem borers

1. Practice synchronous planting.
2. Know the peak of stem borer population in your locality and schedule transplanting to avoid it.

For example – light trap catches of YSB adults at PhilRice Maligaya from 1996 to 1998 showed two population peaks during the year. The first peak was observed from last week of March to third week of May and the second peak from September to October. Based on this information, time your transplanting so that the crop will be harvested before the peaks of stem borer population.

3. Handpick and destroy egg masses.
4. Collect egg masses, place them in small covered bottle and observe when eggs hatch. Check if parasitoids emerge from the eggs. If more than 30% of egg masses are parasitized, no significant damage is expected, hence insecticide application may not be necessary.
5. If however, larvae emerge from more than 70% of the eggmasses collected, insecticide application may be necessary depending on the abundance of egg masses in the field (1-2 egg masses for every m^2). If and when the application of insecticide is deemed necessary, apply the insecticide before the larvae enter the stem (1-2 day after the collected eggs hatch).
6. Biological control - Maximize the use of biological control agents like parasitoids, predators and microbial agents.

7. Harvest plants at the ground level to remove stem borer habitat.
8. Plow and flood the field immediately after harvest to kill larvae and pupae inside the stubbles (in fields where high WH incidence was observed).

Note: With the implementation of the recommended management practices for stem borers, farmers can prevent an estimated yield loss of 20%, or approximately 0.8 to 1 ton, based on an average yield of 5 tons per hectare.

Methodology

- Lecture/Discussion
- Demonstration
- Case study
- Experiential/participatory

Materials/Visuals

- Pictures/slides showing the different insect pests
- Actual insects/specimens
- Powerpoint presentation

References

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Evaluation

True or *False*. Write true if the statement is correct and false if it is not.

_____ 1. Defoliators feed on the stems of plants.

_____ 2. Pest outbreak is the only factor considered in pest management.

_____ 3. GLH is the vector of tungro.

_____ 4. It is alright to use pesticides as long as these are not misused.

_____ 5. All insects undergo the same stages of development.

_____ 6. Tillers that survive the seedling maggots' infestation are discolored or have transparent patches.

_____ 7. When rice leaffolders infestation is high, the plant may have many folded leaves.

_____ 8. Deadhearts is a damage caused by rice stemborers.

_____ 9. It is much safer to provide the plants with excessive nitrogen fertilizer.

_____ 10. Synchronous planting is a good management strategy for controlling pests.

Answer the following questions:

1. What are the major group of insects that feed on the rice plant. Give examples of each group.

2. How does the rice plant compensate for damage caused by insect pests.

3. Are all insects pests? When is an insect considered a pest?

4. Do all insects undergo the same life cycle? Justify your answer.

5. Why do we have to exercise caution in using pesticides?

Enrichment Activity

Identify and illustrate the major pests of rice. Identify which stage of the insects life-cycle it is most damaging to crops, and describe the damage symptoms.

MODULE 11

Integrated Pest Management

C. Role of Natural Enemies in Pest Management

Overview

This module discusses the role of natural enemies in the management of pests in rice. It describes the different groups of natural enemies, advantages and disadvantages of using them as biological control agents, and management considerations in the implementation of biological control.

Control by natural enemies or biological control is the core component of IPM in rice and should be regarded as the first line of defense in pest management. Biological control rests on the premise that parasitoids, predators, and pathogens are able to maintain their host's populations at lower levels than if they were absent. It is important to realize that few insect pests occurring at low levels are helpful for they provide food to maintain populations of beneficial species at levels which can prevent damaging pest outbreaks.

Objectives and Topics

I. Define biological control.

A. Biological control is a type of pest control which involves the action of natural enemies or beneficial organisms.
B. It can be *natural biological control,* where man does not actively manipulate natural enemies or *applied biological control* which involves the use and management of natural enemies by man.

II. Discuss the advantages and disadvantages of biological control.

A. Advantages

1. Biological control, be it naturally occurring or applied is safe,

permanent, economical and nondisruptive to other elements of the ecosystem. However, it is also the factor most likely to be disturbed by the employment of other pest control tactics especially the use of pesticides.

2. The safety of biological control is outstanding, since many natural enemies are host-specific or restricted to a few closely related species.
3. Relatively permanent because efficient natural enemies often continue to have an effect year after year with little or no assistance from man, provided they are not interfered with, in some way.
4. Economical since, once efficient natural enemies are present, little may need to be done other than to avoid disruptive practices.
5. Non-disruptive to other elements of the ecosystem because they do not have any harmful effects on non-target organisms.

B. Disadvantage

Length of time required if applied biological control is to be implemented because of the research and other initial effort involved in setting up.

III. Describe the characteristics of an ideal natural enemy.

A. Density dependent - their effects increase with increasing host density and decrease with decreasing host population. An ideal natural enemy is one that does not permit the host or prey to increase to any degree after it has been reduced to a low level.
B. Exceptional searcher and has a high reproductive capacity - able to find the host or prey at very low densities and keep it there. Since very few natural enemies of this nature are known, there is a need to rely on the integration of two or more management techniques to keep the pest at non-economic levels.

IV. Characterize the groups of natural enemies.

A. Predators

1. Free-living organisms throughout their life
2. Kill their prey immediately
3. Usually larger than their prey and require more than one prey to complete their development

4. The most conspicuous forms, and are sometimes confused with pests, tend to be generalist feeders.

    a. Insects

        a.1 Beneficial species like lady beetles, carabid beetles, predatory grasshoppers and crickets, water bugs, etc.

    b. Spiders

        b.1 Prefer moving prey but some may attack insect eggs.
        b.2 Many species hunt only at night; others make webs and collect whatever enters the web throughout the day and night.
        b.3 Some species also search the plants for prey such as leafhoppers, planthoppers, moths, and larvae of stem borers and defoliating caterpillars.

    c. Other species of predators

        c.1 Frogs, birds, etc. are also important predators of some insect pests

B. Parasitoids/Parasites

1. Often smaller or about the same size of its host and requires only one host/prey to complete development into adult.
2. May attack any life stage, but the majority attack eggs, larvae, nymphs, some attacking pupae and relatively few attacking adults.
3. Generally smaller and more host specific than predators. They could be:

    a. Egg parasitoids; larval parasitoids; pupal parasitoids;
    b. Egg-larval parasitoids in which the parasitoid egg is laid in the host egg, but the parasitoid larva kills the host larva;
    c. Larval-pupal parasitiod in which the parasitoid egg is laid in the larva and the parasitoid larva finally kills the pupa;
    d. Larval-adult parasitiod in which the parasitoid egg is laid in the larva and parasitoid larva finally kills the adult.

4. Lay their eggs either in groups or singly on, in, or near a host. When the parasite egg hatches and the immature parasitoid develops, the host usually stops feeding and soon dies.

5. In most cases, parasitoids become more effective as host abundance increases. They can find their hosts even when host densities are low.

C. Pathogens

1. Microorganisms naturally occurring as control agents;

   a. Applied as microbial insecticides;
   b. Major groups are fungi, viruses and bacteria.

2. Fungi

   a. Important organism for leafhoppers and planthoppers control;
   b. Outbreaks of the fungi *Hirsutella citriformis*, *Beauveria bassiana*, or *Metarhizium spp.*, can infect and kill 90-95% of a population of brown planthopper in the field;
   c. For caterpillar pests, the most striking disease outbreaks are caused by the fungus *Nomurea rileyi* and populations of these pests do not reach damaging levels when the fungus is present.

3. Viruses

   a. Important control agents for caterpillar populations. The most important are the nuclear polyhedrosis and granulosis viruses.
   b. Virus-infected caterpillars cease feeding and the body content liquefies, bodies become flaccid and often hang from the rice plant.
   c. Outbreaks of viruses in populations of leaffolders and cutworms have been recorded.

D. Bacteria

1. *Bacillus popillae* and *Bacillus thuringiensis* (Bt)
2 *Bacillus popillae* causes milky disease in white grubs (common in upland ecosystem) while Bt is a very pathogenic bacterium to many species of lepidopterous larvae.
3. Bt is being commercially used as a microbial insecticide.

V. List examples of different groups of natural enemies.

A. Predators: Insects

1. Lady beetles – *Coleoptera: Coccinellidae*

a. Typical coccinellid beetle.
b. Oval and brightly colored in shades of red and yellow.
c. Consume 5-10 prey (eggs, nymphs, larvae, adults) a day.

2. Ground Beetles – *Ophionea* sp., *Coleoptera: Carabidae*

a. Active hard-bodied insects.
b. Both larvae and adults search for leaffolder larvae and planthoppers.
c. Each predator consumes 3-5 larvae per day.

3. Crickets – *Orthoptera: Gryllidae*

a. *Metioche vittaticollis* adult is black and nymphs are pale with brownish stripes.
b. *Anaxipha longipennis* is brown.
c. Primarily egg predators of striped stemborers, leaffolders, armyworms, whorl maggots.
d. Also feed on small larvae and nymphs of hoppers.

4. Grasshopper – *Orthoptera: Tettigonidae*

Conocephalus longipennis or meadow grasshopper

a. slanted face, long antennae.
b. adults are yellow and green while nymphs are green.
c. predator of rice bug and stem borer eggs and hopper nymphs.
d. can consume 3-4 stem borer eggmasses a day.

5. Water Bugs: *Microvelia* and *Mesovelia* sp. - *Hemiptera: Vellidae*

a. Small fast-moving ripple bugs abundant in flooded fields.
b. Adults are broad shouldered.
c. Congregate to feed on planthopper nymphs and other small, soft-bodied insects.
d. Can prey on 4-7 hoppers a day.

6. Plant Bugs

   Cyrtorhinus lividipennis – Hemiptera: Miridae

   a. Feed on planthopper and leafhopper eggs and young nymphs.
   b. Adults and nymphs are black with green wings.
   c. Feeds consumes 7-10 eggs or 1- 5 hoppers a day.

7. Damselflies and dragonflies

   a. Damselflies are weak fliers compared to the dragonflies.
   b. With narrow wings and long slender abdomen.
   c. Nymphs are aquatic and can climb up rice stems to search for hopper nymphs.

8. Earwigs

   a. Characteristic hind pair of forcep-like pinchers used for defense.
   b. Shiny black with white bands between abdominal segments.
   c. Prey on leaffolder larvae and consume 20-30 prey daily.

B. Predators: Spiders

1. All species of spiders in the rice field are beneficial.
2. Prey on stem borer moths, planthopper and leafhopper nymphs.
3. Consumes 5-15 prey a day.

C. Parasitoids: Egg parasitoids

1. Wasps: *Tetrastichus schoenobii Ferriere & Telenomus rowani* (Gahan)

   a. Parasitize stem borer eggs.
   b. *Tetrastichus* adults are metallic blue-green.
   c. *Telenomus* is black and barely half the size of Tetrastichus.
   d. Both may parasitize the same egg mass but not the same egg.

2. *Psix lacunatus* and *Telenomus cyrus*

   a. Parasitize rice black bug eggs.
   b. *Psix* has hairless eyes and a pitted body.
   c. *Telenomus* has short hairs on its eyes and smooth.

3. *Gonatocerus* spp., *Anagrus optabilis, Oligosita* spp.

   a. Parasitize hopper eggs.
   b. Tiny wasps that have oar-shaped wings with long hairs on the margins.
   c. Adults are brown to dark yellow brown with short waists.
   d. *Gonatocerus* parasitizes an average of 8 eggs a day.
   e. *Anagrus* parasitizes 15-30 eggs a day.
   f. *Oligosita* parasitizes 2-5 eggs a day.

4. *Copidosomopsis nacoleiae*

   a. Wasp lays eggs in leaffolder eggs and parasite larvae develops inside the leaffolder larvae.
   b. Adults are gray to black.
   c. Wasp eggs divide many times and 200-300 wasps are produced from a few eggs. Hundreds of wasp pupae can be seen through the skin of a leaffolder larva.

D. Parasitoids: Larval parasitoids

1. Host: Stem borer Larva

   a. *Amauromorpha accepta metathoracica* - adults are red and black with a white band at the tip of the abdomen.
   b. *Xanthopimpla flavolineata* - medium-sized stout wasp, yellow orange in color with black markings on each abdominal segment.
   c. *Stenobracon nicevillei* - orange-brown body and three black markings on each of the front wings and two black bands on the abdomen.
   d. *Phanerotoma* sp. – small, light brown wasp which has three segments of its broad but short abdomen.

2. Host: Leaffolder larva

   a. *Trichomma cnaphalocrosis* - large slender wasp, black and yellow with an orange brown abdomen. The ovipositor is half the length of the abdomen.
   b. *Macrocentrus philippinensis* - medium-sized with short waist, long orange or dark yellow abdomen and a long ovipositor.
   c. *Cardiochiles philippinensis* - medium-sized stout black wasp.
   d. *Cotesia* spp. – small but stout with clear wings.

e. *Goniozus* nr. t*riangulifer* - small ant-like wasps with flat black bodies and few wing veins.
f. *Elasmus sp.*- elongate small wasps with pointed abdomen, black with a black and red abdomen.

3. Host: Whorl maggot larva

Opius sp. – samll, orange-brown wasps with long antennae

4. Host: cutworm larva

Snellenius manilae - looks like *Cotesia*

5. Host: Several species of lepidopterous larvae (leaffolder, green semilooper, hairy caterpillar, striped stemborer, and pink stemborer)

a. *Itoplectis narangae* - medium-sized with a black head and thorax, orange legs, and abdomen with a black tip.
b. *Charops brachypterum* — large with a black body and yellow orange markings on the bases of the antennae, legs, and abdomen greatly enlarged at the end.
c. *Temelucha philippinensis* - medium-sized, fast flier, orange brown, flattened abdomen and shorter antennae
d. *Cotesia* sp.- black with the base of the hind legs brown to red.
e. *Brachymeria spp.* – distinguished by yellow markings on the legs.
f. *Trichomalopsis apanteloctena* – metallic green wasp with red eyes, yellow legs and short antennae.

6. Host: skipper larva

Argyrophylax nigrotibialis – gray or black spiny flies slightly larger than a housefly; puparia near the dead skipper larva are covered with white powder.

7. Host: Leafhoppers and planthoppers

a. *Dryinids:* ant-like in appearance; females usually wingless and have a pair of pincher-like front claws to grasp prey. Males are winged.

a.1 *Haplogonatopus apicalis* - attack leafhoppers

a.2 *Pseudogonatopus nudus* - attack planthoppers: brown body.
a.3 *Pseudogonatopus flavifemur* - attack planthoppers; black.

b. *Big-headed flies:*

b.1 *Tomasvaryella subvirescens* - small black flies with large round heads formed entirely by the compound eyes; yellow shoulder, transparent wings, and a hairy ridge on each femur.
b.2 *Tomasvaryella oryzaetora*: small black flies with large round heads formed entirely by the compound eyes; black shoulders, a brownish tinge on the front wings, and no hairs at the bases of hind femurs.
b.3 *Pipunculus mutilatus* and *P. javanensis* – yellowish brown tibia and tarsi.

c. *Strepsipterans:* minute, twisted-winged parasites related to beetles females segments; males have knob-like front wings and membranous fan- are wingless and remain inside the host with its head protruding from the abdominal shaped hind wings.

c.1 *Halictophagus spectrus* - specific to leafhoppers.
c.2 *Elenchus yasumatsui* – specific to planthoppers.

E. Pathogens

1. Fungus diseases

a. *Metarhizium anisopliae, Metrahizium flaviviride - Metrahizium* fungi infect hoppers, black bugs and beetles. When the insect dies, the fungus emerges first as white growth from the host body joints. When spores are formed, the fungus turns dark green (*M. anisopleae)* or light green (*M. flavoviride)*.
b. *Beauveria bassiana* – white fungus which attacks planthoppers, leafhoppers, stem borers, leaffolders, rice bugs, and black bugs. It occurs in all rice environments. The spores appear chalky white.
c. *Hirsutella citriformis* – infects planthoppers and leafhoppers. After the fungus enters the body of the host and consumes its inner tissues, it grows out as long filaments that are dirty white at first and later turn gray.
d. *Nomuraea rileyi* - white fungus with pale green spores. It

attacks the larvae of stem borers, leaffolders, green hairy caterpillars, armyworms, and caseworms. Early in the infective stages, larvae attacked by *Nomuraea* become white. After a few days, spores are formed and the caterpillars become pale green.

2. Virus Diseases

   a. Nuclear polyhedrosis viruses – common on armyworms and cutworms. The larvae become infected by eating virus-contaminated foliage. When the virus spreads in the larva's body, the host becomes sluggish and stops feeding. Later, the larva turns whitish and then black and hangs from the rice foliage by the prolegs.
   b. Granulosis viruses - attack moth and butterfly larvae. As with the nuclear polyhedrosis virus, the host larva that eats contaminated foliage slow its movement and later stops feeding. After 1-2 weeks, the body becomes constricted, giving a segmented appearance. Infected larvae turn yellow, pink and black. Virus-infected larvae become soft.

3. Bacterial Disease

   Bacillus thuringiensis (Bt) - pathogenic bacterium for lipidopterous larea. Bt is being commercially used as a microbial insecticide.

Methodology

The trainer can use any or a combination of the following strategies:

a. Lecture discussion with the use of slides/pictures to show symptoms of the disease.
b. Lecture followed by field visit to show actual symptoms of disease.
c. Experiential approach. Letting the participants talk about their experiences and observations supplemented by lecture.

Materials/Visuals

- Pictures, slides, OHP, slide projector
- Samples of diseased rice plants
- Powerpoint presentation

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Evaluation

Answer the following questions:

1. What does “biological pest control” mean? Name some predators and their corresponding prey.

2. Give examples of beneficial insects.

3. What are parasites? How do they act as control measures?

MODULE 12

Integrated Pest Management

D. Major Rice Diseases and Their Management

Overview

This module discusses the viral, fungal, and bacterial diseases of rice, their causal agents, symptoms and strategies for their management and control. Factors influencing the severity of each disease under field conditions are likewise presented.

Understanding the nature of rice diseases, how they occur and spread, and how to control them will be useful in dealing with them to avoid economic losses.

Objectives and Topics

I. Explain what is a disease.

A. A disease is an abnormal condition that injures the plant or causes it to function improperly. It is readily recognized by its symptom-associated visible changes in the entire plant, or on individual plant parts. Rice disease symptoms can be categorized in several groups:

1. Overall dwarfing or stunting of the plant,
2. Changes in color, such as yellowing or chlorosis,
3. Necrosis or death of the tissue (leaf spot, streak, scald, *etc.*)
4. Wilting due to interference in water movement within the plant,
5. Unusual development or transformation of organs (false smut, kernel smut, *etc.*)
6. Formation of galls or swelling of veins.

B. To diagnose a disease in a crop, consider disease distribution, spread occurrence, condition of the field, close and thorough examination of diseased plants, presence of other organisms, toxic substances, and discussion with the farmer.

C. Various agents, acting either singly or in combination, cause diseases. The agents can be biotic (living) or abiotic (nonliving). Living,

disease-inciting organisms are called pathogens. The pathogens of rice diseases are the bacteria, fungi, nematodes, viruses, and mycoplasma-like organisms.

D. A disease is the result of the interactions between a pathogen and a host in a favorable environment. A disease generally occurs because the host cultivar is susceptible, the pathogen strain is virulent, and the environment is favorable.

E. An epidemic or serious outbreak of a disease occurs when a disease increases over time in a crop population. Environmental conditions (biotic and abiotic) and cultural management may influence disease incidence, severity and spread. It can reach epidemic proportions when under favorable climatic conditions, susceptible varieties are planted, there is an application of high nitrogen fertilizers, too dense sowing, no proper crop management, and the like.

F. Cultural practices and chemicals are presently the most important methods for disease control. Diseases that progress slowly are generally managed more easily than those that progress rapidly.

II. Discuss the principles of disease management.

A. Crop production practices influences disease development. Therefore, it is important that disease management be considered in all stages of the crop. Disease management is primarily based on the following principles:

1. Avoidance of the pathogen
2. Exclusion of inoculum
3. Eradication of the pathogen
4. Protection
5. Disease resistance
6. Therapy

B. Reliance on one management option will be inadequate or inefficient. Disease management will be most successful if integrated into the crop production system and employs diverse approaches.

III. Describe the symptoms of viral diseases and their management.

A. Tungro Disease. Tungro which means degenerated growth is one of the most damaging virus diseases of rice in Southeast Asia. It was first observed in the Philippines in 1963.

1. Symptoms

    a. Tungro stunts rice plants and turns the leaves to different shades of yellow or orange
    b. Yellowing begins at the leaf tip and may extend down the blade
    c. Infected leaves may also be mottled or striped
    d. Infected plants also have reduced number of tillers
    e. Plants infected during the early stages of growth are more severely damaged than those that are attacked later
    f. Panicle exertion of infected plants is delayed and often incomplete, panicles are short and produce sterile or partially filled grains

2. Management

    a. Plant resistant variety
    b. Plant in synchrony with neighboring farmers
    c. Remove diseased plants
    d. Do not apply insecticides indiscriminately
    e. Rice-free period for at least one month
    f. Dry the field to destroy weeds and stubble
    g. The only way to control virus diseases is to prevent the plant from becoming infected. Currently, there are no practical ways of curing a plant after it becomes infected. Virus control programs should concentrate on preventing disease during the early stages of plant growth. Infection at such stage causes the most damage.
    h. Planting resistant rice variety is the simplest, cheapest and most effective way of controlling both virus diseases and vector insects. A variety may be resistant to the feeding and development of the insect transmitter or resistant to the infection and development of a virus disease.
    i. It is very difficult to control virus vectors with insecticides. Only one insect is enough to infect a plant. High populations are not necessary to cause high tungro infection rates. It is sometimes difficult to kill insects quickly enough to prevent them from feeding on plants and transmitting the virus.
    j. In areas where virus outbreaks have occurred, it is best to do the following:

        j.1 Protective insecticide applications
        j.2 Eliminate sources of virus diseases by removing infected plants that serve as sources of the disease

j.3 Rogue (remove) diseased rice plants and weeds from the rice field. Roguing is successful when only a small percentage of plants are infected, or when it is done frequently
j.4 Control or destroy weeds in rice fields, levees, and surrounding areas
j.5 Plow under the rice stubble immediately after harvest to prevent ratoon growth, which is a disease source and breeding place for insect transmitters
j.6 Practice synchronous planting with at least one-month fallow period

3. The development and spread of virus depends upon several factors like number of plant virus sources; susceptibility of a rice variety to the virus and the insect transmitter; number and activity of insect transmitters; late planting time, overlapping crops; and the weather.

IV. Discuss the causes, symptoms, and management control of grassy and ragged stunt diseases.

A. Rice grassy and ragged stunt diseases are caused by virus transmitted by the brown planthopper and widely distributed in Asia except in the high latitudes.
B. It infects the rice plant from seedling to tillering stage by sucking the plant sap from the base of the plant that causes the entire plant to dry (burn) then dies.

1. Grassy stunt symptoms (plant height and leaves)

a. Severe stunting
b. Profuse tillering
c. Erect growth habit
d. Leaves are short, stiff, narrow, pale green to yellow with numerous small dark brown spots or stripes
e. Late infected plants have small panicles and panicle exertion is incomplete with sterile or browning grains

2. Ragged stunt symptoms (plant height and leaves)

a. Stunted plant
b. Torn or ragged leaves with twisted or spiral tip
c. Some leaf edges are serrated

d. Vein swelling or linear galls appear on the outer side of leaf blades and leaf sheath near the collar
e. Nodal branching

C. Factors favoring disease development and severity

1. Susceptible variety
2. Overlapping crops
3. High number of BPH and diseased plants

D. Disease management and control

1. Plant resistant variety
2. Dry the field to destroy weeds and stubble especially during ripening stage.
3. Do not apply insecticide indiscriminately

V. Describe the fungal disease of rice plants, including their symptoms and management.

A. Blast

1. Rice blast is caused by the fungal pathogen, *Pyricularia grisea*. It is one of the destructive diseases or rice, causing as much as 50% crop loss in areas where severe outbreaks occur. Crop management greatly affects the disease and it is more severe in irrigated rice grown in temperate regions or at high elevations in the tropics, in rainfed and upland rice. It is least severe in tropical lowland rice grown with good water management. However, it is a continuing problem where blast-susceptible cultivars are widely grown.
2. Losses and added cost for disease control are greatest where farmers practice intensive, high-input rice cultivation, or wherever technological and social change allow increased fertilizer use, making it a constraint to the adoption of improved production practices.

a. Symptoms

a.1 The fungus produces spots or lesions on leaves, nodes, and parts of the panicle and grains. The spots are elongated and pointed at each end
a.2 Severely infected leaves are killed

a.3 The size and shape of the spots vary on different rice varieties
a.4 Infected nodes turn blackish and break easily
a.5 Any part of the panicle may also be infected
a.6 When the base of the panicle is attacked, it turns brown and the stem usually breaks just below the panicle

b. Factors favoring disease development and severity

b.1 A high amount of quick acting fertilizer, such as ammonium sulfate
b.2 Cloudy skies, frequent rains and drizzles
b.3 Blast spores are present in the air throughout the year in the tropics and the disease develops continuously
b.4 A relative humidity of 90% and higher. Long periods when leaves are covered with dew

c. Management

c.1 Planting resistant varieties is the most practical and economical way of controlling rice blast
c.2 Several fungicides control rice blast on leaves and panicles
c.3 Avoid excessive application of nitrogen fertilizer
c.4 Split fertilizer applications
c.5 Avoid late planting
c.6 For leaf blast, reflood if field had been drained
c.7 Destroy infected crop residues
c.8 Application of soil amendment material such as silicate fertilizer with compost

3. Planting resistant varieties is the most economical way to control the disease in environments not highly conducive to blast. However, where the epidemic potential of the disease is very high, it is necessary to include other means of control like manipulating time of planting, fertilizer, and water management as well as the use of fungicides.

B. Sheath Blight

1. The aerial form of the fungus *Rhizoctonia solani*, causes sheath blight. It occurs both in the tropics and in the temperate areas where it is most damaging in intense production systems. Severity of the disease depends on cultivation, land preparation, varieties, crop management, etc. The pathogen affects rice and

other plants in numerous and diverse habitats, and its host range is so broad that it can be said that no plant species is immune. The pathogen infects many weed grass species and several major legume crops used in rotation with rice.

2. The pathogen is soilborne and endemic in most production areas. Rice sheath blight can develop into a major production-limiting disease in a short time. The pathogen can be spread rapidly through irrigation water and by movement of soil during land preparation and cultivation. The disease is usually first observed in the field after plants reach the maximum tillering stage. Incidence of the disease increases as the plants grow older.
3. Yield losses can reach 50% with susceptible cultivars especially when the disease develops at booting stage of the crop. Grain weight, panicle length, and milling quality are affected by sheath blight.

    a. Symptoms

        a.1 Sheath blight causes spots mostly on the leaf sheath, but spots may also occur on the leaf blades if conditions are favorable
        a.2 Infection bodies called sclerotia form on the spots
        a.3 Many of the plant's leaves are killed during severe infections

    b. Factors increasing the severity of sheath blight in the field

        b.1 High temperature and humidity
        b.2 High levels of nitrogen (N) fertilizer and heavy manuring
        b.3 Dense stands

    c. Management

        c.1 No resistant varieties at present
        c.2 Avoid high N fertilization. Split the application
        c.3 Apply fungicides on leaf sheaths before panicle emergence
        c.4 Plow deeply to bury infected stubble and weeds
        c.5 Expose soil to intense sunlight
        c.6 Remove sclerotia from the rice field after puddling
        c.7 Rice following rice or soybeans is more likely to be affected. No variety has a high level of resistance to the disease, but some moderately resistant varieties have been selected. Most long-grain varieties have little

resistance to sheath blight. Medium-grain varieties are more resistant. Cultivar performance is greatly influenced by physiological, morphological and ecological factors. Young plants are more resistant to sheath blight than older plants, with the greatest susceptibility occurring at emerging panicles. Short cultivars with broad leaves and high tillering abilities also produce a closed canopy (a favorable microclimate for sheath blight development) much earlier than tall cultivars with fewer tillers. Cultivars that mature early appear more susceptible to sheath blight disease.

c.8 There are fungicides efficacious in controlling the disease. Two fungicide applications are presently recommended for control of sheath blight, and the rate and timing of these applications is very important. The first application should be made during the growth stage between early internode elongation and development of the 2.5- to 5-cm panicle in the boot. A second application should be made on 80 – 90% of emerging panicles from 10 to 14 days later.

c.9 Fallow periods, with disking to control grasses in the field (which serve as sources of inoculum) and break down crop residue help reduce disease pressure.

C. Brown spot

1. Brown spot, sometimes called *Helminthosporium* leaf spot, is caused by the fungus *Helminthosporium oryzae*. Leaf spots are present on young rice; however, the disease is more prevalent as the plant approaches maturity and the leaves begin to senesce.
2. The pathogen also attacks the coleoptiles, leaf sheath, branches of the panicle, glumes and grains. Heavy leaf spotting is an indication of some unfavorable growth factor, usually a soil problem. Disease is more severe when plants are nutrient deficient or under other stresses.

a. Symptoms

On leaves (tillering stage)

a.1 Small, circular, oval spots fairly scattered on the leaves with gray center

a.2 Spots fuse and leaves wither

On seedlings (seedling on seedbed)

a.3 Brown spots on leaf coleoptile and distortion occurs
a.4 Roots with black lesions

On grains (maturity)

a.5 Black spots on glumes and covered with dark brown velvety mat of fungal spores
a.6 Seeds become discolored and shriveled
a.7 Panicle bases turn brown and cause panicle blight.

b. Factors favoring disease development and severity

b.1 Deficiency in potassium (K)
b.2 Cloudy, light rain, heavy mildew and 20^{o} – 29^{o} C temperature
b.3 Planting infected seeds

c. Disease management and control

c.1 Plant resistant variety
c.2 Proper agronomic practices such as balanced fertilization, field sanitation, good water management, soil amendments, good soil preparation, land leveling, and other cultural practices.
c.3 Apply muriate of potash to correct K-deficiency
c.4 Apply calcium silicate and compost
c.5 Destroy stubble and weeds acting as inoculum sources
c.6 Treating the seeds with fungicides or hot water to reduce inoculum
c.7 Correct stress conditions in the field

D. Stem Rot

1. Caused by the fungus *Magnaporthe salvinii*, stem rot causes severe lodging, which reduces combine efficiency, increases seed sterility and reduces grain filling. Infection takes place at the waterline and angular black lesions form.
2. The number of infected tillers may reach 100% in areas of the field where debris and sclerotia from the previous crop have collected after being windblown on the water surface. Early maturing varieties are less affected by stem rot.

a. Symptoms

a.1 Small, black irregular lesions on outer leaf sheaths near the water line
a.2 Lesions enlarge and infect inner leaf sheaths and stem
a.3 Leaf sheaths rot and many sclerotia are embedded in decaying tissues

b. Factors favoring disease development and severity.

b.1 High N and phosphorus (P) fertilization
b.2 Poor drainage system
b.3 Plants lodge at early growth stage
b.4 Often occurs in degraded paddy soil

c. Disease management and control.

c.1 Plant lodging resistant and early maturing varieties
c.2 Avoid excessive N and P fertilizers
c.3 Add potash , sodium silicate and compost
c.4 Good water management, vary water depth during the season
c.5 If fungicide is to be used, apply it at the plant stems before maximum tillering
c.6 Drain and dry the field at the tillering and early jointing stages of growth
c.7 Destroy stubble and crop residues after harvest
c.8 Use crop rotation, tillage or burning to reduce disease pressure

E. Sheath Rot

1. Sheath rot is caused by the fungus, *Acrocylindrium oryzae*.
2. Little is known about crop losses caused by this disease, but it is not uncommon for 10 – 30% of the tillers to be infected in fields where it occurs.

a. Symptoms:

a.1 Irregular lesions with gray center and brown, diffuse margins on leaf sheaths enclosing the young panicle during the boot stage
a.2 The young panicles remain in the leaf sheath or emerge only partially which produces unfilled and discolored grains

a.3 A whitish, powdery fungal growth occurs on the panicle inside the sheath

b. Factors favoring disease development and severity

b.1 High N fertilization
b.2 Dense plant population
b.3 Cool, moist weather and high humidity
b.4 Insect damages
b.5 Low temperature at the booting stage

c. Disease management and control

c.1 Use certified seeds
c.2 Avoid dense planting
c.3 Do not apply excessive N-fertilizer
c.4 Plow dry diseased plants and weeds

VI. Bacterial Diseases.

A. List the bacterial blight of rice plants, symptoms, and management.

1. Bacterial blight is reported to have reduced Asia's annual rice production by as much as 60%.
2. The disease is caused by *Xanthomonas oryzae pv. oryzae* (Xoo), an organism closely related to the bacteria causing bacterial leaf streak.
3 The bacterium has races that differ in their ability to infect different resistant rice varieties.

a. Symptoms

a.1 Lesions appear first, at about the heading stage, as water-soaked stripes on the leaf margin
a.2 Milky or cloudy dewdrops appear on the surface of young lesions in the morning
a.3 The lesions enlarge, the edges become wavy, and turn yellow or light brown
a.4 Bacterial ooze drops on young lesions
a.5 As the disease advances, the lesions cover the whole leaf blade, and turn grayish and later, white

b. Kresek symptoms

b.1 Kresek symptoms usually occur 2 - 6 weeks after the seedling stage
b.2 Kresek symptoms sometimes resemble rise stem borer damage
b.3 Leaves become water-soaked and fold and roll-up along the midrib
b.4 Then the whole plant wilts and dies

c. Pale Yellow symptoms

c.1 Pale yellow occurs in the tropics, but it is not common
c.2 Older leaves of infected plants are normal green, but the youngest are yellow or have yellow stripe

d. Factors favoring disease development and severity

d.1 Excessive nitrogen, magnesium silicate fertilization: deficiency in P and K
d.2 Highly susceptible variety
d.3 Strong wind and heavy rain
d.4 25-35^{0}C temperature

e. Management

e.1 Plant resistant variety
e.2 Reduce plant injury during transplanting
e.3 Treat seeds or use seeds from healthy plants
e.4 Avoid excessive nitrogen fertilization
e.5 Destroy plant residues

4 Use of resistant cultivars and integration of appropriate control practices help control the disease. These practices are avoidance of excessive nitrogen fertilization, provision of good drainage during severe flooding, plowing under the rice stubble and straw following harvest and allowing them to decompose before transplanting, use of disease-free seeds, removal of alternate hosts, and not allowing ratoon plants or volunteer shoots to grow in the field in between cropping seasons to remove source of infection.
5 Seed treatment with bleaching powder (100 mg/ml) and zinc sulfate (2%) reduce bacterial blight. Control of the disease with copper compounds, antibiotics and other chemicals has not proven highly effective.

B. Bacterial Leaf Streak

1. The bacteria causing the disease *Xanthomonas campestris pv. oryzicola* (Xco) is closely related to the bacteria causing bacterial blight. It infects different species of plants and attacks the rice plant in a different way.
2. Under favorable weather conditions, losses from bacterial leaf streak may be as serious as those from bacterial blight.
3. Though not considered as a major disease of rice in the Philippines, it is very common in the province of Nueva Ecija and nearby provinces.

a. Symptoms

a.1 The first symptoms are transparent, linear lesions or streaks between the vein. Many tiny oozes can be observed on the lesions
a.2 Later, the lesions coalesce ('merging lesions') to form large brown, become longer, and cover the larger veins
a.3 The whole leaves of susceptible varieties may turn brown and die during the later stages of disease development. At this point, the disease symptoms look the same as those of bacterial blight

b. Sources

b.1 Infected seed and straw
b.2 May survive in irrigation water
b.3 Wild rices as alternate hosts

c. Dissemination

c.1 Irrigation water
c.2 Splashing or windblown rain
c.3 Leaf contact

d. Favorable Conditions

d.1 Warm temperature (28 – 30%)
d.2 High relative humidity
d.3 Rainy weather
d.4 Excessive nitrogen fertilization
d.5 Injured leaves

e. Entry Points

e.1 Stomates
e.2 Wounds

f. Management

f.1 Plant certified seeds
f.2 Avoid high dose of nitrogen
f.3 Destroy infected crop residue

4. The only practical method for controlling bacterial leaf streak in tropics is planting of resistant varieties, applying moderate amounts of nitrogenous fertilizers, and a phytosanitary measure like using treated seeds.

Methodology

The trainer can use any or a combination of the following strategies.

a. Lecture discussion with the use of slides/pictures to show symptoms of the disease.
b. Lecture then bring the trainees to the field to show actual symptoms of disease with a discussion to follow the field visit.
c. Experiential approach by letting the participants talk about their experiences and observations then summarized/supplemented by the lecturer.

Materials/Visuals

- Pictures, slides, OHP, slide projector
- Samples of diseased rice plants
- Powerpoint presentation

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Evaluation

True or False. Write true if the statement is correct and false if it is not.

_____ 1. Planting resistant varieties is the simplest, cheapest and most effective way of controlling diseases.

_____ 2. Diseased plants would certainly mean reduction in yield.

_____ 3. Zinc deficiency could be a cause for rice disease.

_____ 4. Once the field is attacked at an epidemic proportion, the disease is already difficult to control.

_____ 5. The weather can be a factor in the development and spread of a viral disease.

_____ 6. If the plants are yellowish and have stunted growth, they are attacked by tungro.

_____ 7. The only means by which tungro is transmitted is through the leafhopper.

_____ 8. Observing a fallow period does not eliminate hosts of viruses and vectors.

_____ 9. Agents of diseases can be biotic or abiotic.

_____ 10. We should just leave the rogued diseased plants to decompose on the levees.

Enrichment Activity

Gather trainees and in a room and share each about their experiences on disease management and control.

MODULE 13

Integrated Pest Management

E. Insect Pest and Disease Damage Assessment

Overview

This module discusses how to assess damages caused by insect pests and diseases. Assessing the damage potential of crop pests and differentiating losses caused by pests from other causes are the first steps toward profitable pest control.

Crop protection specialists can use such assessments to establish guidelines on when pesticides (refer to Appenix 2 for list of registerd pesticides) or other control methods are needed (and when they are not needed). Such guidelines can also assist farmers in decreasing pest losses, reducing unnecessary costs, and increasing yields, profits, and safety.

Objectives and Topics

I. Explain the necessity of pest and damage assessment.

A. For studying the biology and ecology of pests and natural enemies, and to know how and when to control them.
B. For measuring the effects of different pest management measures, such as pesticides, biological and cultural measures, and crop resistance.
C. For surveying pests, studying migration, and forecasting outbreaks.
D. For making decisions based on the economics of pest attack - the benefits of reducing pest damage compared to the costs, and the relationship between yield and pest damage.

II. Enumerate the general types of assessment.

A. Measurement of the pest population.
B. Assessment of symptoms on plants.
C. Assessment of damage to crops.

III. Discuss the different pest damage assessment methods.

A. Time to sample and method to use. The best time to sample pest or crop damage usually is when pests will have the maximum effect on the economic crop yield.
B. Scores or rating scales. For quicker and easier assessment, and because of the difficulty of counting great numbers or complicated areas of damage, both pests and their damages are often grouped into grades or scales, or given scores or ratings (1,2,3, *etc.* or 0-10, 11-20; or 10-100, 101-1,000, or expressed in percentages, *etc.*).
C. Number and size of samples**.** The number and size of samples depend on ease of sampling, accessibility, and availability of time and money for sampling. The purpose of sampling is a very important consideration.

IV. Discuss how insect pest damage is assessed.

A. This involves quantifying insect populations and crop damage.
B. Population density is the actual number of insects per unit area. Population density may be impossible to measure completely because it is too difficult, too costly, or too time-consuming.
C. Populations are often estimated from samples. If a population cannot be measured or estimated, assessment may be done indirectly by measuring or estimating the effect of pests on the crop, as injury or damage.

V. Enumerate the different methods of assessing insect and natural enemy populations.

A. Visual counting
B. Use of sweepnets
C. Use of water traps or sticky traps
D. Use of light traps
E. Use of suction devices

VI. Explain the sampling procedure used to assess insect damage

A. Sampling unit

1. Transplanted rice - hill
2. Direct-seeded rice - 10 cm x 10 cm quadrat

B. Number of sampling units

1. It depends on the area to be sampled.
2. Ten to twelve sampling units may be enough per sampling area.
3. Sampling units are designated at random in a diagonal transect or following an X pattern.

C. Sampling period depends on the incidence or severity of damage.

1. Mid tillering (MT): 30 days after transplanting (TPR)
   20 days after sowing (DSR)
2. Panicle initiation (PI): Based on field observation
3. Early dough/milk (ED): Based on field observation (optional)
4. Maturity (MAT): Based on field observation

VII. Give examples of insect damage assessment

A. Defoliators or insects that reduce leaf area.

Ex. Leaffolder

Damage incidence by leaffolder is measured in terms of percent damaged and folded leaves per hill or quadrat.

$$\% \text{ damaged leaf} = \frac{\text{no. of damaged leaves/hill or quadrat}}{\text{total no. of leaves/hill or quadrat}} \times 100$$

$$\text{Incidence} = \frac{\text{sum of \% damaged and folded leaves per hill or quadrat 1 to 12}}{\text{12 (no. of sampling units)}}$$

The same procedure can be used for caseworm, whorl maggot, and other defoliators.

B. Insects that reduce tillers (stem borers)

Damage of stem borers is represented by the number or percent deadhearts (DH) per hill or quadrat, and the number or percent whiteheads (WH) per hill or quadrat. Deadheart assessment can be done at mid-tillering and panicle initiation stage while whiteheads can be done at early dough and maturity stages.

Deadheart incidence is calculated as:

$$\% \text{ DH} = \frac{\text{no. of deadhearts per hill or quadrat}}{\text{total no. of tillers per hill or quadrat}} \times 100$$

Whitehead incidence is calculated as:

$$\% \text{ WH} = \frac{\text{no. of whiteheads per hill or quadrat}}{\text{total no. of panicles per hill or quadrat}} \times 100$$

C. Hopperburn due to BPH and WBPH

Hopperburn damage is assessed by estimating the percent infested area (sum of area ground covered by the patches within the sampling area).

For severity assessment, plants within the infested area or patch can be elevated using the following scale:

0 - no damage
1 - slight yellowing or discoloration of few plants; no hopperburn.
3 - leaves partially yellow, but with no hopperburn.
5 - leaves with pronounced yellowing and some stunting or wilting and 1-25% of the plants with hopperburn, remaining plants severely stunted.
7 - more than half of the plants wilting or with hopperburn, remaining plants severely stunted.
9 - all plants dead

$$\% \text{ severity index} = \frac{\text{Most prevalent severity rating}}{\text{9 (maximum rating)}} \times 100$$

VIII. Explain disease incidence assessment.

A. Disease can be measured as an incidence of diseased material or as a degree of disease development and expression (disease severity).
B. Incidences can be measured on a large scale, such as the proportion of fields in a production area that have at least some disease (disease prevalence).
C. Within fields, the number of infected plants in a sample can be counted. This, expressed as proportion of infected plants, is one of the most commonly reported measures of disease incidence.
D. Disease incidence may also be used as an indirect measurement of disease severity. At a low disease level, incidence and severity are often closely correlated. At incidences greater than 30-40%, the relationship is not reliable.
E. In cereals such as rice, the two uppermost leaves often are sensitive to small changes in the rate of epidemic development, especially leaves associated with chemical treatment or resistance.
F. Leaves lower in the canopy often have the earliest and greatest amounts of infection and are useful for measurements related to disease and crop loss surveys and to disease management.

IX. Examples of disease assesment.

A. Foliar diseases

These include bacterial blight (BB), bacterial leafstreak (BLS), leafblast, narrow brown spot, leaf scald, and leaf smut. Each of these diseases is assessed as a number of diseased leaves counted in each sample hill.

Example: Bacterial blight (BB)

$$\text{Incidence} = \frac{\Sigma \text{of \% infected leaves per hill or quadrat 1-12}}{\text{12 (or number of samples)}}$$

where, % infected leaves per hill or quadrat is calculated as:

$$\text{\% infected leaves} = \frac{\text{no. of infected leaves per hill or quadrat}}{\text{total no. of leaves per hill or quadrat}} \times 100$$

$$\text{Disease severity per field} = \frac{\sum \text{ of \% disease severity from each hill or quadrat 1 - 12}}{\text{12 (or number of samples)}} \times 100$$

$$\text{Disease severity per hill} = \frac{(\sum \text{of \% severity from tiller 1 to 3}) \times \text{(no. of infected tillers per hill)}}{\text{total no. of tillers per hill x 3}} \times 100$$

where,

$$\text{Mean \% disease severity per tiller} = \frac{\sum \text{of disease severity rating from leaf 1-5}}{5 \times 9}$$

B. Rating scale for foliar diseases

1. Bacterial blight

0 - no symptom observed
1 - 1-5% leaf area covered by lesion
3 - 6-10% leaf area covered by lesion
5 - 11-25% leaf area covered by lesion
7 - 26-50% leaf area covered by lesion
9 - more than 50% leaf area covered by lesion

2. Leaf blast

0 - no lesion
1 - small brown pinpoint size to slightly elongated necrotic spots infecting up to 2% of leaf area.
3 - small roundish to slightly elongated necrotic spots (1-2 mm in diameter with a distinct brown margin or yellow hallow along with a few typical susceptible blast lesions infecting 3-10% leaf area.
5 - ypical susceptible blast lesions (3 mm or longer with gray center and brown margin) infecting 31-60% of leaf area.
7 - typical blast lessions infecting 31-60% of leaf area.
9 - more than 60% leaf area affected by rapidly coalescing lesions.

3. Narrow brown spot and bacterial leaf streak

0 - no symptom observed
1 - less than 1%
3 - 1-5% of leaf area infected
5 - 6-25% of leaf area infected
7 - 26-50% leaf area infected
9 - 51-100% of leaf infected

C. Diseases that affect the tiller or panicle

These include sheath blight, sheath rot, stem rot, panicle blast, kernel smut, and false smut.

Example: Sheath blight and sheath rot

$$\text{Incidence} = \frac{\sum \text{of \% infected tillers from hill or quadrat 1-12}}{12}$$

where:

$$\text{\% infected tiller per hill or quadrat} = \frac{\text{no. of infected tiller per hill or quadrat}}{\text{total no. of tillers per hill or quadrat}} \times 100$$

$$\text{Severity per field} = \frac{\sum \text{of disease severity from hill or quadrat 1-12}}{12}$$

where:

$$\text{\% severity per hill} = \frac{(\sum \text{of disease severity from tiller 1-3}) \times (\text{no. of infected tillers per hill})}{\text{total no. of tillers per hill} \times 3 \times 9} \times 100$$

where, 3 is the number of tillers assessed per hill and 9 is the maximum disease grade.

Example: Panicle or neck blast

$$\text{Incidence per field} = \frac{\sum \text{of disease severity from hill or quadrat 1-12}}{12}$$

where:

$$\text{\% infected panicle per hill or quadrat} = \frac{\text{no. of infected panicles per hill or quadrat}}{\text{total no. of panicles per hill or quadrat}} \times 100$$

$$\text{Severity per field} = \frac{\sum \text{ of disease severity from hill or quadrat 1-12}}{12}$$

where:

$$\text{\% severity per hill} = \frac{(\sum \text{ of disease severity from panicles 1-5}) \times (\text{no. of infected panicles per hill})}{\text{total no. of panicles per hill} \times 5 \times 9} \times 100$$

where, 5 is the number of infected panicles assessed per hill and 9 is the maximum disease rating.

D. Rating scale for diseases that affect the tiller or panicles

1. Sheath blight

0 - no infection observed
1 - lesions limited to lower 10% of the plant height
3 - lesions limited to lower 25% of the plant height
5 - lesions limited to lower 50% of the plant height
7 - lesions limited to lower 75% of the plant height
9 - lesions > 75% of the plant height

2. Sheath rot

0 - no infection observed
1 - less than 5% boot leafsheath infected
3 - 6-25% boot leafsheath infected
5 - 26-50% boot leafsheath infected
7 - 51-100% boot leafsheath infected; partial choking of panicle; infection may spread to lower sheath.
9 - complete choking of panicle (not exerted)

3. Panicle or neck blast

0 - no visible lesion
1 - less than 5% of pedicels infected
3 - 5-25% of pedicels infected
5 - 26-50% of pedicels infected
7 - 51-75% of pedicels infected
9 - 76-100% of pedicels infected; lesions completely around panicle base or uppermost internode or panicle axis near the base.

E. Viral diseases - Tungro

Tungro damage is assessed by recording the percent infested area (sum of the patches) per field.

For severity assessment, use the following scale:

0 - no damage
1 - very slight damage
3 - yellowing of first and second leaves
5 - all leaves yellow; pronounced stunting or both
7 - more than half the plant wilted; remaining plants stunted
9 - all plants dead

$$\text{Severity index} = \frac{\text{most prevalent rating}}{9} \times 100$$

F. Calculate rat damage assessment

Rat damage is estimated as percent damaged area (sum of ground area covered by the patches of damage) per field. For severity assessment, plants within the damaged area is evaluated using the following scale:

0 - no damage
1 - less than 5%
3 - 6-25%
5 - 26-50%
7 - 51-75%
9 - 76-100%

$$\text{Severity index} = \frac{\text{most prevalent rating}}{9} \times 100$$

G. Calculate golden apple snail damage assessment

Count the number of tillers and total number of tillers per square meter.

$$\%\ \text{snail damage} = \frac{\sum \text{of no. cut tillers from spot 1-3}}{3\ (\text{no. of samples})} \times 100$$

Suggested Methodology

a. Lecture-discussion
b. Experiential approach.

Materials/Visuals

- Slides, pictures, transparencies, OHP, slide projector
- Samples/pictures of infected rice plants
- Powerpoint presentation

References

Crop Loss Assessment In Rice. 1990. International Rice Research Institute, Los Baños, Philipines.

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PhilRice. 1999. Rice stem borers in the philippines. Rice Technology Bulletin No. 20. Philippine Rice Research Institute, Maligaya, Science City of Muñoz, Nueva Ecija, Philippines.

Tiongco, ER, UG Duque, HX Truong, ML Aragon, RC Joshi, and JJ Tagubase. 2002. Field guide on major disorders of the rice plant in the Philippines. Philippine Rice Research Institute, Maligaya, Sciencec City of Muñoz, Nueva Ecija.

Excercise

In an actual rice field, the class can perform damage assessments of pests.

Insects: Assess field for damage of:

Defoiliators - whorl maggot, caseworm, leaffolder, caterpillars

Select a field with defoliator damage and randomly select 12 hills (or more) diagonally or using an X pattern. Count the number of damaged leaves in the sample hill and the total number of leaves.Compute for percent damaged leaves and damage incidence per field sampled using the given formula.

Stem borers - deadhearts and/or whiteheads

Select a field with deadheart/whitehead damage and select randomly 12 hills (or more) diagonally or using an X pattern. For each sample hill, count the deadhearts and healthy tillers. Compute for percent deadheart/ whitehead incidence.

Brown planthoppers/whitebacked planthppers - hopperburn
Assessed damage by estimating the percent ground area showing hopperburn if any.

Snail and rat damage, if any

Damage by snails or rats can be estimated by means of percent ground area damage or number of damage tillers/hills.

Diseases - assess incidence and/or severity of:

- Bacterial blight (BB)
- Sheath blight (ShB)
- Blast
- Tungro

For BB and blast - estimate incidence and severity per field using the given formula. Calculate also for severity index.

For incidence - count infected and healthy leaves per sample hill and calculate percent infected leaves using the given formula.

For severity per field - get the sum of percent infected leaves per hill 1-12 and divide it by 12. Get the sum of percent infected leaves per hill or quadrat 1-12. Calculate severity using the given formula.

MODULE 14

Integrated Pest Management

F. Integrated Weed Management

Overview

This module gives an overview of the type of weeds associated with rice, the components and principles of integrated weed management (IWM), the use of herbicides as a control measure, and the management of weeds in different types of rice culture. IWM is the best mix of several weed management strategies, direct and indirect, cost-effective, environmentally sound, and socially acceptible.

Objectives and Topics

I. Discuss the harmful effects of weeds on the rice plants.

A. Weeds reduce rice yields by competing with the rice plants for sunlight, moisture, and soil nutrients.
B. Fertilizer application may not increase yields in weedy fields because weeds absorb nitrogen more effectively than the rice plants.
C. Weeds are also harmful because they may be alternate hosts for insect pests and diseases of rice and provide shelter for rats.
D. The severity of weeds differ in different types of rice culture. Weeds are usually most serious in dryland and dry-seeded rainfed rice and may destroy the entire crop if they are not adequately controlled. They are usually least serious in irrigated transplanted fields but may still reduce yield.
E. A combination of different control methods over a long period of time can effectively control weeds.
F. Weeds can reduce yields by competing with the plants for sunlight, moisture and soil nutrients. Moreover, they can be hosts for insect pests, diseases, and even rats.

II. Differentiate the general types of weeds based on their morphology, life cycle, and habitat:

A. Morphology

1. *Grass*. They have long narrow leaves; parallel veins, round hollow stems, prominent nodes and internodes, and alternate leaf arrangement.
2. *Sedge*. The leaf blades are similar to grasses but do not have nodes or internodes. Their stems are usually solid and rectangular and leaves are arranged on three ranks or in a rosette.
3. *Broadleaf weeds* have leaf blades larger than those of grasses and sedges and of various shapes with netted veins.

B. Life cycle

Weeds are sometimes grouped according to the length of their life cycles: *perennials* complete their life cycles for more than one year and *annuals* in one year or less.

C. Habitat

1. *Aquatic*. Weeds living in the water, either submerged, floating, and emerged.
2. *Upland*. Weeds living in well-drained or unflooded soil conditions.

III. Enumerate the components in IWM.

A. Preventive method includes measures taken to avoid introduction or spread of specific weed species in an area. It includes the use of certified seeds, proper management of implements and livestock, keeping bunds and irrigation canals free from weeds, preventing seeding of weeds in the field and spread of perennial weeds that reproduce vegetatively.
B. Physical/mechanical method involves hand-weeding and inter-row cultivation.
C. Cultural and ecological methods involve alteration of growing conditions aimed at surpressing indirectly weed populations by decreasing competitive ability. It can be done directly by encouraging weed growth at specified periods during which direct control methods can be applied. It includes land preparation, water management, method of planting, etc.

D. Chemical method involves the use of herbicides (*see Appendix 2.9)*.

IV. Discuss the general principles of IWM.

A. The major purpose of weed management is to reduce weed populations to levels that do not significantly reduce crop yields.
B. Control measures should effectively kill seeds, seedlings and vegetative propagules of weeds.
C. Start weed suppression activities early in the season, and sustain these until the crop leaf canopies close in.
D. The choice of control measure is influenced by the expected or existing weed species, cost, availability of control inputs, crop culture, and safety to non-target organisms.

V. Describe the different methods of weed control.

A. Hand-weeding is the oldest, simplest and most direct way of controlling weeds in rice fields. This should be done early in the crop's growth since more labor is needed to handweed as the crop develops.
B. Rotary-weeding is applicable in straight row transplanted rice. The spacing must not be closer than 20 x 20 cm and the soil must be soft and saturated.
C. Water management will suppress weeds if water is applied before the weeds germinate or before they emerge above the soil surface. In transplanted rice, 2-3 cm water is introduced at 3-4 days after transplanting. For direct-seeded rice, 3-5 cm water is introduced at 7-10 days after seeding. As the crop grows, water level can be raised up to 5-7 cm water.
D. Land preparation can suppress weeds by deep plowing, puddling, increased tillage, timing of land preparation and stale seedbed technique. Stale seedbed technique involves repeated plowing and harrowing during the fallow period. The weeds are allowed to grow up to 3 weeks after which herbicide is applied or the field is harrowed to kill the weeds.

VI. Define herbicide use as a weed control method.

A. A herbicide is a chemical sed to kill or prevent the growth of weeds.
B. For a successful and economical use, it is important to understand how these chemicals work and their limitations.

C. Herbicide use requires skill. Careless herbicide application may result in inadequate weed control and damage or it may completely kill the crop.

VII. Cite advantages and disadvantages of the use of herbicides as a weed control method.

A. Applying herbicides saves labor.
B. Herbicides can be used in all environments.
C. The continued use of the same herbicide leads to a build-up of weeds resistant to the herbicide. To prevent this build-up rotate crops, change herbicides, and use several control methods together.
D. The best way to prevent the build-up of weeds tolerant to herbicides is to periodically remove them by hand or by mechanical weeding.

VIII. Determine the best time of herbicide application.

A. Preplanting (before the crop is planted)
B. Pre-emergence (before weeds and rice plants emerge from the soil)
C. Post-emergence (after weeds and rice plants emerge from the soil.

IX. Describe the types of herbicides.

A. Contact herbicide kills only the plant parts that are sprayed. They are generally most effective against broadleaf weeds and seedlings of perennials. They do not kill established perennial weeds. Thorough coverage of the plant is essential for contact herbicides to be effective.
B. Systemic herbicide moves within the plant to kill portions that are not treated. They can be sprayed on the foliage or applied to the soil and absorbed by the plant's roots.
C. Selective herbicide kills some plant species, but do not damage others.
D. Non-selective herbicides kills all plants.

X. Describe injury as a result of the improper use of herbicides.

A. Improper herbicide use such as using the wrong herbicide, applying too much, or applying at the wrong time causes injury to the rice plant.

B. Symptoms of herbicide injury include onion-like leaf formation, leaf curling, unfurled youngest leaf, yellowing, albinism, stunting, and spread of tillers.
C. Herbicide injury maybe confused with injury caused by insects or diseases.

XI. Discuss management of weeds in different types of rice culture.

A. Preventive weed control measures should be used on all types of rice culture to prevent the introduction and spread of weeds.

These include:
1. use of weed-free seeds
2. keeping tools and irrigation canals free of weeds
3. keeping tools and machinery clean
4. keeping animals out of the field as much as possible
5. not allowing weeds to produce seeds or reproduce vegetatively.

B. For Transplanted Rice

1. Plow the field to incorporate weeds left from the previous crop or fallow period into the soil.
2. Puddle the soil and harrow 3-4 times to destroy weeds not killed by plowing.
3. Level the field so that uniform flooding and water depth can be maintained.
4. If water is available, flood the field 2-3 days after transplanting and maintain 5-10 cm of standing water continuously throughout the season.
5. For severe weed problem, additional weed control method may be necessary.
6. Control weeds before topdressing fertilizer so that the crop is benefited and not stimulate weed growth.

C. Wet-seeded Rice

1. Prepare the land as in transplanted rice.
2. Weed problem is more serious in this method of establishment as weeds germinate at the same time with rice.
3. Pre-emergence or early post-emergence herbicide is necessary to prevent early competition.
4. Irrigate the field with 2-3 cm water at 7-10 days after seeding, Increase the water level to 5-7 cm as the crop grows and maintain water until 7 days before harvesting.

5. Additional weed control methods maybe necessary after 30 days if weed density is high.

D. Dry-seeded Rice

1. Dry-seeding is done in some rainfed lowland rice areas when farmers want to intensify their cropping system.
2. Weeds are more serious in this rice culture. Rice and weeds germinate at about the same time so there is competition between them.
3. If possible, the field should be plowed immediately after the previous crop is harvested and the field weed-free through tillage during the dry season.
4. Two to three weedings may be needed during the first eight weeks of growth.
5. Do not apply the herbicide to dry soil immediately after seeding. Apply it after the soil has been moistened and before weed seeds germinate.
6. There maybe no standing water in the early crop growth stages of direct seeded rainfed lowland rice. Thus, water accumulated from rain is an important tool to suppress weed growth.
7. Where rainfall is not enough to reduce weed population, other weed control methods are essential.
8. Handweeding may not be desirable because the rice seeds are not planted in rows.
9. Herbicides are important in controlling weeds because other control methods are not very effective or are laborious.
10. If herbicides are to be used, the most appropriate for weed problem should be chosen. Calibrate the sprayer and apply the herbicide at the prescribed rate and time.

E. Upland Rice

1. Prepare the land as in dry-seeded rice. Remove weed flushes before final harrowing.
2. Plant seeds in rows to facilitate inter row cultivation.
3. Develop a weed management program by choosing the most appropriate components from among the available control options, based on the expected and existing weed species and financial resources.
4. Handweeding 2-3 times within 40 days after seeding is usually sufficient.
5. Inter row cultivation usually needs additional handweeding to control weeds within the rows.
6. Use herbicides if labor and cultivation costs are high.

Suggested Methodology

a. Lecture-discussion
b. Experiential approach. Group the trainees and let them identify weed samples by group. Let them talk about their observations and experiences. Then present the result of their small group discussion to the class.

Materials/Visuals

- Slides, pictures, transparencies, OHP, slide projector
- Samples of weeds
- Powerpoint presentation

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Evaluation

True or False. Write true if the statement is correct and false if it is not.

_____ 1. There are more problems of weeds on transplanted rice than on upland rice.

_____ 2. Weeding is necessary until harvesting.

_____ 3. If labor cost is high, the farmer can resort to herbicides.

_____ 4. All herbicides have the same action and can kill all weeds.

_____ 5. Preventive weed control is so far the best for weed management.

Answer briefly the following questions.

1. Why are herbicides most effective when used in combination with other control methods?

2. Explain briefly the components of integrated weed management.

3. Why should utmost care be practiced in the use of herbicides?

Enrichment Activity

Facilitator may discuss and demonstrate steps in calibrating and using a knapsack sprayer.

MODULE 15

Integrated Pest Management

G. Integrated Rat Management

Overview

This module discusses the characteristics, damage and management of rice field rats. Rats are chronic rice pests of farmers.

Crop losses caused by rats often exceed the combined losses from all other pests. Aside from farm crop losses, they are also problems in warehouses. They consume and contaminate stored food in homes and are vectors of several diseases to humans and domestic animals. The continuous availability of susceptible crops provides the basic requirements of rats such as abundant food, water, and shelter. Field rats are present in all places at all times, although rat populations are lower at certain times of the year such as the end of the dry season.

Objectives and Topics

I. Describe the characteristics of field rats (*see figure 15.1*).

A. Poor vision but sensitive to motion.
B. Sensitive sense of smell, taste, touch, and hearing.
C. Nocturnal - active by night.
D. Good climbers
E. Good swimmers
F. Can jump fairly high.
G. Has chisel-like teeth/incisors.
H. Continually chews to sharpen their teeth.
I. Has long whiskers and guard tails to guide them when they travel.
J. Engages in cannibalism when food is scarce.
K. Exhibits temporary fear when there is a change in an otherwise familiar condition, protecting them from consequences of curiosity.
L. High reproductive potentials; few males can mate with almost all the females in the area.

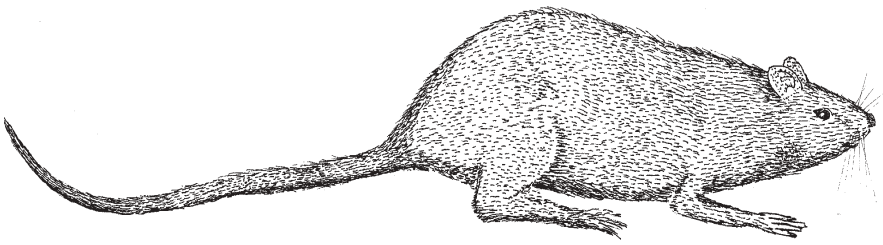

Figure 15.1 Field rat (*Rattus* spp.)

II. List the food preference and feeding habits of field rats.

A. Primary foods are rice, green corn, and other grains.
B. Secondary foods are cassava, coconut, sugarcane, shelled corn, etc.
C. Also feeds on insects, snails, dried fish, fowl, and weaker members of the group when food is scarce.

III. Describe the burrows and harborage prefered by field rats.

A. Typical burrows have a principal entrance with one or more exits.
B. 1-5 ft long, and curves underground to as deep as 2 ft.
C. With sections for storing food and delivery; it also has a section for giving birth.

IV. Describe the life cycle of field rats (*see figure 15.2*).

A. Rats can live up to 3-4 years in the laboratory but the average lifespan is from six months to more than one year in field conditions.
B. Pregnancy lasts for 3 weeks.
C. A female rat produces a litter of up to 21 pups (average of 6-8 pups) and can give birth 3-4 times a year.
D. Pups are born blind and helpless up to 21 days.
E. Pups grow rapidly and are ready to breed at 6 weeks of age.
F. A pair of rats with their offspring can produces more than 500 rats in one year if food and other conditions are favorable.

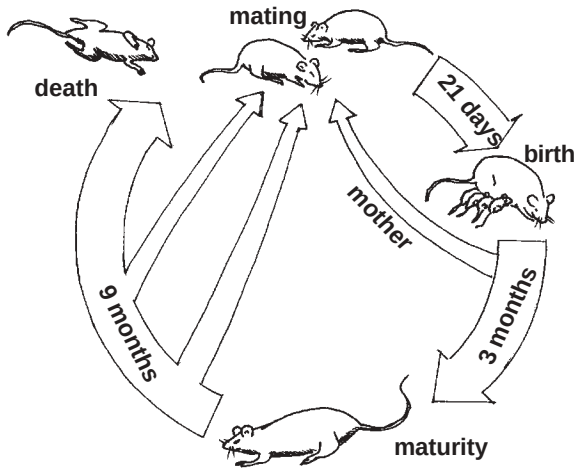

Figure 15.2 Life cycle of rats

V. Describe the symptoms/damage caused by field rats.

A. Missing germinated plants.
B. Missing hills.
C. Chopped young seedlings.
D. Irregular cutting of stem.
E. Chewed developing buds or ripening grains.
F. Tillers cut near the base at a 45° angle.
G. Retillering of stems.
H. Delayed grain maturity.
I. Missing grains or panicles.

VI. Enumerate the control methods in effective field rat management.

A. Cultural methods

1. Practice proper sanitation by removing weeds and straw piles in the paddies.
2. Practice synchronous planting.
3. Minimize size of levees to 15 cm wide x 20 cm high to avoid rat burrows.

B. Physical/Mechanical methods

1. *Trapping* - sometimes practiced to capture rats that have caused localized damage in the field.

2. *Destroying burrows* - Rats are killed with men armed with sticks, usually done in the absence of crops to minimize the places where rats can escape or hide.
3. *Use of flame throwers* - attack rat burrows with torches or flame throwers. The nozzle with flame is placed into the opening of one rat burrow while other burrows are closed to suffocate the rats.
4. *Blanketing method* - a group of men surround the rats' hiding places, forcing them to come out and eventually clubbing them to death.
5. *Rat proofing* - the utilization of concrete walls, floors and rat-proof doors in warehouses.
6. *Trap barrier system* (TBS).

    a. Using the TBS (*see figure 15.3*). For every 10 hectares contiguous rice area

        a.1 Plant rice in a 20 x 20 m area one month before the normal planting time.
        a.2 Use aromatic or good eating quality rice variety as bait.
        a.3 Fence the area with 24.5 inch high plastic sheets (similar to the material used to cover books).
        a.4 Use bamboo stakes to erect the plastic material. The stakes should be inside the plastic fence.
        a.5 The trap is made of metal screen wire (rectangular in shape), having a cone-shaped inclined entrance tunnel narrowing to the end with bent metal wire. Rats are caught in the traps while trying to enter the trap barrier system.

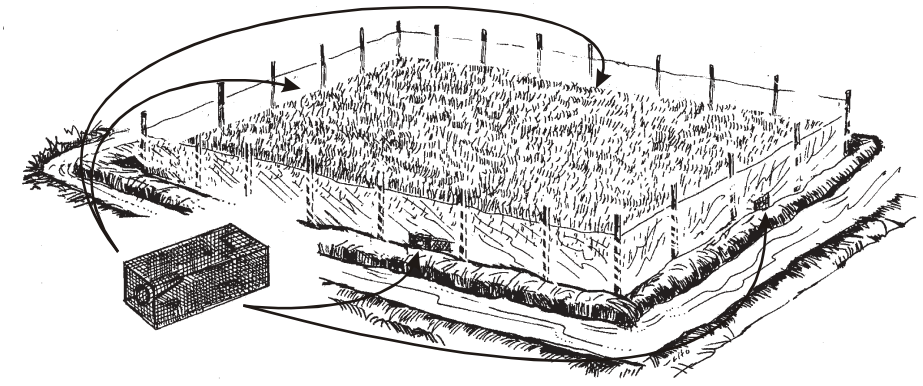

Figure 15.3 The trap barrier system (TBS)

b. Advantages of the TBS

b.1 Environment-friendly and relatively a low-cost technology.
b.2 The TBS capitalizes on the rat's behavior of entering holes and running along sides of the rice paddy in search of food.
b.3 TBS is more effective when adopted as a community-wide action to control rats.
b.4 Rat control using TBS should start at the seedbed to protect the seedlings.
b.5 Requires P2700* (P1900 for plastic, P600 for four rat traps, and P200 for labor) to control rats in a 10 ha rice field.

*subject to change

C. Chemical methods

1. *Acute rodenticide* is a quick acting poison, a single dose is enough to cause death. Death occurs shortly after ingestion.
2. *Chronic rodenticide* is a slow acting poison, requiring multiple dose feeding, resulting to death from internal bleeding.

VII. Describe the proceedures in baiting.

A. Apply acute rodenticides in areas where pre-baiting was successful to avoid the establishment of a new rat population in the same area. This will increase chances of killing them by about 70%.
B. Two weeks after transplanting, install 5 initial baiting stations per hectare. Place chronic baits in the baiting stations to further reduce the remaining 30% population.
C. Use locally available materials such as bamboo, oil cans, coconut husks, etc as bait holders.
D. Mix 1 kg of rodenticide with 19 kg of milled or broken rice.
E. Deposit 6 tbsp of mixed bait per baiting station.
F. Place baiting stations along rats' breeding places, such as irrigation dikes, uncultivated areas in addition to those placed along rice fields.
G. Inspect all baiting station every day and replace consumed biats.
H. For every station visited by the rats, add 1-2 baiting stations 10 meters apart from the original baiting station.
I. Increase the amount of mixed baits to 8 tbsp per baiting station. Replace spoiled baits with new ones.

J. Before harvest time, collect all baits. Clean, repair, and keep them for the next cropping season.

    1. Pre-baiting. Distribute the baits (without the poison) 3-5 days prior to massive acute baiting to familiarize the rats with the bait before the toxic bait is used. This is also used to minimize bait shyness. This should be done before seeding and before transplanting to target the rats that attack the seedbed.
    2. Bait shyness - The reduction in the effectiveness of acute poisons after repeated use in the same locality or area when more and more rats realize the sub-lethal effects of the poison.

Methodology

This module can make use of the following activities:

a. Lecture for the knowledge/information portion.
b. Excercise on calculation of the fecundity of field rats.
c. Demonstration on the preparation and placement of baits
d. Case method on the damage caused by field rats.

Materials/Visuals

- Picture, slides, transparencies, OHP, slide projector
- Powerpoint presentation

References

Controlling Field Rats. Rice Production Skills Development Series RP3-33. International Rice Research Institute, Los Baños, Laguna,Philippines.

Duldulao VA. 2000. Let's produce more rice. Department of Agricuture, Philippine Rice Research Institute. Muñoz, Nueva Ecija, Philippines.

PhilRice. 2000. Rice Technology Bulletin Series No. 28. Management of field rats. Philippine Rice Research Institute, Maligaya, Science City of Muñoz, Nueva Ecija, Philippines.

Evaluation

True or False. Write true if the statement is correct and false if it is not.

_____ 1. Field rats are a problem in specific areas.

_____ 2. It does not matter whether the bait is moldy, since field rats are just pests.

_____ 3. Damage is usually higher during the vegetative growth of the rice plant.

_____ 4. Three baiting stations are enough for one hectare.

_____ 5. Field rats die immediately after eating bait with chronic rodenticide.

Answer the following questions:

1. How do you estimate yield loss caused by field rats?

2. How many offsprings can a pair of field rats produce in one year?

3. How can you distinguish the damage done by a high field rat population?
4. At what stage of the rice plant does field rat damage reach its peak?

5. What is the best management strategy when there is a high field rat population?

MODULE 16

Integrated Pest Management

H. Integrated GOLDEN APPLE SNAIL Management

Overview

This module discusses the introduction of the golden apple snail (GAS), or golden kuhol, into the country, its life cycle and habitat, the damage it causes the rice plants, and its management.

Because of its voracious feeding habits resulting in rapid growth and reproduction, it became a major pest attacking rice seedlings (direct-seeded rice are more susceptible). It is essential, therefore, to manage and control GAS in major activities of rice production.

Objectives and Topics

I. Discuss the introduction of the GAS into the Philippines.

A. The golden apple snail (*Pomacea caniculata*), belongs to the snail family Ampullariidae.

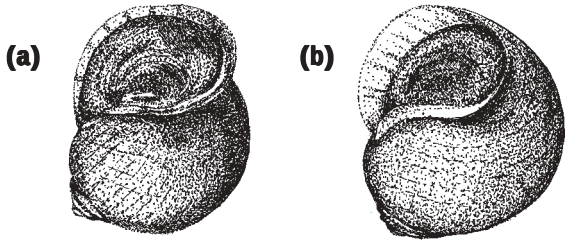

Figure 16.1 The GAS male shell (a) curves outward; the female adult snail (b) curves inward.

B. It is locally known as the "*golden kuhol*" and was introduced in the Philippines between 1982 and 1984.

C. It came from South America (Argentina and Brazil) via Taiwan. GAS was introduced in the Philippines by civic-minded organizations as

a supplement to the protein-deficient diet of Filipinos, and as an export potential to the gourmet restaurant trade. Additionally, there was no market outlet for the GAS. These reasons prompted the loss of the snails' commercial value that caused the abandonment of the GAS. The abandoned GAS escaped, dispersed in waterways and ultimately invaded the rice fields.

II. Discuss the biology of the GAS.

A. Eggs

1. Bright pink-red in color; laid in clusters which are usually oval in shape, with 50-500 eggs/clusters and turn light pink to light brown tinged when about to hatch.
2. They are usually laid very early in the morning or late in the evening on any vegetation or objects above the water surface.
3. One female can lay around 1000-1200 eggs in a month.
4. Hatch in 7-14 days after egg laying; hatchability is around 80%.

B. Hatchlings

1. Newly hatched snails cling on objects above the water surface.
2. They grow fast and reach maturity in 15-25 days.
3. They are voracious feeders.

C. Grown-up to adults

1. Growing period is 44-59 days.
2. Reproductive period is 60 days to 3 years (*see figure 16.2*).
3. Adults mate for more than 3 hours anytime of the day at 3-4 times /week where there is water and thick vegetation.

D. Habitat

1. Freshwater ecosystem (slow-moving or stagnant water in lowland swamps, ponds, ditches, canals, lakes, and rivers).
2. If field is drained, they bury themselves under the soil and continuously dig deeper as the dry season progresses.
3. Can aestivate for more than 4 months under the soil and go out and become active when water is available; this is one reason for the occurrence of many GAS at the start of land preparation.

4. Can survive harsh environmental conditions such as pollutants in the water.

E. Feeding habits and host range

1. Macrophytophagous and zoophagous.
2. Can feed a wide range of plants – azolla, duck weed, water lily, rice seedlings, and other plants that are succulent.
3. They prefer young plant parts because they feed by scraping the plants surface with their rough tongue.
4. Feed also on decaying organic matter.

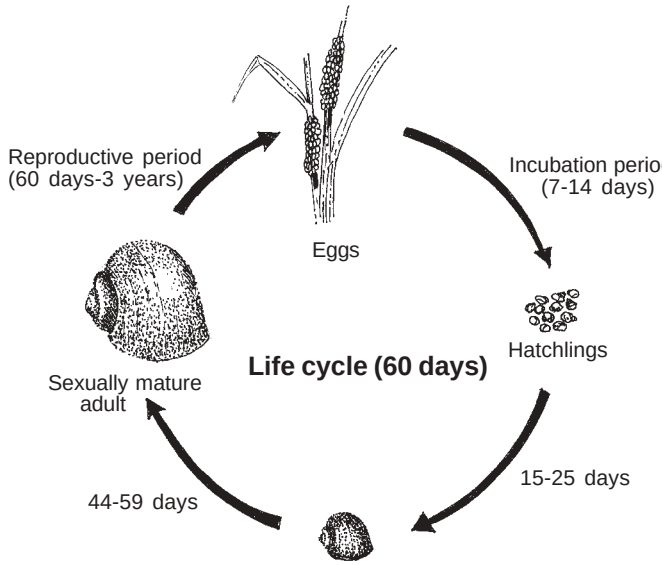

Figure 16.2 Life cycle of GAS

III. Discuss the damage done by GAS.

A. It is considered a serious pest and can destroy 3.5% of the total area planted to rice. The problem of GAS infestation in rice farming systems include damage to the rice plant, yield losses, additional expenses, side effects of chemicals and destructive effects on native snails.

B. The extent of damage to the rice crop depends on the snail size, population density and growth stage. GAS with a shell height of 1.3 cm feed on young plants up to four weeks old, while those with shell

height of 6.5 cm feed on young plants up to nine weeks old.

C. Plants at two weeks after transplanting are most vulnerable to damage by GAS.

D. Damage increases with GAS density. At a density of 1 snail/m^2 with shell height of 2-3 cm, the number of tillers could be reduced by 19% at 30 days after transplanting. This loss can be up to 98% when GAS density increases to 8 snails/m^2.

E. Signs of GAS infestation are *missing hills* and *floating cut leaves* (which can be mistaken from rat damage). GAS devour at the base of the young seedlings and can consume a whole plant in a paddy overnight.

IV. Discuss the management of the GAS.

A. During land preparation

1. Before final harrowing, handpick GAS from rice paddies in the morning and late afternoon when they are most active and easy to find.
2. Construct small canals to confine snails and place plants that contain toxic substances against GAS. Examples of these plants are *gogo* (bark), *tubing- kamisa* leaves, *sambong* leaves, *tuba-tuba* leaves, *lagtang* leaves, *tobacco* leaves, *calamansi* leaves, *tubli* roots, *makabuhai* leaves, red pepper fruit, star flower leaves, neem tree.
3. Use of attractants such as leaves of gabi/taro, banana, papaya, trumpet flower, and newspaper in canals to facilitate collection of GAS.
4. During last harrowing, construct deep strips (at least 25 cm wide and 5 cm deep) in the paddies and along the edges of the paddies.
5. Place a wire or woven bamboo screen on the main irrigation water inlet and outlet to prevent entry of hatchlings and adults. This also facilitates collection of trapped GAS.

B. During and after transplanting

1. Follow the standard seeding rate and distance to have plants with sturdy stems.
2. Transplant 25-30-day-old seedlings of early-maturing varieties if GAS is really a problem.
3. Put up bamboo stakes in the paddy for GAS to lay eggs. This allows easy collection and crushing of eggs.

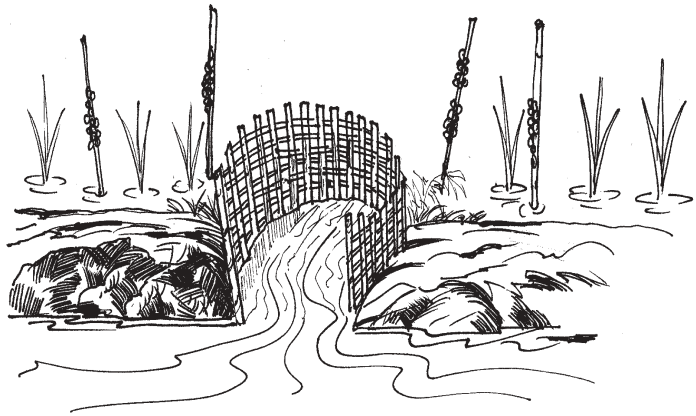

Figure 16.3 Wire screen placed at water inlets prevent GAS from transferring to other fields.

4. Maintain shallow paddy water level of 2-3 cm deep starting 3 days after transplanting.
5. Flood and drain water alternately to hinder snail mobility and feeding activity.
6. Collect, crush and feed GAS to duck and pigs.
7. Use tolerant or high-tillering varieties to compensate damage.
8. Herd ducks 30-35 days after transplanting for early-maturing varieties and 40-45 days for late-maturing varieties. However, do not herd ducks when they shed their feathers (*see figure 16.4*).

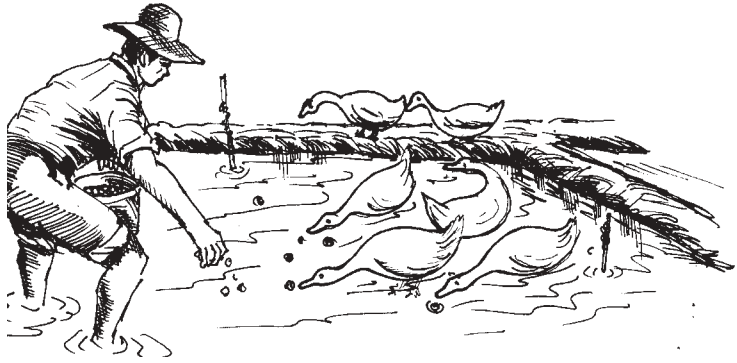

Figure 16.4 Herding ducks into rice paddied help reduce GAS population

C. After harvesting

Herd ducks in rice paddies immediately after harvest up to the last harrowing for the succeeding crop.

V. Identify biological control agents (predators/natural enemies) of GAS.

A. Red ants and long-horned grasshopper feed on eggs of GAS.
B. Ducks eat GAS both live in the field and as feeds after hand collections.
C. Humans are the best predators.
D. Some PSB varieties least preferred by GAS such as; PSB Rc28, Rc 36, Rc40, and Rc 68.
E. Basal application of complete fertilizer and urea incorporated with the soil at recommended rate during the last harrowing reduced GAS population up to 54%.
F. Spot-treatment of GAS egg masses with niclosamide 250EC reduced cost for GAS management and environmental pollution.

Methodology

a. Experiential learning: Show sample specimens of golden apple snail egg mass of different sizes, and GAS of different sizes and sex. Let the participants talk about their experiences and observations. This activity is preferably done outdoors.
b. Lecture-discussion

Materials/Visuals

- Pictures, slides, transparencies, OHP, slide projector
- Powerpoint presentation.

References

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Evaluation

True or False. Write true if the statement is correct and false if it is not.

_____ 1. The GAS is native to the Philippines.

_____ 2. There is no need to be alarmed by the GAS since it is just a small creature.

_____ 3. If you do not like your rice plants to be damaged by GAS provide the snails alternative feeds throughout the rice plant growth stages.

_____ 4. Handpicking is so far the best control measure.

_____ 5. Transplanted rice are more susceptible to GAS damage.

Fill in the blanks. Write the correct anwers on the space provided.

1. The GAS reached the Philippines through _____ from Argentina.

2. GAS was originally intended for human consumption to increase the Filipino's _____ intake.

3. One egg mass can contain as many as _____ eggs.

4. The pest is so serious and can cause damage to _____ % of the total area planted to rice.

5. The extent of damage depends on snail size, population density, and _____.

MODULE 17

Agroecosystems Analysis (AESA)

Overview

This module presents a general procedure in conducting agroecosystem analysis (AESA). It discusses the basic concepts necessary in the understanding and management of the complex agroecosystems.

A detailed knowledge of the agroecosystem is necessary to harmonize the control practices for different pests to prevent unacceptable disruptive effects. AESA is an essential decision tool for every crop protection specialist and/or farmer. The dynamics and behavior of one agroecosystem varies from place to place or even from farm to farm, within the same locality due to the variations in the management systems. With AESA, the participants and the facilitators of the training acquire knowledge and skills in identifying changes and interactions in rice and its surroundings and to use this in decision making.

Objectives and Topics

I. Define what is an agroecosystem (agricultural ecological system).

   A. Is an ecological system partly modified by man to produce food, fiber, or other agricultural product.
   B. Is a unit composed of the total complex of organisms in a crop area together with the overall conditioning environment, and as further modified by the various agricultural, industrial, recreational, and social activities of man.
   C. The ecological system existing in an agricultural area is sufficiently large to permit long-term interactions among all the living organisms and with the non-living organisms in the environment.

II. Identify the basic components of a rice agroecosystem.

A. The sun as the primary energy source (quantity, quality, day length).
B. The media as modified by prevailing weather:

1. Air - O_2, CO_2, N_2, H_2O
2. Soil - nutrients, H_2O, texture, pH, etc.
3. Water

C. Plants and the environment.
D. Herbivores or phytophagous forms. Plant-eating organisms such as insect pests and rats.
E. Carnivores. Animal-eating organisms such as parasites, predators, pathogens which prey upon the phytophagous forms.
F. Non-pest organisms (pollinators, decomposers, etc.)
G. Agronomic practices of farmer.

III. Discuss the procedures in the conduct of AESA.

A. Divide the training participants into four learning teams with one facilitator for each team. These learning teams are permanent throughout the duration of the training. Each team is assigned to a specific field plot for the weekly AESA.
B. Conduct AESA 14 days after transplanting (DAT) and weekly thereafter up to two weeks before harvest.
C. Randomly pick a hill and record the observations and data gathered. Get a minimum of 5 sample hills.
D. The following will be observed and recorded in sequence:

1. Cautiously observe, identify, count, and classify highly mobile insects first, according to pests and natural enemies without disturbing the sample plants at the canopy.
2. Observe and count other insects at the middle part of the plants by looking closer between tillers.
3. Identify and count adult and nymphs of the brown planthoppers (BPH), whitebacked planthoppers (WBPH), and other insects at the base of the plant. Observe also the presence of the natural enemies of these pests such as mired bugs, dwarf spiders, and wolf spiders.
4. Tap the plants after examining the hill. It will help dislodge other insects that are not counted or identified.

5. Be aware that there are plenty of helpful aquatic predators such as water striders, Mesovelia and Microvelia, which are effective against hopper adults and nymphs. These too are to be counted or estimated and included as other observations.
6. Observe the sample hill for plant health, diseases, nutrient deficiency, and leaf damages. Determine Nitrogen deficiency by using the Leaf Color Chart (LCC).
7. Measure water level using an improvised bamboo stick or meter stick.
8. Determine weed status by rating weed density as abundant, frequent, and rare.

    a. *Abundant* - when field is almost covered by weeds;
    b. *Frequent* - when weed condition will be spotted in occurrence; and
    c. *Rare* - when weeds are almost absent.

    Weed rating can be done while conducting field sampling and can generally be observed while standing at the edge of the field.

9. Take at least 10 LCC readings at random if PTD is LCC based. If 6 or more of the LCC readings are lower than 4, apply the recommended fertilizer.

E. Stake 5 representative hills per treatment for plant development data. Take the average number of tillers, plant height, and the number of leaves of the highest tiller.
F. Consolidate the data gathered such as the insect pests and their natural enemies and other field observations in a Manila paper. Include also the general observations such as the variety planted, date sown, date transplanted, fertilizer applied, average number of tillers, average plant height, number of leaves, and age and stage of the plant. Other AESA data, *e.g.*, weather conditions, water depth, weed status, plant health, pest and other damages will be indicated as observations. Recommendations will be indicated opposite the observations.
G. Present/report AESA results after the processing of the data. A representative of the team will present their output in the big group. Questions and clarifications will be raised and opinions/answers/recommendations and discussion will follow. The facilitators can clarify matters/issues with contrasting ideas and supply additional information when necessary. This activity will be undertaken once a week, up to 2 weeks, before harvesting.

Methodology

a. Lecture
b. Fieldwork
c. Workshop

Materials/Visuals

- Pen/Markers
- Colored pens/Crayons
- LCC
- Ruler
- Manila paper
- Actual specimen of insects (field)

Reference

Duldulao, VA. 2000. Let's produce more rice. Department of Agriculture, Philippine Rice Research Institute. Muñoz, Nueva Ecija, Philippines.

Field Guide of Discovery-Based Exercises on Rice IPM. 2000. The Philippine National IPM Program.

Evaluation

The class can perform an actual AESA. Follow the instructions on how to conduct an AESA in this module then write the class' observations on a piece of Manila paper following the sample ASEA form on the next page.

Sample form

Date: _____
Time: _____

AESA No.
Title of Demo

General Information:
Variety:
Date Sown:
Date Transplanted:
Fertilizer Applied:
Weather Condition:

Agonomic Data:
Stage of the crop:
Ave. no. of tillers:
Ave. plant height:
Ave. no. of leaves:
LCI:

Natural Enemies

No.	Name/Drawing of Natural Enemies

_____
= total

Insect Pests

No.	Name/Drawing of Insect Pests

_____
= total

Observations:

1.
2.
3.
4.
5.

Recommendations

1.
2.
3.
4.
5.

MODULE 18

Safe and Effective Use of Pesticides

Overview

This module defines pesticide and its different formulations. It presents a profile of pesticide use in rice in the country. It also describes the effects of indiscriminate pesticides use on farmer's health and the rice environment. The guidelines for safe and effective use of pesticides are also discussed.

Pesticides continue to be a growing component of modern rice technology even if there are already alternatives to chemical pest control. Guidelines on the effective use of pesticides must be observed to safeguard the user's health and the environment.

Objectives and Topics

I. Define pesticide and describe its different formulations.

A. A pesticide is any chemical used to control pests. The pesticides used to control pests for rice are: insecticides, herbicides, rodenticides, molluscicide, and fungicides.

B. A pesticide is not usually applied in pure form. It must be diluted with water, oil or an active solid so it is less toxic to humans and can be spread evenly over a large area. The final product is called a pesticide formulation. These formulations include:

1. *Dusts*. These require no mixing and can be applied directly to the plant. However, dusts may drift from where they are applied and contaminate areas where humans and livestocks live.
2. *Granules*. These can be applied as bought with simple equipment and require no additional mixing. Granules do not easily drift to other areas.
3. *Liquid Formulations* (LFs). These are also called *Emulsifiable*. Samples of LFs are:

a. *Concentrates (*ECs*)* and are mixed with water and sprayed.

They contain a high concentration of pesticides and are easy to transport and store. They are effective for treating foliage and require little agitation in the tank to have them mixed.

b. *Flowables* (LFs). These are special kinds of LFs in which finely ground solid particles of pesticides are suspended in a liquid. They are applied and used in the same way as other LFs.
c. *Wettable Powders* (WPs). These have the same kind of materials as ECs except that the insecticide is in small, dry, powderlike particles. WPs are mixed with water to form suspensions and has to be agitated during application.
d. *Soluble Powders* (SPs). These have the same materials as the WPs but are dissolved in water to form solutions. Thus, they do not settle down like the WPs.
e. *Poisonous Baits* (PBs). A poisonous bait is food or other substances with which pesticides are mixed. Pests eat the bait and die.

II. Describe pesticide use for rice in the Philippines.

A. In 1991, rice production accounts for about 50% of the total insecticide usage. Over 80% of the herbicides and 4% of the fungicides are sold in the Philippines (APIP, 1991).
B. Molluscicides have also been used in small quantities since 1987 to control GAS (Warburton and Pingali, 1993).
C. The total quantities of pesticides used in the Philippines are small compared to South Korea and Japan. Rice agrochemicals in the country accounted for only 2% of the world market value in 1988 (Woodburn,1990).
D. Rice farmers have been applying pesticides for over three decades. They make two to three applications of insecticides and one application of herbicides.
E. With the advent of rice varieties that are resistant to a wide variety of insects and diseases, the importance of insecticides for rice production has declined.
F. The release of resistant varieties, however, was not accompanied by supporting information campaign on the reduced need for insecticides.
G. Compared to other crops, insecticide use in rice is low. Insecticide use in rice neither enhances grain quality nor improves yield in the absence of pest pressures.

H. If IPM technology leads to the reduction of pesticide use, any associated improvements on health and environmental quality should be counted as benefits from the adoption of IPM.

III. Cite effects of indiscriminate use of pesticides.

A. Health impairment due to direct or indirect exposure to hazardous chemicals.
B. Contamination of ground and surface water through run-off, seepage and percolation
C. Pesticide residue through the food chain to the farm family and urban consumers.
D. An increase in the resistance of pest populations to pesticides.
E. Reduction of beneficial organisms.
F. Pesticides are useful component of IPM in rice but these must be used only when necessary and be applied properly. Improper use may cause the following side effects :

1. *Environment pollution*. Some pesticides may be taken in from the environment and accumulated in animals and plants. Wildlife and people who eat meat contaminated with pesticides may be poisoned even without direct contact with a pesticide. This type of pesticide is very harmful to the environment and causes long-lasting damage.

2. *Phytotoxicity*. The active ingredient (ai) or materials in pesticide formulations may damage crop plant. Phytotoxicity or toxicity to plant may be caused by:

a. Using the wrong pesticide.
b. Applying an inappropriate pesticide mixture.
c. Wrong timing of application.
d. Using too much pesticide.
e. Selecting the wrong pesticide formulation.

3. *Damage to non-target organism*. If pesticides are carried by wind, water or other means from the area where they are applied, they may be harmful to friendly insects and microorganisms, humans, livestock, wildlife, and crops.

IV. Discuss the steps to consider before choosing and applying any pesticides.

A. Identify the pest. Carefully check the field to determine both symptoms or sign of damage and species of pests.
B. Consider other control methods. After you have identified the pest, determine if control is necessary, and considering other control measures, decide on the most appropriate one to implement.
C. Choose a pesticide that is effective against the target pest, has directions on the label, will not cause injury to the crop, and is least harmful to beneficials (parasitoids and predators).
D. If possible, chose pesticides with color bands; blue (moderately toxic) and green (slightly toxic) in the label rather than yellow (highly toxic) and red (extremely toxic) bands.

V. Enumerate the precautions in handling pesticides.

A. Before Application

1. Read the label to determine:

a. Target organism;
b. Rate and time of application;
c. Need for protective clothing and equipment;
d. Antidotes and other safety measures;
e. Field reentry intervals after treatment.

2. Check the sprayer

a. Fill the tank with plain water and test the sprayer to be sure that there are no leaks or loose connections and the equipment is working properly.
b. Repair or replace any worn-out or faulty part.

3. Mixing and filling. Extra precaution is necessary when mixing and filling sprayers because pesticides are concentrated.

a. Wear protective clothing.
b Open pesticide container carefully to avoid splashes, spills, or drift.
c. Stand upwind when adding materials to the sprayer to avoid drift of pesticides fumes or particles.
d. Keep your head away from the opening of the sprayer.

e. Wash and change clothes immediately if pesticide is spilled on clothing.
f. Do not use bare hands in mixing pesticides, nor allow concentrated materials to touch bare skin.

B. During application

1. Wear protective clothing.
2. Do not eat, drink, smoke, or blow clogged nozzles, with your mouth while applying pesticides.
3. Do not apply when it is windy to avoid pesticide drift.
4. Do not spray near or in ponds, lakes or streams.
5. Spray areas near homes in early mornings or evenings when humans, pets and livestocks are less likely to be exposed.

C. After Application

1. Make sure the sprayer is empty. Clean and rinse the sprayer inside and out and return it to storage area.
   Dispose of empty pesticide containers properly.
2. Store remaining pesticides properly.
3. Bathe and change clothing.
4. Stay away from treated field for 1-2 days. This prevents poisoning through contact with treated plants, or inhalation of pesticide fumes.

VI. Describe the types of pesticide poisoning and their symptoms.

A There are two different kinds of poisoning. These are acute and chronic.

1. *Acute poisoning* occurs after exposure to just a single dose of pesticide. Symptoms may occur immediately or be slightly delayed.
2. *Chronic poisoning* occurs after repeated exposures over a long period of time. Symptoms include nervousness, slowed reflexes, irritability, and a general decline of health.

B. The general symptoms of poisoning include:

1. Mild poisoning or early symptom of acute poisoning:

a. irritation of eyes, nose, or throat;
b. headache and/or dizziness;

c. fatigue and/or diarrhea.

2. Moderate poisoning or early symptoms of acute poisoning:

a. upset stomach, blurred version;
b. extreme weakness, excessive perspiration;
c. muscle twitches, rapid heartbeat.

3. Severe or acute poisoning:

a vomiting and convulsions, pinpoint pupils;
b. difficulty in breathing, unconsciousness.

VII. Describe the first aid measures for pesticide poisoning.

A. Call a doctor or bring the patient to the hospital. Show the pesticide and/or label to the doctor.
B. While waiting for medical help or while transporting the victim to the hospital, apply the following first aid measures:

1. If the patient has pesticide on the skin, wash it off quickly to lessen the degree of injury.

a. Remove the patient's clothing.
b. Drench his/her skin and body with water.
c. Dry the patient and wrap him/her in a clean blanket.

2. If the patient has poison in the eye, wash the eye immediately and as gently as possible.

a. Hold the eyelids open and wash the eyes with a gentle stream of running water for 15 minutes or more.
b. Do not use chemicals in the wash water.

3. If the patient has inhaled poison, immediately move him/her to fresh air.

1. Loosen all his/her tight clothing, prevent chilling.
2. Apply artificial respiration if breathing stops or is irregular.
3. Do not give him/her alcohol in any form.

VIII. Describe the proper storage and disposal of pesticides.

A. Store pesticides in their original containers and keep them in safe, dry, locked, and well ventilated area.
B. They must be sealed, labeled correctly, and kept out of the reach of children and animals.

Methodology

- Lecture
- Demonstration of correct spraying practices.
- Experiential approach. Let the participants discuss their current methods of spraying, and the problems they have encountered.

Materials/Visuals

- Slides
- Pictures
- Samples of different formulations
- Powerpoint presentation

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Evaluation

Multiple Choice. Select the best answer from among the choices given.

1. Pesticides used to control insect pests in rice are called:
   a) insecticides b) suicides
   b) herbicides c) molluscicides

2. Which of this pesticides are mixed with either water or oil before application?
   a) dust b) wettable powder
   c) granules d) none of the above

3. Chemical used to control golden kuhol is called:
   a) insecticides b) suicides
   b) herbicides c) molluscicides

4. What should NOT be done when using pesticides?
   a) Wear protective clothing.
   b) Blow clogged nozzle of the sprayer with your mouth.
   c) Spray with the wind.
   d) Bathe and change clothes after spraying.

5. Indiscriminate use of pesticides may result to:
   a) environmental pollution.
   b) reduction of beneficial insects.
   c) poisoning
   d) all of the above.

Answer the following questions.

1. Describe the different pesticide formulations.
2. Cite the effects of indiscriminate use of pesticides.
3. Discuss the steps to consider in choosing and applying pesticides.
4. Enumerate the precautions in handling pesticides.
5. Describe the first aid measures for pesticide poisoning.

MODULE 19

Harvest and Postproduction Operations

Overview

This module emphasizes the importance of post production handling of rice. It discusses the different operations from harvesting to milling, including the principles and practices for each post production activity.

Postproduction operations such as threshing, drying, cleaning, and milling are interdependent. The technique employed for harvesting, time of harvest, temperature, and moisture content affect the milling recovery and quality of milled rice. Hence, it is important to know the proper and efficient postproductiom operations.

Objectives and Topics

I. Cite the importance of postproduction technology in rice.

A. The technique employed, the timing of each operation and the environment in which they are carried out all contribute to the quality and quantity of rice that are sold or consumed.
B. There is a close relationship between performance at the processing level and operation at the farm level. If rice is improperly threshed, dried, and cleaned at the farm level, it is impossible to achieve high milling efficiency at the processing level.
C. Low rice yield in farmers' fields may be further aggravated by losses from old and wasteful techniques in post production.
D. The losses, both quantitative and qualitative take place at various stages in the harvest and postharvest operations.
E. It is estimated that losses from harvesting through milling account to about 15% of all rice grain harvested.
F. In the market, the price of rice is often determined by the appearance of the rice grain. The milling and market quality of rice are greatly affected by harvesting and postharvest operations.

II. Describe harvesting as a process and the factors that affect it.

A. Harvesting is the process of gathering a crop. For rice, this generally refers to the cutting and gathering of panicles attached to the stalks. This is usually done manually.
B. The rice crop is observed to determine the best time of harvesting.
C. It is important to harvest a crop on time otherwise there will be grain losses due to feeding of rats, birds, and other insects and from shattering and lodging. Both early and late harvests are detrimental to grain yield and to milling recovery.
D. Timely harvesting ensures good grain quality, a high market value, and improves consumer acceptance.
E. To determine whether the rice is ready for harvest, gather a spoonful of grain. If the hulled kernels are clear, translucent and firm, the crop is ready for harvest.
F. Another way to determine if the crop is ready for harvest is to see whether 80-85% of the grain at the upper portion of the panicles are yellowish or straw colored or those at the base are at the hard dough stage. If these signs are present, the crop is ready for harvest.
G. Farmers harvest at maturity to minimize field losses due to shattering of overripe grains, unfavorable weather, and pilferage.
H. Delays in harvest are caused primarily by lack of labor especially during the peak months of harvest.
I. Based on maximum grain yield with highest milling recovery and seed viability, the best time to harvest transplanted rice is between 30-42 days after heading during the wet season and between 28-34 days after heading during the dry season.
J. The method of threshing and the subsequent use of the stalks affect the technique of harvesting.
K. Farmers use sickle in harvesting. They cut the stalks in a slicing action usually 61-91 cm from the base of the panicle. But those who will use the straw for mulching or those who use hold-on type threshers cut the stalks as low as possible.
L. During the field drying process, overmature rice shatter and fall thus contributing to postproduction losses.
M. An estimated 10% of the rice crop is lost when grains are left in the field to dry to 14-16% moisture before harvest.
N. It takes 60-80 man hours to harvest one hectare and additional 40 man hours to stack the rice stalks.

III. Describe the threshing practices particularly in the Philippines.

A. Threshing is the process of detaching and separating rice grains from the panicle (*see figure 19.1*).

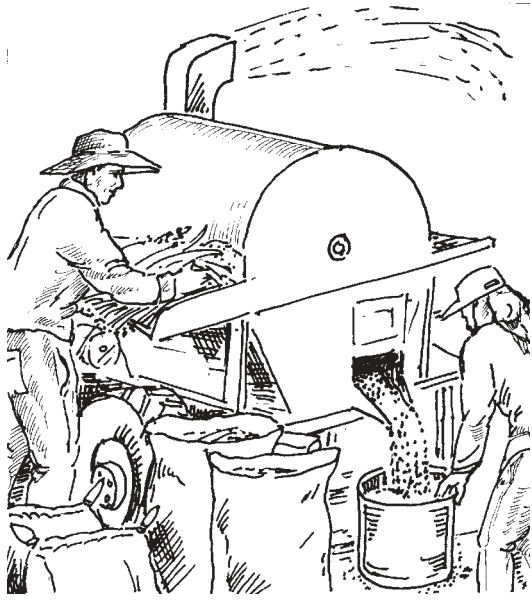

Figure 19.1 Farmers threshing harvested palay

B. As much as possible, the harvested rice should be threshed immediately. There are some farmers, who practice skin drying. They stack harvested rice in the field for several days before threshing.
C. Threshing can be done manually or mechanically. The manual methods of threshing are treading by feet, flail, and beating stalks against tubs, threshing boards or racks.
D. In treading by feet, palay spread on the threshing floor is trampled upon by the human feet. The continuous treading of one person separate about 14.5 kg of grain from the straw in one hour.
E. In animal treading, the harvested palay is laid around a stake or pole with the panicles toward the stake. A team of animals (carabao, cow) is driven slowly around the stake to trample the grain off the straw. The palay is raked occasionally until the grain is completely threshed, and all the straw has been removed. However, many of the grains may be damaged due to the hard hooves and heavy weight of the animals.
F. In flail threshing, grain separation is done by beating the paddy with a stick or hinged device called flail.

G. Another method called the *hampasan* method is through the impact of rice heads struck against a solid object such as a log, concrete slab or a platform of bamboo slots. This method can thresh 20-60 kg of palay per person per hour.
H. A low-cost mechanized thresher that can be used is the foot-driven (pedal) thresher. This has wire loops on a cylindrical drum that detach the rice grain. It has low initial cost and one worker can thresh about 1-2 cavans per hour.
I. Another low cost model is the *throw-in axial flow thresher*. This is portable, weighs about 100 kg and requires 5-7 horsepower engine. It can thresh up to 600 kg/hr.
J. A bigger version of the throw-in axial flow thresher has a built-in blower and cleaner. It is mounted on tires and requires a 10-16 horsepower engine. It has a capacity of 2000 kg/hr with three men operating it.
K. Threshing losses vary with the thresher used. A study conducted in the Philippines; shows that a manual thresher, 6.87%; axial flow thresher, 2.07%; and the portable thresher, 1.97%.

IV. Describe the proper cleaning of rice and cite the importance of this activity on the quality and marketability of rice.

A. The palay should be cleaned immediately after threshing by removing foreign seeds and other impurities.
B. Cleaning is an essential postharvest operation since it affects the storeability and milling quality of rice. It also affects the maintenance requirements of rice mills, especially if there are stones mixed with the palay.
C. Rice with impurities is more likely to deteriorate in storage. Impurities also reduce milling recovery, especially if there are stones mixed in the rice.
D. In some mechanical threshers, cleaning is carried out simultaneously with threshing. For manual or animal treading, further cleaning is necessary because the grain is mixed with straw, chaff, dirty stones, and other impurities.
E. In the Philippines, the most common method of cleaning is with the use of winnowing basket called *bilao*. Winnowing sieves called *bitsay*, made of either wire mesh or bamboo slats, are also used in cleaning.
F. Another method of cleaning is with the use of a hand-operated winnower called *hungkoy*. This implement consists of a paddle-type fan mounted on a wooden frame to direct air blasts to the grain or foreign matter that fall from the hopper.

V. Discuss the importance of drying before storage or milling and how this is done.

A. The reduction of moisture content is done by drying. The drying process is basically the transfer of heat by converting the water in a grain to a vapor and transferring it to the atmosphere.
B. Normally, rice has a moisture content of 20% or more after harvest. This should be reduced to 14% or below by drying within 12 hours but not later than 24 hours after harvest.
C. Two methods of sundrying are used in the Philippines. In the first, the harvested rice are in loose bundles and left to dry in the field for several days (although this practice contributes to *grain fissures* due to exposure to hot and cold air). The length of drying time depends on the weather, the practices in the area, and the availability of a thresher.
D. In the second method, the grains are spread on drying surface such as concrete pavement, mats, plastic sheets, canvases and fish nets at 2-4 cm layer (thickness). The palay is stirred regularly at 30 minutes interval for uniform drying.
E. Dryers of various forms have been developed but individual farmers can not afford to buy these. However, for better profits in farming, the farmer can put their money together and invest in these types of dryer (*see figure 19.2*).

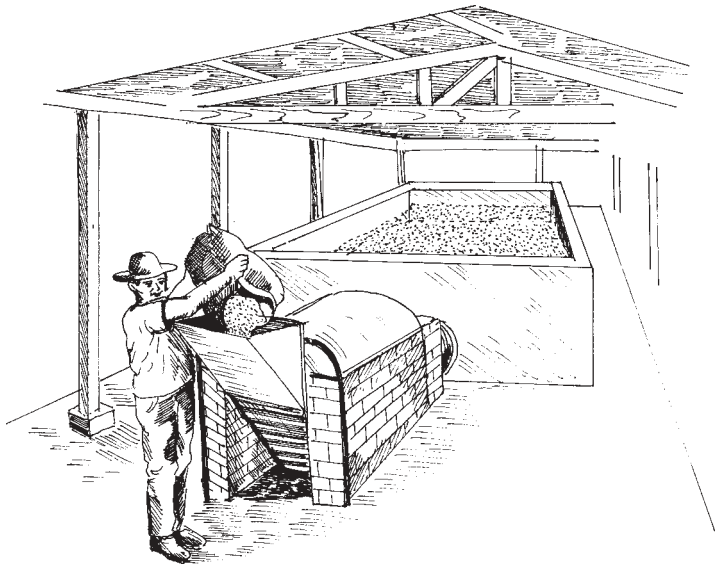

Figure 19.2 Flatbed dryer used by farmers

F. A maximum drying air temperature of 43.3°C is considered safe for grain seeds. A drying air temperature of 52°C can kill the germs of most seeds including rice. For milling purposes, the drying air temperature should not exceed 54.4°C.

VI. Relate the principle of storage in the proper storing of rice.

1. Rice is subject to deterioration because of changes in temperature and relative humidity. Insects and diseases are also more active when in temperature and relative humidity increases.
2. Since the moisture content of rice grains changes until it is in equilibrium with the surrounding air temperature and relative humidity, it is critical to have a storage structure that can keep the moisture content and relative humidity of the grain stable through out the storage period.
3. After drying the palay, store it properly if it is not sold immediately. Safe storage involves the preservation of the quality and quantity of palay for future use. The palay should be protected from the weather, pests, microorganisms, objectionable odors, moisture and other types of contamination (*see figure 19.3*).

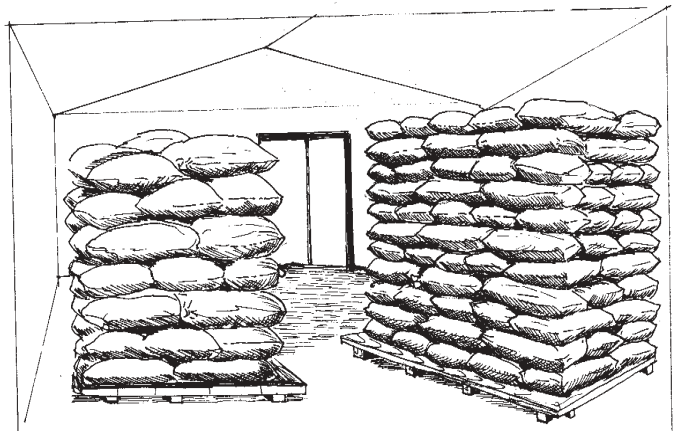

Figure 19.3 Storage area for palay

4. Store the palay in clean containers. Sacks can be used since these are flexible and easy to handle.
5. Separate varieties by storing them in different sacks and piling them according to the lots it came from. The sacks are handled with care to avoid damage and eventual spillage. Storage pests may also attack the sacks of grains. The quality of the stored palay may also deteriorate if the palay gets repeatedly wet and then dries.

6. Inspect stored palay frequently to detect pest infestation. The more obvious sign of pest infestation is the presence of live or dead beetles, flying moths and insect feces on the sacks.
7. The simplest and most effective preventive measure against storage pest is good housekeeping. The bodega must be clean before storing new grains.
8. Clean the sacks to remove insect pests. Separate old stocks from new ones to prevent infestation.
9. Since chemicals are expensive and hazardous to health and the environment, they should only be used as a last resort in controlling storage pests.

VII. Describe the milling operation and the different milling methods and their efficiency.

A. Rice milling involves the removal of hulls and bran from rough rice to produce milled or white rice.
B. A great quantity of rice is lost during the milling process. Therefore, milling requires careful planning and using properly designed and operated equipment. A good rice milling operation should:

    1. Produce the maximum yield of edible rice
    2. Obtain the best possible quality
    3. Minimize losses
    4. Minimize processing cost

C. The quality of milled rice is highly affected by the process. Good palay contains 22% hull; 6% bran; and 72% milled rice. However, these values cannot be obtained from ordinary milling facilities due to breakage and poor milling equipment.
D. In many rural areas, hand pounding is still practiced with various indigenous devices. The percentage yield from these hand pounding devices is low.
E. The steelhuller or *kiskisan* has a milling recovery of only 60-62% out of a potential 72% while the *cono* type mill has 68% recovery.
F. A modified *kiskisan*, the improved village rice mill, provides a maximum milling recovery up to 66% out of a potential 72%.
G. The *micromill*, a modification of a similar portable mill from China, is now gaining popularity in homes far from a barangay center where the big ricemills are usually located. The machine can mill 1-1.5 cavans palay per hour with a 64% milling recovery. It uses a 1-horsepower electric motor or a 3-horsepower gasoline engine.

H. Post production losses range from 1.73-28.61% or an average of 15.7% from harvesting to milling. Therefore, sound postharvest practices decrease losses and increase consumable rice supply.

Methodology

a. Experiential approach: Let the farmers discuss their methods of threshing. Discuss the advantages and disadvantages of mechanical and hand-threshing.
b. Lecture discussion with demonstration.
c. Field trip to the National Rice Engineering and Mechanization Center to see the postharvest machinery and to interact with the researchers.

Materials/Visuals

- Transparencies /OHD
- Slides /Slide projector
- Powerpoint presentation
- Pictures
- Posters
- Graphs, Tables
- Actual machines

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Evaluation

Modified True or False. Write true if the statement is correct. If false, change the underlined word to make the statement true.

_____ 1. The post production technologies 10 years ago are still the *same* today.

_____ 2. With more cropping from a piece of land, *there is now a need* for post production technologies.

_____ 3. Each postharvest operation is *independent from* the others.

_____ 4. The estimate for grain loss from harvesting to milling is *10%*.

_____ 5. For maximum grain yield, the best time to harvest transplanted rice is between *30-42 days after heading* in the wet season.

_____ 6. When the rice crop is *80-85% golden yellow*, the crop is ready for harvest.

_____ 7. Among the methods of threshing in the Philip-pines, *the large stationary thresher* has the least loss at 1.97%.

_____ 8. Cleaning is an essential postharvest operation since it affects the storeability and milling quality of rice.

_____ 9. The moisture content of rice before storage is *14 % or above*.

_____10. For milling purposes, the temperature *should exceed* 54.4°C.

APPENDICES

Appendix 1 Characteristics of Popular Philippine Rice Varieties *(as of April 2003)*

VARIETY	AGRONOMIC CHARACTERISTICS						DISEASE & INSECT PEST REACTIONS*					
	Developed by	Year Released	Ave Yield (t/ha)	Max Yield (t/ha)	Growth Duration	Height (cm)	Blast	Bacterial blight	Tungro	BPH	GLH	Stem borer
IRRIGATED LOWLAND												
IR 36	**IRRI**	1976	4.8		110	85	R	R	S	S	R	MR
IR 42	**IRRI**	1977	5.0		135	110	R	R	S	S	R	MR
IR 60	**IRRI**	1983	4.8		107	86	R	R	R	R	R	MR
BPI Ri 10	**BPI**	1983	4.7		108	84	MR	MR	MR	S	R	MR
IR 62	**IRRI**	1984	4.8		115	100	R	R	R	R	R	MR
IR 64	**IRRI**	1985	5.3		113	105	R	R	S	MR	R	MR
IR 66	**IRRI**	1987	5.2		108	88	MR	R	R	R	R	-
BPI Ri 12	**BPI**	1987	4.9		119	96	S	MR	R	-	MR	MR
IR 68	**IRRI**	1988	4.5		121	100	I	I	R	I	I	MS
IR 72	**IRRI**	1988	5.0		112	88	S	I	R	I	I	MS
IR 74	**IRRI**	1988	4.7		131	88	I	I	R	I	I	MR
PSB Rc2 *(Nahalin)*	**IRRI**	1991	5.1	7.1	123	99	I	I	R	MR	MR	I
PSB Rc4 *(Molawin)*	**IRRI**	1991	4.6	6.1	104	81	R	I	I	MS	MR	I
PSB Rc6 *(Carranglan)*	**PhilRice**	1992	5.2	6.8	112	84	I	I	I	S	I	MR
PSB Rc8 *(Talavera)*	**PhilRice**	1992	5.0	7.1	108	82	I	I	I	S	I	MR
PSB Rc10 *(Pagsanjan)*	**IRRI**	1992	4.8	7.5	106	77	R	I	I	R	MR	I
PSB Rc18 *(Ala)*	**IRRI**	1994	5.1	8.1	123	102	I	I	I	I	I	MS
PSB Rc20 *(Chico)*	**IRRI**	1994	4.9	7.1	111	86	I	I	I	I	I	I
PSB Rc22 *(Liliw)*	**UPLB**	1994	5.0	7.2	129	96	I	I	I	I	I	S
PSB Rc26H *(Magat)*	**IRRI**	1994	5.6	7.6	110	88	R	I	S	I	I	MS
PSB Rc28 *(Agno)*	**IRRI**	1995	5.0	7.6	111	93	R	I	I	I	I	I
PSB Rc30 *(Agus)*	**IRRI**	1995	5.0	8.0	118	88	I	I	I	I	I	I
PSB Rc32 *(Jaro)*	**UPLB**	1995	5.2	8.8	112	94	I	R	I	R	I	S
PSB Rc34 *(Burdagol)*	**PhilRice**	1995	4.8	10.3	124	101	R	R	I	R	I	I
PSB Rc52 *(Gandara)*	**IRRI**	1997	5.3	5.3	115	86	I	I	I	I	I	I
PSB Rc54 *(Abra)*	**IRRI**	1997	5.0	6.6	113	91	R	I	I	I	I	I
PSB Rc56 *(Dapitan)*	**PhilRice**	1997	5.3	7.5	114	88	I	I	I	I	I	I
PSB Rc58 *(Mayapa)*	**UPLB**	1997	4.9	7.3	124	93	I	R	S	I	I	I
PSB Rc64 *(Kabacan)*	**IRRI**	1997	5.0	8.9	124	96	I	I	I	I	I	I
PSB Rc66 *(Agusan)*	**PhilRice**	1997	5.2	10.2	123	90	I	R	I	I	I	MS
PSB Rc72H *(Mestizo)*	**IRRI**	1997	5.4	9.9	123	97	I	I	I	S	I	S
PSB Rc74 *(Aklan)*	**UPLB**	1998	5.2	8.3	114	92	S	I	S	MR	R	MR
PSB Rc76H *(Panay)*	**Agroseed**	1998	4.8	7.9	106	102	R	I	S	MS	I	R
PSB Rc78 *(Pampanga)*	**PhilRice**	2000	5.0	9.5	111	94	I	R	S	MS	MS	I
PSB Rc80 *(Pasig)*	**IRRI**	2000	5.0	8.7	112	92	I	I	S	I	MS	I
PSB Rc82 *(Peñaranda)*	**IRRI**	2000	5.4	12.0	110	100	R	I	S	I	MS	I
IR69726-29-1-2-2-2	**IRRI**	2001	4.4	7.6	116	105	I	I	R/S	MR	I	MR
NSIC Rc110 *(Tubigan 1)*	**IRRI**	2002	4.8	6.7	113	91	I	I	I	MS	S	I
NSIC Rc112 *(Tubigan 2)*	**IRRI**	2002	4.9	7.3	111	92	I	I	S	I	I	I
NSIC Rc114H *(Mestizo 2)*	**IRRI**	2002	5.8	8.7	106	98	I	I	S	MS	MS	MR
NSIC Rc116H *(Mestizo 3)*	**IRRI**	2002	5.8	8.6	106	98	I	I	S	I	I	MR
IR73885-1-4-3-2-1-6 *	**IRRI**	2002	5.7	5.7	115	102	I	I	R	MS	I	MR

** stop gap for RTV*

IRRIGATED LOWLAND (GLUTINOUS)												
UPLRi 1	**UPLB**	1977	4.0		130	97	MR	MS	MR	-	-	MR
BPI Ri 1	**BPI**	1979	4.3		120	91	R	R	R	-	-	-
IR 65	**IRRI**	1985	4.7		115	86	R	R	R	S	R	MR
RAINFED LOWLAND (TRANSPLANTED)												
PSB Rc12 *(Caliraya)*	**UPLB**	1992	3.5	6.0	109	89	I	I	S	I	I	MS
PSB Rc14 *(Rio Grande)*	**UPLB**	1992	3.6	6.1	110	92	I	I	S	I	I	I
PSB Rc36 *(Ma-ayon)*	**PhilRice**	1995	3.1	5.3	127	121	I	I	MS	S	I	MS
PSB Rc38 *(Rinara)*	**PhilRice**	1995	3.2	5.0	127	119	I	I	MS	S	I	I
PSB Rc40 *(Chayong)*	**PhilRice**	1995	3.1	4.9	130	126	R	I	MS	S	I	MS
PSB Rc98 *(Lian)*	**UPLB**	2001	2.6	4.5	116	98	I	I	I/S	R	I	I
PSB Rc100 *(Santiago)*	**PhilRice**	2001	4.1	4.1	118	111	I	I	S	I	S	R
PSB Rc102 *(Mamburao)*	**IRRI**	2001	2.3	4.4	117	101	I	I	S	I	I	I
RAINFED (DRY-SEEDED)												
PSB Rc16 *(Ennano)*	**PhilRice**	1993	2.7	4.5	125	112	I	I	S	S	I	-
PSB Rc24 *(Cagayan)*	**PhilRice**	1994	3.1	5.8	117	99	I	I	I	S	I	MS
PSB Rc42 *(Baliwag)*	**PhilRice**	1995	3.2	4.9	114	113	R	I	MS	S	S	MS
PSB Rc60 *(Tugatog)*	**IRRI**	1997	3.6	4.5	113	100	I	I	S	I	I	MR
PSB Rc62 *(Naguilian)*	**PhilRice**	1997	3.7	4.7	117	116	R	I	S	S	S	I
PSB Rc68 *(Sacobia)*	**IRRI**	1997	3.4	4.4	116	116	I	I	S	I	I	I
PSB Rc70 *(Bamban)*	**IRRI**	1997	3.2	4.5	114	116	R	I	S	S	S	MS
COOL ELEVATED												
PSB Rc44 *(Gohang)*	**IRRI**	1995	4.1	5.7	144	98	I	S	S	S	-	R
PSB Rc46 *(Sumadel)*	**IRRI**	1995	4.3	5.8	135	98	I	I	-	MS	I	-
PSB Rc92 *(Sagada)*	**IRRI**	2001	3.6	6.7	131	94	S	S	I/S	I	S	-
PSB Rc94 *(Hungduan)*	**IRRI**	2001	3.3	8.6	133	80	S	S	S	I	S	-
PSB Rc96 *(Ibulao)*	**IRRI**	2001	3.6	5.3	136	80	S	S	S	MR	S	-
NSIC Rc104 *(Balili)*	**PhilRice**	2001	4.3	6.3	154	93	I	I	S	I	MS	S
SALINE - PRONE												
PSB Rc48 *(Hagonoy)*	**IRRI**	1995	2.7	5.3	126	88	S	I	S	S	I	-
PSB Rc50 *(Bicol)*	**IRRI**	1995	3.0	4.3	118	90	S	R	S	I	-	R
PSB Rc84 *(Sipocot)*	**IRRI**	2000	2.0	3.7	111	77	S	I	S	MR	MS	I
PSB Rc86 *(Matnog)*	**IRRI**	2000	2.1	4.3	113	82	S	I	S	MR	MS	MS
PSB Rc88 *(Naga)*	**IRRI**	2000	2.2	7.0	116	88	I	S	S	I	-	I
PSB Rc90 *(Buguey)*	**PhilRice**	2001	3.4	4.2	124	86	I	S	S	MS	MS	-
NSIC Rc106 *(Sumilao)*	**IRRI**	2001	2.9	4.8	117	77	I	S	S	MS	MS	R
NSIC Rc108 *(Anahawan)*	**PhilRice**	2001	2.9	3.8	128	85	I	S	S	MS	MS	MR
UPLAND												
C 22	**UPLB**	1972	2.2		128	108	MS	MS	MR	S	-	R
UPL Ri 5	**UPLB**	1980	2.7		120	117	MS	S	MS	S	-	I
UPL Ri 7	**UPLB**	1981	3.0		116	104	MS	R	MR	-	-	MR
PSB Rc1 *(Makiling)*	**IRRI**	1990	2.4	3.9	121	104	R	I	S	MS	-	MR
PSB Rc3 *(Ginilingan Puti)*	**PhilRice**	1997	2.9	6.0	123	106	R	I	S	I	S	I
PSB Rc5 *(Arayat)*	**IRRI**	1997	2.9	4.2	122	104	R	I	S	S	S	S
PSB Rc7 *(Banahaw)*	**PhilRice**	2001	2.9	4.0	121	119	R	I	S	MS	S	I
NSIC Rc9 *(Apo)*	**IRRI**	2001	2.9	5.5	119	98	I	I	S	MS	S	MR
NSIC Rc11 *(Canlaon)*	**PhilRice**	2001	2.6	4.9	125	104	I	I	S	S	S	R

R - Resistant ■ MR - Moderately Resistant ■ I - Intermediate ■ MS - Moderately Susceptible ■ S - Susceptible
■ BPH - Brown Plant Hopper ■ GLH - Green Leafhopper ■ PSB - Philippine Seedboard ton (t) = 20 sacks, 50 kilos each
* Several varieties were rated resistant to tungro at the time of their release. These may no longer be resistant now.

Appendix 2.1. Reformulated BFS Recommendations for Irrigated Rice: (May 1998).

Group 1. Mixed organic-inorganic fertilizer, irrigated rice

Provinces:
Region 1: Ilocos Norte*, Ilocos Sur, La Union, Pangasinan*
Region 2: Isabela • **Region 3:** Tarlac*, Pampanga • **Region 5:** Albay

Recommendations (bags/ha)	Wet Season		Dry Season	
	Heavy/Medium	Light	Heavy/Medium	Light
Option 1				
Basal Application				
Commercial Organic	5	5	5	5
14-14-14	3	3	2	2
16-20-0 or (20-20-0)	0	0	1 (1)	1 (1)
Urea or (Ammosul)	1(2)	1(2)	1(2)	1.5 (3)
Top Dress				
Urea or (Ammosul)	2 (4)	3 (6)	3 (6)	2.5 (5)
Total Fertilizer Mix				
Organic Fertilizers	5	5	6	6
Inorganic Fertilizers	6 (9)	7 (11)	7 (11)	7 (11)
Option 2				
Basal Application				
Compost/Manures	20	20	30	30
14-14-14	3	3	2	2
16-20-0 or (20-20-0)	0	0	1 (1)	1 (1)
Urea or (Ammosul)	1 (2)	1 (2)	1 (2)	1.5 (3)
Top Dress				
Urea or (Ammosul)	1 (2)	1 (2)	1 (2)	1.5 (3)
Total Fertilizer Mix				
Organic Fertilizer	20	20	30	30
Inorganic Fertilizer	6 (9)	7 (11)	7 (11)	7 (11)

Notes
** Basal application of 10 kg ZnSO4/ha. as maintenance dosage. Adjustment for Zn application by municipality will be made as validation progresses.*
Topdressing and possible addition of N fertilizer should be guided by leaf color chart.

Appendix 2.1. (continuation...)

Group 2 Mixed organic-inorganic fertilizer, irrigated rice

Provinces:
Region 2: Cagayan, Quirino • **Region 3:** Bataan, Zambales, Bulacan
Region 4: Aurora, Mindoro Occ., Laguna, Quezon, Mindoro Or.
Region 5: Catanduanes, Masbate, Camarines Norte, Sorsogon, Camarines Sur
Region 6: Aklan, Iloilo, Antique, Negros Occ., Capiz
Region 7: Bohol, Negros Or. • **Region 8:** Northern Leyte, Eastern Samar, Southern Leyte, Northern Samar, Western Samar • **Region 10:** Misamis Occ., Misamis Or., Bukidnon • **Region 11:** Davao Or., Davao Sur, South Cotabato
Region 12: Lanao del Norte, Cotabato, North Cotabato, Sultan Kudarat
CAR: Abra

Recommendations (bags/ha)	Wet Season		Dry Season	
	Heavy/Medium	Light	Heavy/Medium	Light
Option 1				
Basal Application				
Commercial Organic	5	5	6	6
14-14-14	2	2	0	1
16-20-0 or (20-20-0)	1 (1)	1 (1)	3 (3)	4 (4)
Urea or (Ammosul)	1(2)	1(2)	1(2)	0.5 (3)
Top Dress				
Urea or (Ammosul)	2 (4)	2 (4)	3 (6)	2.5 (5)
Total Fertilizer Mix				
Organic Fertilizers	5	5	6	6
Inorganic Fertilizers	6 (9)	6 (9)	7 (11)	8 (11)
Option 2				
Basal Application				
Compost/Manures	20	20	30	30
14-14-14	2	2	0	1
16-20-0 or (20-20-0)	1 (1)	1 (1)	3 (3)	4 (4)
Urea or (Ammosul)	1 (2)	1 (2)	1 (2)	0.5 (1)
Top Dress				
Urea or (Ammosul)	2 (4)	2 (4)	3 (6)	2.5 (5)
Total Fertilizer Mix				
Organic Fertilizer	20	20	30	30
Inorganic Fertilizer	6 (9)	6 (9)	7 (11)	8 (11)

Notes
Add 5 kg $ZnSO_4$/ha as maintenance dosage.
Topdressing and possible addition of N fertilizer should be guided by leaf color chart.

Appendix 2.1. (continuation...)

Group 3. Mixed organic-inorganic fertilizer, irrigated rice

Province:
Region 3: Nueva Ecija*

Recommendations (bags/ha)	Wet Season		Dry Season	
	Heavy/Medium	Light	Heavy/Medium	Light
Option 1				
Basal Application				
Commercial Organic	5	5	6	6
14-14-14	2	2	1	1
16-20-0 or (20-20-0)	1 (1)	1 (1)	2 (2)	2 (2)
Urea or (Ammosul)	1(2)	1.5 (3)	1.5 (3)	2 (4)
Top Dress				
Urea or (Ammosul)	2 (4)	2 (4)	2 (4)	2 (4)
Total Fertilizer Mix				
Organic Fertilizers	5	5	6	6
Inorganic Fertilizers	6 (9)	6.5 (10)	6.5 (10)	7 (11)
Option 2				
Basal Application				
Compost/Manures	20	20	30	30
14-14-14	2	2	1	1
16-20-0 or (20-20-0)	1 (1)	1 (1)	2 (2)	2 (2)
Urea or (Ammosul)	1 (2)	1.5 (3)	1.5 (3)	2 (4)
Top Dress				
Urea or (Ammosul)	2 (4)	2 (4)	2 (4)	2 (4)
Total Fertilizer Mix				
Organic Fertilizer	20	20	30	30
Inorganic Fertilizer	6 (9)	6.5 (10)	6.5 (10)	7 (11)

Notes
** Basal application of 10 kg $ZnSO_4$/ha. as maintenance dosage. Adjustment for Zn application by municipality will be made as validation progresses.*
Topdressing and possible addition of N fertilizer should be guided by leaf color chart.

Appendix 2.1. (continuation...)

Group 4. Mixed organic-inorganic fertilizer, irrigated rice

Province:
Region 4: Marinduque • **Region 9:** Zamboanga Norte
CARAGA: Surigao Norte • **ARMM:** Lanao Sur, Maguindanao

Recommendations (bags/ha)	Wet Season		Dry Season	
	Heavy/Medium	Light	Heavy/Medium	Light
Option 1				
Basal Application				
Commercial Organic	5	5	6	6
14-14-14	2	2	0	1
16-20-0 or (20-20-0)	1 (1)	1 (1)	2 (2)	2 (2)
Urea or (Ammosul)	1(2)	1 (2)	1.5 (3)	1.5 (3)
Top Dress				
Urea or (Ammosul)	1.5 (3)	1.5 (3)	1.5 (3)	1.5 (3)
Total Fertilizer Mix				
Organic Fertilizers	5	5	6	6
Inorganic Fertilizers	5.5 (8)	5.5 (8)	5 (8)	6 (9)
Option 2				
Basal Application				
Compost/Manures	20	20	30	30
14-14-14	2	2	0	1
16-20-0 or (20-20-0)	1 (1)	1 (1)	2 (2)	2 (2)
Urea or (Ammosul)	1 (2)	1 (2)	1.5 (3)	1.5 (3)
Top Dress				
Urea or (Ammosul)	1.5 (3)	1.5 (3)	1.5 (3)	1.5 (3)
Total Fertilizer Mix				
Organic Fertilizer	20	20	30	30
Inorganic Fertilizer	5.5 (8)	5.5 (8)	5 (8)	6 (9)

Notes
Add 5 kg $ZnSO_4$/ha as maintenance dosage.
Topdressing and possible addition of N fertilizer should be guided by leaf color chart.

Appendix 2.1. (continuation...)

Group 5. Mixed organic-inorganic fertilizer, irrigated rice

Province:
CAR: Apayao, Ifugao, Kalinga • **Region 4:** Cavite, Palawan*, Romblon
Region 9: Zamboanga Sur* • **CARAGA:** Agusan Norte*, Agusan Sur*, Surigao Sur

Recommendations (bags/ha)	Wet Season		Dry Season	
	Heavy/Medium	Light	Heavy/Medium	Light
Option 1				
Basal Application				
Commercial Organic	5	5	6	6
14-14-14	2	3	0	0
16-20-0 or (20-20-0)	1 (1)	1 (1)	3 (3)	3 (3)
Urea or (Ammosul)	1(2)	1 (2)	1 (2)	1.5 (3)
Top Dress				
Urea or (Ammosul)	2 (4)	2 (4)	2 (4)	2.5 (5)
Total Fertilizer Mix				
Organic Fertilizers	5	5	6	6
Inorganic Fertilizers	6 (9)	7 (10)	6 (9)	7 (11)
Option 2				
Basal Application				
Compost/Manures	20	20	30	30
14-14-14	2	3	0	0
16-20-0 or (20-20-0)	1 (1)	1 (1)	3 (3)	3 (3)
Urea or (Ammosul)	1 (2)	1 (2)	1 (2)	1.5 (3)
Top Dress				
Urea or (Ammosul)	2 (4)	2 (4)	2 (4)	2.5 (5)
Total Fertilizer Mix				
Organic Fertilizer	20	20	30	30
Inorganic Fertilizer	6 (9)	7 (10)	6 (9)	7 (11)

Notes
** Basal application of 10 kg $ZnSO_4$/ha. as maintenance dosage. Adjustment for Zn application by municipality will be made as validation progresses.*
Topdressing and possible addition of N fertilizer should be guided by leaf color chart.

Appendix 2.2. Reformulated balanced fertilization for flooded special micronutrient zone.

Group 6. Mixed organic-inorganic fertilizer, irrigated rice

(Provinces)/Muncipalities:
Region 1: (Pangasinan) San Manuel, Urdaneta • **Region 2:** (Nueva Vizcaya) Villaverde, Solano, Bagabag • **Region 3:** (Tarlac) Camiling, (Pampanga) Arayat, Magalang, (Bulacan) San Ildefonso, (Bataan) Hermosa, (N. Ecija) Gapan, Zaragosa, • **Region 4:** (Laguna) Sta. Cruz, Pila • **Region 5:** (Camarines Sur) Magarao • **Region 6:** (Aklan) Banga, (Antique) Sibalom, (Iloilo) Oton, Barotac Nuevo, Cabatuan, Pototan • **Region 8** (Leyte) Palo, (Samar) Basey • **Region 9:** (Zamboanga N.) Polanco, (Zamboanga S.) Tukuran **Region 10:** (Misamis Or.) Gingoog • **Region 13:** Surigao City, (Agusan N.) Butuan City, (Agusan S.) Prosperidad • ARMM: (Maguindanao) Sinsuat **CAR:** (Kalinga) Tabuk

Recommendations (bags/ha)	Wet Season	Dry Season
Option 1		
Basal Application		
Commercial Organic	4	6
16-20-0	1.5	2
Urea or (Ammosul)	5 (2.5)	6 (3)
$ZNSO_4$	5 (2.5)	6 (3)
Top Dress		
Urea or (Ammosul)	4	6
Total Fertilizer Mix		
Organic Fertilizers	11.5 (6.5) plus	14 (8) plus
Inorganic Fertilizers	20 kg $ZNSO_4$	20 kg $ZNSO_4$

Notes
Other municipalities will be added as validation progresses.
Topdressing and possible addition of N fertilizer should be guided by leaf color chart.

Appendix 2.3. Reformulated balanced fertilization for saline intruded, flood-prone areas, Group 7. (>7 pH 7.5; EC>2 but <8)

Group 7. Mixed organic-inorganic fertilizer

Province:
Region 1: (Ilocos N.) Currimao, (Ilocos S.) Sta. Catalina, Sta. Maria, (Pangasinan) Binmaley, Lingayen, Sual • Region 3: (Pampanga) Sexmoan, Macabebe, Masantol

Recommendations (bags/ha)	Wet Season		Dry Season	
	Heavy/Medium	Light	Heavy/Medium	Light
Option 1				
Basal Application				
Commercial Organic	5	5	6	6
14-14-14	2	2	1	1
16-20-0 or (20-20-0)	1 (1)	1 (1)	2 (2)	2 (2)
Urea or (Ammosul)	1(2)	1.5 (3)	1.5 (3)	2 (4)
$MgSO_4$				
$ZNSO_4$				
Top Dress				
Urea or (Ammosul)	2 (4)	2 (4)	2 (4)	2 (4)
Total Fertilizer Mix				
Organic Fertilizers	5	5	6	6
Inorganic Fertilizers	6 (9)	6.5 (10) plus 10 kg $ZNSO_4$	6.5 (10)	7 (11)

Appendix 2.3 *(continuation...)*

Group 7. Mixed organic-inorganic fertilizer

Province:
Region 2: (Cagayan) Aparri, Bugney, Abulog • Region 3: (Bulacan) Paombong, Hagonoy, Bulacan, Obando, Malolos • Region 5: (Camarines Sur) Calabanga, Bonbon, Cabusao, Libmanan, Canaman, Minalabac, Milaor • Region 6: (Iloilo) Oton, Tigbauan • Region 8: (Eastern Samar) Borongan • Region 11: (Davao Oriental) Mati

Recommendations (bags/ha)	Wet Season		Dry Season	
	Heavy/Medium	Light	Heavy/Medium	Light
Option 1				
Basal Application				
Commercial Organic	5	5	6	6
14-14-14	2	2	1	1
16-20-0 or (20-20-0)	1 (1)	1 (1)	2 (2)	2 (2)
Urea or (Ammosul)	1(2)	1.5 (3)	1.5 (3)	2 (4)
$MgSO_4$				
$ZNSO_4$				
Top Dress				
Urea or (Ammosul)	2 (4)	2 (4)	2 (4)	2 (4)
Total Fertilizer Mix				
Organic Fertilizers	5	5	6	6
Inorganic Fertilizers	6 (9)	6.5 (10) plus 10 kg $ZNSO_4$	6.5 (10)	7 (11)

Appendix 3. FPA Approved Pesticides*

Company	Active ingredient	Brand Name	Uses**
Abigail Farm Supply	CYPERMETHRIN	TORPEDO 5 EC	I
Access Agricare	2,4-D IBE	ACCESS 2,4-D ESTER	H
	BPMC + CHLORPYRIFOS	SUPREMO EC	I
	BUTACHLOR	MACHO 60 EC	H
	BUTACHLOR + PROPANIL	CLEANFIELD EC	H
	CYPERMETHRIN	BULLET 5 EC	I
	ETOFENPROX	CARANCHO 2.5 EC	I
	LAMBDACYHALOTHRIN	5 STAR GENERAL	I
	MANCOZEB	ATTAIN M-80	F
	NICLOSAMIDE	SPEED 25 EC	M
	NICLOSAMIDE	SPEED 50 WP	M
Agchem Mfg. Corp	2,4-D AMINE	DMA 3.34 LBS/USG	H
	2,4-D IBE	WEEDTROL 40 EC	H
	BUTACHLOR + PROPANIL	TORNADO 60 EC	H
	BUTACHLOR + PROPANIL	TWISTER EC	H
	CHLORPYRIFOS + BPMC	GAROTE EC	I
	ISOPROTHIOLANE	FUJI-ONE 40 EC	F
	MCPA	KARET 40	H
	METALDEHYDE	META BAIT 6% PELLETS	M
	METALDEHYDE	PORSNAIL 75 WP	M
	METALDEHYDE	SNAILKIL 6% P	M
Agri Dyne Tech., Inc.	BUTACHLOR	WEEDER 60 EC	H
	CARBARYL	PROVIN 85 WP	I
	CHLOROTHALONIL	SENTINEL 75 WP	F
	COPPER HYDROXIDE	HYDROX 77 WP	F
	COPPER OXYCHLORIDE	OXYCHLOR 85 WP	F
	CYPERMETHRIN	FIST 5 EC	I
Agri-Care Service Corp.	BUTACHLOR	BUTATAF 60 E	H
	CARTAP HYDROCHLORIDE	PADAN 50 SP	I
	ESFENVALERATE	SUMI-ALPHA 2.5 EC	I
	FENITROTHION	SUMITHION 40 WDP	I
	FENITROTHION	SUMITHION 50 EC	I
	FENVALERATE	SUMICIDIN 3 EC	I
Agropoint Corp.	CARTAP HYDROCHLORIDE	AGROPOINT CARTAP 50 SP	I
	COPPER OXYCHLORIDE	VICTORY BLUE 85 WP	F
	COPPER OXYCHLORIDE	VITIGRAN BLUE 58 WP	F
	CYPERMETHRIN	SPECTRA 5 EC	I
	NICLOSAMIDE	ROBODAX 25 EC	M
Agsystech, Inc.	CYPERMETHRIN	CYPRO 5 EC	I
	NICLOSAMIDE ETHANOLAMINE	KHULOSCIDE 70 WP	M

* *As of December 2001*

** *F - Fungus, H - Herbs (Grasses), I - Insects, M - Mollusk (Snails), N - Nematode, O - Others R - Rodents, Fum - Fumigation*

Appendix 3. continued...

Company	Active ingredient	Brand Name	Uses**
Agway Chemicals	CYPERMETHRIN	ADER 5 EC	I
Agworld Phils., Inc.	CYPERMETHRIN	CYPER-5	I
Aldiz Incorporated	BUTACHLOR	SONIC 60 EC	H
	CARBOSULFAN	ELTRA 200 SC	I
	CARFENTRAZONE-ETHYL	PARTNER 40 DF	H
	CHLOROTHALONIL	ROVER	F
	CHLOROTHALONIL	SHIELD	F
	CHLORPYRIFOS	SIGA 300 EC	I
	CLOMAZONE	COMMAND 3 ME	H
	CLOMAZONE + PROPANIL	COMPRO 600 EC	H
	COPPER HYDROXIDE	FUNGURAN-OH	F
	CYPERMETHRIN	MAGNUM 5 EC	I
	IMAZALIL	FUNGAFLOR 50 L	F
	IMAZALIL	FUNGAFLOR 75 SP	F
	LAMBDACYHALOTHRIN	BIDA 2.5 EC	I
	MANCOZEB	VONDOZEB 42 SC	F
	MANCOZEB	VONDOZEB 75 DF	F
	MANCOZEB	VONDOZEB PLUS	F
	MANEB	MANEB 80 WP	F
	MANEB W/ ZINC	VONDOZEB L	F
	SULFUR	MICROTHIOL DF	F
	THIABENDAZOLE + 0-PHENOL	CITRUS LUSTER 213	F
Allied Botanical Corp.	COPPER OXIDE	NORDOX 50 WP	F
Altrade	CHLORPYRIFOS + BPMC	BAZOOKA	I
	COPPER HYDROXIDE	KOCIDE DF 2000	F
	CUPRIC HYDROXIDE	KOCIDE 101	F
	CUPRIC HYDROXIDE	KOCIDE DF	F
	CYPERMETHRIN	BULL'S EYE INSECTICIDE	I
	MANCOZEB	SHOTGUN-M	F
Amway Phils., L.L.C.	ALKYL ARYL ALKOXYLATE + TALL OIL FATTY ACID	AMWAY APSA 80	O
Ancom Phils., Inc.	BUTACHLOR	ANCOM BUTACHLOR 60 EC	H
	CYPERMETHRIN	ANCOM CYPERMETHRIN 5 EC	I
	GLYPHOSATE IPA	ASSET 48 SL	H
Arysta Agro Phils., Inc.	BUTACHLOR	SAMURAI 60 EC	H
	CHLOROTHALONIL	BANKO 720 SC	F
	CHLOROTHALONIL	BANKO 75 WP	F
	ETOFENFROX	TREFIC 20 WP	I
	ETOFENPROX	POLIDO 2.5 EC	I
	ETOFENPROX	TREBON 10 EC	I
	ETOFENPROX	VECTRON 20 WP	I
	NICLOSAMIDE	ARCHER 50 WP	M

** *F - Fungus, H - Herbs (Grasses), I - Insects, M - Mollusk (Snails), N - Nematode, O - Others R - Rodents, Fum - Fumigation*

Appendix 3. continued...

Company	Active ingredient	Brand Name	Uses**
Arysta Agro Phils., Inc.	BUTACHLOR	SAMURAI 60 EC	H
	CHLOROTHALONIL	BANKO 720 SC	F
	CHLOROTHALONIL	BANKO 75 WP	F
	ETOFENFROX	TREFIC 20 WP	I
	ETOFENPROX	POLIDO 2.5 EC	I
	ETOFENPROX	TREBON 10 EC	I
	ETOFENPROX	VECTRON 20 WP	I
	NICLOSAMIDE	ARCHER 50 WP	M
Asiatic Agrochem Corp.	ACEPHATE	ORTHENE/ACETAM 75 SP	I
	BISPYRIBAC-SODIUM	NOMINEE 100 SC	H
	CAPTAN	CAPTAN 50 WP	F
	CLETHODIM	SELECT 120 EC	H
	DIAZINON	DIAGRAN 5 G	I
	DIAZINON	DIAZINON 60 EC	I
	POLYOXYETHYLENE	SURFACTANT A-100	O
	DODECYL ETHER	SATURN 60 EC	H
	THIOBENCARB	SATURN S	H
	THIOBENCARB	GRASSEDGE	H
	THIOBENCARB + 2,4-D	SATURN D	H
AVC Chemical Corp.	CHLORFLUAZURON	ATABRON 5 E	I
	FLUAZIFOP-P-BUTYL	ONECIDE 15 EC	H
BASF	2,4-D AMINE	2,4-D AMINE 3.34 LBS/USG	H
	2,4-D AMINE	2,4-D AMINE 6 LBS/USG	H
	2,4-D IBE	2,4-D ESTER	H
	ACEPHATE	ORTHENE 75 SP	I
	ALPHACYPERMETHRIN	FASTAC 15 WDG	I
	ALPHACYPERMETHRIN	FASTAC 250 SC	I
	ALPHACYPERMETHRIN + BPMC	FASTAC R	I
	BENTAZON	BASAGRAN 48 EC	H
	BUTACHLOR + PROPANIL	TORO	H
	CARBENDAZIM	BAVISTIN 50 DF	F
	CARBOSULFAN	ADVANTAGE 5 G	I
	CARTAP HYDROCHLORIDE	DIMO 50 SP	I
	CINMETHYLIN	ARGOLD 10 EC	H
	CINMETHYLIN + 2,4-IBE	ARGOLD PLUS	H
	CYCLOSULFAMURON	INVEST 10 WP	H
	CYPERMETHRIN	ATTACK 5R	I
	CYPERMETHRIN	RIPCORD 2.5 EC	I
	DAZOMET	BASAMID G	O
	DIAZINON	DIAGRAN 5 G	I
	DIAZINON	DIAZINON 40 EC	I
	DIAZINON	DIAZINON 60 EC	I
	DIMETHOATE	PERFEKTHION 40 EC	I
	DIMETHOMORPH	ACROBAT 50 WP	F
	DIMETHOMORPH + MANCOZEB	ACROBAT MZ	F

** *F - Fungus, H - Herbs (Grasses), I - Insects, M - Mollusk (Snails), N - Nematode, O - Others R - Rodents, Fum - Fumigation*

Appendix 3. continued...

Company	Active ingredient	Brand Name	Uses**
BASF	DINICONAZOLE	SUMI-EIGHT 12.5 WP	F
	DIURON	DIUREX 80 WP	H
	ELEMENTAL SULFUR	KUMULUS DF	F
	ESFENVALERATE	SUMI-ALPHA 2.5 EC	I
	FENITROTHION	SUMITHION 50 EC	I
	FENVALERATE	SUMICIDIN 3 EC	I
	FLOCOUMAFEN	STORM WAX W/ BITREX	R
	FLUFENOXURON	CASCADE 10 WDC	I
	HYDRAMETHYLNON	AMDRO ANT BAIT	I
	IMAZAQUIN	IMAGE 1.5 LC	H
	MALATHION	MALATHION 57 E PREMIUM	I
	METHAMIDOPHOS	MATADOR 60 SC	I
	NICLOSAMIDE	SWIPE 25 EC	M
	NICLOSAMIDE	SWIPE 50 WP	M
	PENDIMETHALIN	HERBADOX 33 E	H
	POLYCARBOXYLIC ACID	HERBIMAX	O
	TEMEPHOS	ABATE 500 E	I
	TEMEPHOS	ABATE SG	I
	TERBUFOS	COUNTER 10 G	I
	THIOPHANATE METHYL	SWEEP	F
	TRIDEMORPH	CALIXIN 75 EC	F
	TRIFORINE	SAPROL EC	F
Bayer Crop Science Phils., Inc***	ANILOFOS + ETHOXYSULFURON	ACTIVO 22 SC	H
	BPMC	HOPCIN 50 EC	I
	CARBARYL	SEVIN 50 WP	I
	CARBARYL	SEVIN 85 WP	I
	CARBARYL	STIX 480 EC	I
	CHLOROPHENOXY PROPIONIC ACID	FRUITONE CPA	O
	CHLOROTHALONIL	BRAVO 720 FLO	F
	CHLOROTHALONIL	DACONIL 2787 50 WP	F
	CHLOROTHALONIL	DACONIL 2787 75 WP	F
	CHLOROTHALONIL	DACONIL 720 SC	F
	CHLOROTHALONIL	PASSPORT 500 SC	F
	COPPER OXYCHLORIDE	VITIGRAN BLUE 58 WP	F
	CYPERMETHRIN	SHERPA 5 EC	I
	DELTAMETHRIN	DECIS 1% SC	I
	DELTAMETHRIN	DECIS 2.5 EC	I
	DELTAMETHRIN	DECIS R	I
	DELTAMETHRIN	DECIS TAB	I
	DELTAMETHRIN + BUPROFEZIN	STINGRAY 5.625 EC	I
	DIURON	DIURON 80 WP	H
	ETHEPHON	ETHREL 10 SL	O
	ETHEPHON	ETHREL PGR 48 %	O
	ETHOPROP	MOCAP 10 G	N
	ETHOXYSULFURON	SUNRICE 15 WDG	H

** *F - Fungus, H - Herbs (Grasses), I - Insects, M - Mollusk (Snails), N - Nematode, O - Others R - Rodents, Fum - Fumigation*

*** *Products formerly produced by Aventis Crop Science (merged with Bayer as of April 2002)*

Appendix 3. continued...

Company	Active ingredient	Brand Name	Uses**
Bayer Crop Science Phils., Inc***	ETOFENPROX	TREBON 10 EC	I
	FENOXAPROP P-ETHYL	RICESTAR EC	H
	FENOXAPROP-P-ETHYL	WHIP-S 120 EW	H
	FENOXAPROP-P-ETHYL	WHIP-S 75 EW	H
	FIPRONIL	ASCEND 50 SC	I
	FIPRONIL	REGENT 0.3 GR	I
	FORMETHANATE HCL	DICARZOL 20 SP	I
	FOSETHYL-AL	ALIETTE 80 WP	F
	FOSETHYL-AL	ALIETTE 800 WG	F
	GLUFOSINATE AMMONIUM	BASTA 15 SL	H
	IPRODIONE	ROVRAL 50 WP	F
	IPRODIONE	ROVRAL AQUAFLO 50 SC	F
	LINDANE	LINDAFOR 75 F	I
	LINURON	AFALON 50 WP	H
	NICLOSAMIDE ETHANOLAMINE SALT	BERDUGO 50 WP	M
	OXADIARGYL	RAFT 800 WG	H
	OXADIARGYL	TOPSTAR 60 EC	H
	OXADIAZON	RONSTAR 25 EC	H
	OXADIAZON	RONSTAR 2G	H
	PARAFFINIC COMPLEX	HERBIDOWN EC	O
	PARAFFINIC MINERAL OIL	BANOLE OIL 60	O
	PERMETHRIN	CORSAIR 5 EC	I
	PHENTHOATE	PENNANT 50 EC	I
	PHENTHOATE + BPMC	VINDEX PLUS	I
	PROCHLORAZ MN	TRIO 50 WP	F
	PROPAMOCARB HCl	PREVICUR-N	F
	PYRIMETHANIL	SIGANEX 600 SC	F
	THIODICARB	LARVIN 350 FS	I
	TRIAZOPHOS	HERCULES 20 EC	I
	TRIBUTYLPOLYGLYCOETHER	HOESTICK	O
	ZINC PHOSPHIDE	ZINC PHOSPHIDE 80 DP	R
Bayer Crop Science Phils., Inc.	2,4-D AMINE	HEDONAL LIQ. SL 400	H
	2,4-D IBE	2,4-D ESTER	H
	ACEPHATE	ACETAM 75 SP	I
	BENSULFURON METHYL	BENSUL 10 WP	H
	BISPYRIBAC SODIUM	NOMINEE 100 SC	H
	BITERTANOL	BAYCOR 300 EC	F
	CADUSAFOS	APACHE 10 G	I
	CADUSAFOS	APACHE 100 ME	I/N
	CARBOFURAN	FURADAN 3 G	I
	CARBOFURAN	FURADAN 5 G	I
	CARBOSULFAN	MARSHAL 200 SC	I
	CHLORPYRIFOS	PREDATOR EC	I
	CHLORPYRIFOS + BETACYFLUTHRIN	RADOR 262.5 EC	I

** *F - Fungus, H - Herbs (Grasses), I - Insects, M - Mollusk (Snails), N - Nematode, O - Others R - Rodents, Fum - Fumigation*

*** *Products formerly produced by Aventis Crop Science (merged with Bayer as of April 2002)*

Appendix 3. continued...

Company	Active ingredient	Brand Name	Uses**
Bayer Crop Science Phils., Inc.	CHLORPYRIFOS + CYPERMETHRIN	PREDATOR PLUS	I
	CLETHODIM	SELECT 120 EC	H
	COPPER OXYCHLORIDE	CUPRAVIT OB 21	F
	COUMATETRALYL	RACUMIN DUST	R
	CYFLUTHRIN	BAYTHROID 0125 EC	I
	CYFLUTHRIN	BAYTHROID 050 EC	I
	DIURON	DIURON80 WP	H
	EDIFENPHOS	HINOSAN 300 EC	F
	EDIFENPHOS	HINOSAN 50 EC	F
	FENTHION	LEBAYCID 50 EC	I
	FENTRAZAMIDE + PROPANIL	LECSPRO 44WP	H
	FLUFENACET	DRAGO 60 WP	H
	IMIDACLOPRID	ADMIRE 5 WP	I
	IMIDACLOPRID	CONFIDOR 100 SL	I
	IMIDACLOPRID	CONFIDOR 200 SL	I
	IMIDACLOPRID	GAUCHO 70 WS	I
	IMIDACLOPRID + CYFLUTHRIN	PROVADO SUPRA 050 EC	I
	IPROVALICARB + PROPINEB	MELODY DUO	F
	ISOPROCARB	ETROFOLAN 50 WP	I
	METHAMIDOPHOS	TAMARON 600 SL	I
	METHIOCARB	MESUROL 50 WP	I
	METRIBUZIN	SENCOR 70 WP	H
	NICLOSAMIDE	BAYLUSCIDE 250 EC	M
	NICLOSAMIDE	ULTIMO EC 200	M
	NICLOSAMIDE	ULTIMO EC 225	M
	NICLOSAMIDE ETHANOLAMINE SALT	BAYLUSCIDE 50 WP	M
	NICLOSAMIDE ETHANOLAMINE SALT	BAYLUSCIDE 70 WP	M
	PHENAMIPHOS	NEMACUR 10 G	N
	PHENAMIPHOS	NEMACUR 400EC	N
	POLYOXYETHYLENE DODECYL ETHER	SURFACTANT A-100	O
	PROPINEB	ANTRACOL 70 WG	F
	PROPINEB	ANTRACOL 70 WP	F
	TEBUCONAZOLE	FOLICUR 250 EC	F
	TEBUCONAZOLE	FOLICUR 430 SC	F
	TRIADIMEFON	BAYLETON 25 WP	F
	TRICHLORFON	DIPTEREX 95 SP	I
	TRIFLOXYSTROBIN	TEGA 075 EC	F
Berris Agric'l. Co., Inc	CYPERMETHRIN	ZOOM 5 EC	I
	NICLOSAMIDE	ADIOS 250 EC	M
	NICLOSAMIDE	FLIP 500 WP	M
	NICLOSAMIDE ETHANOLAMINE SALT	FLIP 700 WP	M

** *F - Fungus, H - Herbs (Grasses), I - Insects, M - Mollusk (Snails), N - Nematode, O - Others R - Rodents, Fum - Fumigation*

Appendix 3. continued...

Company	Active ingredient	Brand Name	Uses**
Bioagro Technologies Corp.	CARBOFURAN	BIODAN 3 G	I
	CARTAP	ROYAL CARTAP	I
	CHLOROTHALONIL	ROYANIL 75 WP	F
	CHLORPYRIFOS	EXPERT 20 EC	I
	CYPERMETHRIN	KILLER 5 EC	I
	MANCOZEB	BIOZEB 80 WP	F
	POLYETHER;POLMETHYLSILOXANE COPOLYMER	BREAK-THRU	O
	THIOPHANATE METHYL	TOP 70 WP	F
Biostadt Mktg. Corp.	BACILLUS THURINGIENSIS	HALT	I
	BPMC	HOPCIDE 50 EC	I
	CYPERMETHRIN	SMASH 5 EC	I
	MANCOZEB	REDEEM 80 WP	F
	NICLOSAMIDE	DEADBOL	M
	THIOBENCARB + 2,4-D IBE	GRASSEDGE 800 EC	H
	ZINC PHOSPHIDE	RATKIL ZINC PHOSPHIDE 80%	R
Bugman, Inc.	METHYL BROMIDE + CHLOROPICRIN	MEBROM	FUM
Camcord Phils., Inc.	CYPERMETHRIN	COTRIN 5 EC	I
	NICLOSAMIDE	GAS 250 EC	M
Cardinal Farms Supply	CYPERMETHRIN	WINNER 5 EC	I
Centrochem Mktg., Inc.	CHLOROTHALONIL	ECHO 720 SC	F
Chemical Applicators	METHYL BROMIDE + CHLOROPICRIN	BROMO GAS	FUM
Cropking Chem., Inc.	2,4-D IBE	2,4-D ESTER	H
	BACILLUS THURINGIENSIS	DIPEL WP	I
	BACILLUS THURINGIENSIS	XENTARI WDG	I
	BETA PINENE POLYMER	SURFIX	O
	BUTACHLOR + PROPANIL	KLIK 700 EC	H
	GIBERRELIC ACID	BERELEX TABLET	O
	GLYPHOSATE ISOPROPYLAMINE SALT	BURNDOWN 160 AS	H
	GLYPHOSATE ISOPROPYLAMINE SALT	KLEEN UP 480 AS	H
	LAMBDACYHALOTHRIN	KRISS EC	I
	MANCOZEB	DITHANE M-45	F
	NICLOSAMIDE	HIT 250 EC	M
	NICLOSAMIDE	HIT WP	M
	NICLOSAMIDE ETHANOLAMINE SALT	HIT 700 WP	M
	OXYFLOURFEN	GOAL 24 EC	H
	TEBUFENOZIDE	MIMIC 20 F	I

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Appendix 3. continued...

Company	Active ingredient	Brand Name	Uses**
Cultiva Inc.	CARTAP	BOLT 50 SP	I
	COPPER HYDROXIDE	KOP-HYDROXIDE 50 WP	F
	CYPERMETHRIN	FLASH 5 EC	I
Diversified Agrochem Trdg.	ALUMINUM PHOSPHIDE	DEGESCH PHOSTOXIN	FUM
	ALUMINUM PHOSPHIDE	DETIA GAS EX-B	FUM
	ALUMINUM PHOSPHIDE	DETIA GAS EX-T	FUM
	ALUMINUM PHOSPHIDE	DETIA PHOSPHINE PELLETS	FUM
	MAGNESSIUM PHOSPHIDE	DEGESCH MAGTOXIN	FUM
	MAGNESSIUM PHOSPHIDE	DEGESCH PLATES/STRIPS	FUM
Dow Agro Sciences B.V.	CARBOFURAN	SANAFURAN 3 G	I
	CHLORPYRIFOS	GLADIATOR	I
	CHLORPYRIFOS	HARABAS EC	I
	CHLORPYRIFOS	LORSBAN 3E	I
	CHLORPYRIFOS	LORSBAN 40 EC	I
	CHLORPYRIFOS + CYPERMETHRIN	NURELLE D	I
	CYHALOFOP BUTYL	CLINCHER 100 EC	H
	CYPERMETHRIN	STRIKE 5 EC	I
	DICHLOROPROPENE	TELONE II	I
	FENBUCONAZOLE	INDAR 2F	F
	GLYPHOSATE ISOPROPYLAMINE SALT	GLYPHOMAX	H
	MANCOZEB	DITHANE F-448	F
	MANCOZEB	DITHANE M-45 WP	F
	MANCOZEB	DITHANE OS 600	F
	MANCOZEB	SAVIOR 80 WP	F
	NICLOSAMIDE	TRAP 70 WP	M
	OXYFLUORFEN	GOAL 24 EC	H
	PHTHALIC GLYCEROL ALKYL	LATRON B-1956	O
	PICLORAM + 2,4-D	TORDON 101 MIXTURE	H
	PROPANIL	STAM LV-10	H
	PROPICONAZOLE	SANAZOLE 250 EC	F
	SPINOSAD	SUCCESS 25 SC	I
	TEBUFENOZIDE	MIMIC 20 F	I
	TRICLOPYR	GARLON 4	H

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Appendix 3. continued...

Company	Active ingredient	Brand Name	Uses**
Du Pont Far East, Inc.	BENSULFURON-METHYL	BENLATE 50 WP/ OD	F
	BROMACIL	LONDAX WP	H
	CYPERMETHRIN	HYVAR X WEEDKILLER	H
	DIURON	AMMO 5 EC	I
	GLYPHOSATE IPA	KARMEX WEEDKILLER	H
	MANCOZEB	SIGMA	H
	MANCOZEB	MANZATE 200 FUNGICIDE	F
	MANCOZEB + CYMOXANIL	MANZATE 75 DF	F
	METHOMYL	CURZATE M FUNGICIDE	F
	METSULFURON METHYL + CHLORIMURON ETHYL	LANNATE 40 SP	I
	OXAMYL	ALMIX 20 WP	H
	OXAMYL	VYDATE L INSECTICIDE	I
	QUIZALOFOP-P-ETHYL	ASSURE II EC	H
Everland Agri Corp.	CYPERMETHRIN	SNIPER 5 EC	I
Farm Depot	CYPERMETHRIN	SUPREME 5 EC	I
Fercom Mktg., Inc.	MANCOZEB	FERCOZEB 80 WP	F
Fumitechniks Services	ALUMINUM PHOSPHIDE	QUICKPHOS (ROUND TAB)	FUM
Gamecore Enterprises	CYPERMETHRIN	BOXER 5 EC	I
Gem Agrologic	2,4-D IBE	GEM 2,4-D ESTER	H
	ATRAZINE	GEM ATRAZINE	H
	CARTAP HYDROCHLORIDE	GEMTRAK 50 SP	I
	CYPERMETHRIN	MAGIK 5%EC	I
	MANCOZEB	REV 800WP	F
	NICLOSAMIDE	MASO 70 WP	M
Goodfield Mktg.	CYPERMETHRIN	GUARDIAN 5 EC	I
Graintec	ALUMINUM PHOSPHIDE	FUMITOXIN	FUM
Grand Harvest Ventures	CHLORPYRIFOS	COBRA 20 EC	I
	CYPERMETHRIN	PREMIUM 5 EC	I
	MANCOZEB	RED-OUT 80 WP	F
Hunter Mktg. & Dev't. Corp.	ATRAZINE	WEISSER ATRAZINE 80 WP	H
	CYPERMETHRIN	WEISSER CYPERMETHRIN 5 EC	I
Intervet Agric'l Products, Inc.	CHLORPYRIFOS	VA PYRITILINE 20 PE M/B	I
	CYPERMETHRIN	CYCLONE 5 EC	I
	DIURON	IVA DIURON 80 WP	H
	MANCOZEB	IVAZEB 80 WP	F

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Appendix 3. continued...

Company	Active ingredient	Brand Name	Uses**
Jardine Davies, Inc.	2,4-D AMINE	MIRACLE AMINE	H
	2,4-D IBE	WEEDKILL 2,4-D	H
	BETACYPERMETHRIN	CHIX 2.5 EC	I
	BRODIFACOUM	KLERAT WITH BITREX	R
	BUPROFESIN	APPLAUD 10 WP	I
	BUTACHLOR + PROPANIL	TORNADO 60 EC	H
	CAPTAN	CAPTAN 50 WP	F
	CARTAP HYDROCHLORIDE	PADAN 50 SP	I
	CHLORPYRIFOS	VEXTER 300 EC	I
	CHLORPYRIFOS + CYPERMETHRIN	BLINK 275 EC	I
	CYPERMETHRIN	MATON 5 EC	I
	ESFENVALERATE	SUMI-ALPHA 2.5 EC	I
	FENITHROTHION	SUMITHION 50 EC	I
	FENVALERATE	SUMICIDIN 3 EC	I
	GIBERRELIC ACID	BERELEX TABLET	O
	LAMBDACYHALOTHRIN	MASTER 2.5 EC	I
	MCPA	AGROXONE S	H
	METALDEHYDE	BAYONET 6% PELLETS	M
	NICLOSAMIDE	KICK 25 EC	M
	NICLOSAMIDE	SUREKILL 70 WP	M
	PERMETHRIN	SOLIGNUM BROWN	O
	PERMETHRIN + Zn	SOLIGNUM COLOURLESS	O
	PIRIMIPHOS METHYL	ACTELLIC 25 EC	I
Jeels Masagana Farm Supply	CYPERMETHRIN	ARROW 5 EC	I
Jocanima	ATRAZINE	CONTRAZINE 80 WP	H
	CARBARYL	CARBARYL 85 S	I
	CARTAP HYDROCHLORIDE	MINER 50 SP	I
	COPPER HYDROXIDE	HYDROXIDE SUPER 77 WP	F
	CYPERMETHRIN	CYPERTHRIN 5 EC	I
	DELTAMETHRIN	DELMARK 2.5 EC	I
	NICLOSAMIDE	KICK 70 WP	M
	NICLOSAMIDE	SNAIL CHAMP 25 EC	M
	NICLOSAMIDE	SNAIL OUT 50 WP	M

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Appendix 3. continued...

Company	Active ingredient	Brand Name	Uses**
Kemistar Corp.	LAMBDACYHALOTHRIN	ARNIS 2.5 EC	I
	NICLOSAMIDE	TARGET 25 EC	M
	NICLOSAMIDE ETHANOLA-MINE	CALIBER 70 WP	M
	NICLOSAMIDE ETHANOLA-MINE SALT	PISTOL 50 WP	M
Kingpoles, Inc.	COPPER, CHROME, ARSENIC	CELCURE A(P) WOOD PRESERV.	I
Kital, Ltd.	ATRAZINE	KITAL ATRAZINE	H
	CYPERMETHRIN	KITAL STRYKER 5 EC	I
	MANCOZEB	KITAL MANCOZEB	F
Lancaster Phils., Inc.	BUTRALIN	TAMEX 360 EC	H
Lapanday Agric'l & Dev't. Corp.	PARAFFIN OIL	SUNSPRAY 8N	O
Leads Agri Product Corp	2,4-D AMINE	LEAD CORP. 2,4-D AMINE	H
	2,4-D IBE	2,4-D ESTER	H
	2,4-D IBE	2,4-D GRANULES	H
	AMETRYNE	AMETREX 80 WP	H
	AMETRYNE + ATRAZINE	ATRAMET COMBI 80 WP	H
	ATRAZINE	ATRAKORN 80 WP	H
	BPMC + CHLORPYRIFOS	ALAKDAN 300	I
	BUTACHLOR	BLADE 60 EC	H
	CARTAP HYDROCHLORIDE	LEADCORP CARTAP	I
	CHLOROTHALONIL	CIVIL 75 WP	F
	CHLOROTHALONIL	LEADONIL 500 SC	F
	CHLORPYRIFOS	BUGBUSTER 5 EC	I
	DIAZINON	DIAZOL 40 EC	I
	DIAZINON	DIAZOL 60 EC	I
	DIURON	DIUREX 80 WP	H
	ETHEPHON	LEADTHREL 480 SL	O
	ETOFENPROX	VECTRON 10 EW	I
	FENVALERATE	LEADCORP MALATHION 57 EC	I
	ANCOZEB	MANAGER 80 WP	F
	METALDEHYDE	STOP 6% PELLETS	M
	NICLOSAMIDE	NICLOS M	M
	NICLOSAMIDE	SURE 250 EC	M
	PROPICONAZOLE	BUMPER 25 EC	F
	THIOPHANATE METHYL	ARMOR	F
	TRISILOXANE ALKOXYLATE + ALLYLETHOXYLATE	SILWET 408	O
Luv Agrochem Trdg.	2,4-D IBE	LUV 2,4-D ESTER	H
	CYPERMETHRIN	TRIPLEX 50 EC	I

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Appendix 3. continued...

Company	Active ingredient	Brand Name	Uses**
Marine Colloids Phils.	CADUSAFOS	APACHE 10 G	N
	CADUSAFOS	APACHE 100 ME	N
	CARBOFURAN	FURADAN 10 G	I
	CARBOFURAN	FURADAN 3 G	I
	CARBOFURAN	FURADAN 5 G	I
	CARBOSULFAN	ADVANTAGE 5 G	I
	CARBOSULFAN	POSSE 200 SC	I
	CARFENTRAZONE-ETHYL	PARTNER 40 DF	H
	CLOMAZONE	COMMAND 3 ME	H
	CLOMAZONE + PROPANIL	COMMAND PLUS 600 EC	H
	CYPERMETHRIN	ARRIVO 5 EC	I
Mastra Phils., Inc.	CUPRIC HYDROXIDE	CHAMPION WP	F
	DIURON	MASTRA DIURON 80 WP	H
	GLYPHOSATE IPA	BURNDOWN 160 AS	H
	GLYPHOSATE IPA	KLEEN UP 480 AS	H
	GLYPHOSATE ISOPROPYLAMINE SALT	SMART 480	H
Mc Mai & Co., Inc.	COPPER, CHROME, ARSENIC	WOLMAN CCA-C	O
Megacrop Dev't., Inc.	CHLORPYRIFOS	MEGARIFOS 20 EC	I
	CYPERMETHRIN	MEGATHRIN 5 EC	I
Menzi & Co., Inc.	METHYL BROMIDE + CHLOROPICRIN	METABROM	FUM
Mission Hills	SALMONELA ENTIRITITIS VAR. D. NEGATIVA + WARFARIN	BIORAT	R
Model Agric'l Supply	CYPERMETHRIN	MODEL 5 EC	I
Monsanto Phils., Inc.	BUTACHLOR		
	BUTACHLOR	MACHETE 5 G	H
	BUTACHLOR	MACHETE EC	H
	BUTACHLOR + 2,4-D	MACHETE EXPRESS	H
	BUTACHLOR + PROPANIL	ROGUE EC	H
	BUTACHLOR + SAFENER	ADVANCE EC	H
	GLYPHOSATE AMMONIUM SALT	DIREK 800	H
		ROUND-UP MAX	H
	GLYPHOSATE DI-AMMONIUM SALT	BRONCHO	H
	GLYPHOSATE DI-AMMONIUM SALT	POWER SUPRATECH	H
	GLYPHOSATE IPA		
	GLYPHOSATE IPA	POWER	H
	GLYPHOSATE	ROUNDUP EW	H
	MONOETHANOLAMINE SALT	ROUND-UP BIOSORB	H
	POLYETHER-POLYMETHYLSILOXANE COPOLYMER	SPEEDEX	O

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Appendix 3. continued...

Company	Active ingredient	Brand Name	Uses**
Noble Mercantile & Dev't. Corp.	ETHEPHON	NYDREL 100	O
	ETHEPHON	NYDREL 480	O
Novartis HealthCare Phils., Inc.	BENZOXONIUM CHLORIDE	BELORAN 400 SL	O
Old Town Agric'l Kinds	NICLOSAMIDE	BULLDOZER 50 WP	M
OTH, Int'l.	CYPERMETHRIN	CAPTURE 5 EC	I
	MALATHION	MALATHION 57 EC	I
Pacific Fumigation Co., Inc.	METHYL BROMIDE + CHLOROPICRIN	MEBROM	FUM
Plantek, Inc.	CYPERMETHRIN	COTRIN 5 EC	I
Planters Product, Inc.	ATRAZINE	ATRAZINE 80 WP	H
	BPMC	CARVIL 50 EC	I
	CARTAP	VEGETOX 50 SP	I
	CHLORPYRIFOS + BPMC	BRODAN 31.5 EC	I
	CYPERMETHRIN	BUSHWACK 5 EC	I
	DIAZINON	PARAPEST D 400 EC	I
	MALATHION	PLANTERS MALATHION 57 EC	I
	MANCOZEB	PARAFUNGUS 80 WP	F
	MIPC	HYTOX 50 WP	I
	NICLOSAMIDE	AQUADIN 25 EC	M
	NICLOSAMIDE	AQUADIN 70 WP	M
	THIOPHANATE METHYL	FUNGITOX 70 WP	F
	WARFARIN	RATOXIN P	R
PRC Mktg.	TRIAZOPHOS	HOSTATHION 20 EC	I
Radisson Agrochem. Corp.	CYPERMETHRIN	COMBAT 5 EC	I
	MANCOZEB	RADISSON MANCOZEB 80 WP	F
	NICLOSAMIDE	ALPHA 250 EC	M
	NICLOSAMIDE ETHANOLAMINE SALT	CONTROL 70 WP	M
	NICLOSAMIDE ETHANOLAMINE SALT	NET 50 WP	M
Ramgo International Corp.	CHLOROTHALONIL	PILARICH 500 G/L FP	F
	MANCOZEB	PILARZEB 80 WP	F
Richland Agric'l Supply	CHLOROTHALONIL	---	F
	CYPERMETHRIN	---	I

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Appendix 3. continued...

Company	Active ingredient	Brand Name	Uses**
Servwel Agri-Trdng. Corp.	2,4-D AMINE	SERVWEL 2,4-D AMINE	H
	2,4-D IBE	SERVWEL 2,4-D GRANULES	H
	CHLORPYRIFOS + BPMC	TROJAN 31.5 EC	I
	COPPER HYDROXIDE	BLUE COP 770 WP	F
	CYPERMETHRIN	SERVWEL TKO 50 EC	I
	MALATHION	SERVWEL MALATHION 57 EC	I
	MANCOZEB	SERVWEL MANCOZEB 80 WP	F
Shell Chemical, Co., Phils.	PARAFFINIC MINERAL OIL	BANOLE OIL	O
Spectrum Agric'l Supply	CYPERMETHRIN	RAPIDO 5 EC	I
St. Anne Agro Trading	CYPERMETHRIN	PESTMASTER	I
Syngenta Phils., Inc.	ACIBENZOLAR-S-METHYL	BOOST 500 SC	O
	AMETRYNE	GESAPAX 500 FW	H
	AMETRYNE	GESAPAX 80 WP	H
	AMETRYNE + ATRAZINE	GESAPAX COMBI 80 WP	H
	ATRAZINE	GESAPRIM 80 WP	H
	AVERMECTIN	AGRI MEK 1.8 EC	I
	AZOXYSTROBIN	AMISTAR 25 SC	F
	AZOXYSTROBIN	BANKIT 2.5 SC	F
	BRODIFACOUM	KLERAT W/ BITREX 0.005% WAX BLOCKS	R
	CHLORPYRIFOS	VEXTER 300 EC	I
	CHLORPYRIFOS + CYPERMETHRIN	BLINK 275 EC	I
	CINOSULFURON + PIPEROPHOS	PIPSET 35 WP	H
	CYPERMETHRIN	CYMBUSH 5 EC	I
	CYROMAZINE	TRIGARD 75 WP	I
	DIAFENTHIURON + FENOXYCARB	DICARE 37.5 WG	I
	DIAZINON	BASUDIN 40 WP	I
	DIAZINON	BASUDIN 400 EC	I
	DIAZINON	BASUDIN 600 EC	I
	DIAZINON + CYPERMETHRIN	FENOM D 225 EC	I
	DIFECONAZOLE + PROPICONAZOLE	ARMURE 300 EC	F
	DIFENOCONAZOLE	SCORE 250 EC	F
	DIFENOCONAZOLE	SICO 250 EC	F
	HEXACONAZOLE	ANVIL 5 SC	F
	ISAZOFOS	MIRAL 3 G	I
	LAMBDACYHALOTHRIN	KARATE 2.5 EC	I
	LAMBDACYHALOTHRIN	KARATE W/ ZEON TECHNOLOGY	I F

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Appendix 3. continued...

Company	Active ingredient	Brand Name	Uses**
Syngenta Phils., Inc.	MANCOZEB	AGRICOTE MZ 80 WP	F
	METALAXYL	APRON 35 SD	F
	METALAXYL + MANCOZEB	RIDOMIL MZ 58 WP	F
	METALAXYL-m + MANCOZEB	RIDOMIL GOLD MZ 68 WP	F
	MONOCROTOPHOS	NUVACRON 300 SCW	I
	PACLOBUTRAZOL	CULTAR 25 SC	O
	PARAQUAT DICHLORIDE	GRAMOXONE 20 AS	H
	PIPEROPHOS + 2,4-D IBE	RILOF H 500 EC	H
	PRETILACHLOR	SOFIT 300 EC	H
	PRETILACHLOR + FENCLORIM	RIFIT 500 EC	H
	PROFENOFOS	SELECRON 500 EC	I
	PROMETRYNE	GESAGARD 80 WP	H
	PROPICONAZOLE	TILT 250 EC	F
	PYMETROZINE	CHESS 25 WP	I
	PYMETROZINE	CHESS 50 WG	I
	SORBITAN MONOOLEATE (SB), POLYOXYETHYLENE SORBITAN	AL-100 TS	O
	THIABENDAZOLE	TECTO 45 FW	F
	THIAMETOXAM	ACTARA 25 WG	I
Teamagro Trdg.	CYPERMETHRIN	**KING 5 EC**	I
Texicon Agrichem. Corp.	NICLOSAMIDE	TEXIMIDE 250 EC	M
	NICLOSAMIDE	TEXIMIDE WP	M
	NICLOSAMIDE ETHANOLAMINE	TEXIMIDE 50 WP	M
The Cathay Drug. Co., Inc.	CYPERMETHRIN	MARVEL 5 EC	I
Top Agro Products Co.	CYPERMETHRIN	AGRO CYPERMETHRIN 5 EC	I
Transworld Trdg. Co., Inc.	ACETAMIPRID	MOSPHILAN 3 EC	I
	BPMC	DIACARB 50 EC	I
	BUPROFESIN + MIPC	PROCIN 25 WP	I
	CARBOFURAN	DIAFURAN 10 G	I
	CARBOFURAN	DIAFURAN 3 G	I
	CARBOFURAN	DIAFURAN 5 G	I
	CHLORPHENAPYR	KOTETSU 10 SC	I
	CHLORPYRIFOS	CYREN 300 EC	I
	HEXYTHIAZOX	NISSORUN 5 EC	F
	MANCOZEB	TRANZEB 455 FC	F
	MANCOZEB	TRANZEB 80 WP	F
	MIPC	MIPCIN 50 WP	I
	NICLOSAMIDE	MOLUXIDE 250 EC	M
	SETHOXYDIM	NABU-S	H
	THIOPHANATE METHYL	TOPSIN-M 70 WP	F
	TRIFLUMIZOLE	TRIFMINE 30 WP	F

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Appendix 3. continued...

Company	Active ingredient	Brand Name	Uses**
Transworld Trdg. , Co., Inc.	ACETAMIPRID	MOSPHILAN 3 EC	I
	BPMC	DIACARB 50 EC	I
	BUPROFESIN + MIPC	PROCIN 25 WP	I
	CARBOFURAN	DIAFURAN 10 G	I
	CARBOFURAN	DIAFURAN 3 G	I
	CARBOFURAN	DIAFURAN 5 G	I
	CHLORPHENAPYR	KOTETSU 10 SC	I
	CHLORPYRIFOS	CYREN 300 EC	I
	HEXYTHIAZOX	NISSORUN 5 EC	F
	MANCOZEB	TRANZEB 455 FC	F
	MANCOZEB	TRANZEB 80 WP	F
	MIPC	MIPCIN 50 WP	I
	NICLOSAMIDE	MOLUXIDE 250 EC	M
	SETHOXYDIM	NABU-S	H
	THIOPHANATE METHYL	TOPSIN-M 70 WP	F
	TRIFLUMIZOLE	TRIFMINE 30 WP	F
Tropi-Cuke, Inc.	FENBUCONAZOLE	INDAR 2F	F
	MANCOZEB	DITHANE F-448	F
	MANCOZEB	DITHANE M-45	F
	MANCOZEB	DITHANE OS-600	I
UCB Philippines	TETRAMETHYLTHIURAM DISULPHIDE	THIRAM 80 WG	F
United Agro Trade Corp.	BUTACHLOR	BUTACHLOR 600 EC	H
	CYPERMETHRIN	CYPERMETHRIN 5 EC	I
	MANCOZEB	AGROZEB 80 WP	F
WellChem Corp.	ATRAZINE	WEISSER ATRAZINE 80 WP	H
Zagro Corp.	2,4-D AMINE	2,4-D AMINE EC	H
	2,4-D IBE	2,4-D ESTER	H
	2,4-D IBE	2,4-D GRANULES	H
	ACEPHATE	COMPETE 75 SP	I
	AMETRYNE	AMETREX 80 WP	H
	AMETRYNE	AMETRYNE 80 WP	H
	AMETRYNE + ATRAZINE	TRAMEX COMBI 80 WP	H
	BPMC	HOPKILL 50 EC	I
	CAPTAN	MARSCAP 50 WP	F
	CARBARYL	MARSBYL 50 WP	I
	CARBARYL	MARSBYL 85 WP	I
	CARBARYL	ZACARB 85 WP	I
	CHLORPYRIFOS	X-PHOS 20 EC	I
	CHLORPYRIFOS	X-PHOS 40 EC	I
	COPPER HYDROXIDE	HIDROCOB 77 WP	F
	CYPERMETHRIN	CYPEX 50 EC	I
	CYPERMETHRIN	PUNISH X 5.5 EC	I

** *F - Fungus, H - Herbs (Grasses), I - Insects, M - Mollusk (Snails), N - Nematode, O - Others R - Rodents, Fum - Fumigation*

Appendix 3. continued...

Company	Active ingredient	Brand Name	Uses**
Zagro Corp.	DIAZINON	MOSPHILAN 3 EC	I
	DIAZINON	DIAZINON 60 EC	I
	DIAZINON	DIAZOL 40 EC	I
	DIURON	DIAZOL 60 EC	I
	ETHEPHON	DIURON 80 WP	H
	ETHEPHON	XTRAGRO 10 LS	O
	ETHEPHON	XTRAGRO 240 PGR	O
	FENVALERATE	XTRAGRO 480 PGR	O
	MALATHION	KILPES 3 EC	I
	MANCOZEB	MALATHION 57 EC	I
	MANEB	COZEB 80 WP	F
	METALDEHYDE	MANEB 80 WP	F
	METHOMYL	ZECTRIC 6% PELLETS	M
	MIPC	STIMUKIL FLY BAIT	I
	MN-ZN ETHYLENE	ZACK 50 WP	I
	BISDITHIOCARBAMATE	MANZEB 80 WP	F
	PENDIMETHALIN	PREKILL 330	H
	PERMETHRIN	CORSAIR 5 EC	I
	PERMETHRIN	PYTOX 10 EC	I
	PROPAMOCARB HCl	PROPLANT	F
	SULPHUR	COSAVET DF	F
	THIOPHANATE METHYL	SCOPE 70 WP	F

** *F - Fungus, H - Herbs (Grasses), I - Insects, M - Mollusk (Snails), N - Nematode, O - Others R - Rodents, Fum - Fumigation*

Appendix 3. Fertilizers

Brand Name	Company
16408	KITAL LIMITED
AGRI-BOOSTER FOLIAR FERT.	E.M. BISAYA FARM SUPPLY
BIO NATURE LIQUID FERTILIZER	FESHAN PHILS., INC.
BUSYBEE HORTICULTURE 20-20-20 + TE	FCX INT'L. CORP.
DOFEC ORGANIC FERTILIZER	DAVAO ORGANIC FERTILIZER ENVIRONMENTAL COOP.
EVERGREEN ORGANIC FERTILIZER	EVERGREEN ENTERPRISES
GROW MORE	SAGREX
GROW MORE 10-50-10	SAGREX
GROWPLUS MICRONUTRIENT	ZYME INDUSTRIES, INC.
HB 101 LIQUID FERTILIZER	GRETORIA TRADING
JUMBO FOLIAR FERTILIZER	BR-L ASTRA
LA THEMGAS LIQUID FERTILIZER	SUYCO ENTERPRISES
LESCO 18-24-12	ASIA PACIFIC GOLF CORP.
LESCO 19-0-19	ASIA PACIFIC GOLF CORP.
LESCO 20-0-15	ASIA PACIFIC GOLF CORP.
LESCO 21-4-11	ASIA PACIFIC GOLF CORP.
LESCO 29-0-0	ASIA PACIFIC GOLF CORP.
LIQUID CHELATE CALCIUM ZINC	SOUTHERN AGRO EXPORT CORPORATION
MANGOFLOR MULTI NPK 12-2-44	ALDIZ, INCORPORATED
MANUSOL FOLIAR 50	RAMGO INT'L. CORP.
MANUSOL FOLIAR 57	RAMGO INT'L. CORP.
MANUSOL FOLIAR 60	RAMGO INT'L. CORP.
MEGA BOOSTER 10-20-30	LEAD CORPORATION
MEGA F-21 FOLIAR FERT. (21-21-21)	LEADS AGRI CORP.
MEGA YIELD LIQUID FERTILIZER	EAGLECHEM RESOURCES DEV'T. CORP.
NUTRA ACT FOLIAR FERTILIZER	PRO GREEN PHILS., INC.
PETER'S PROFESSIONAL WSF	ALLIED BOTANICAL CORP.
PETER'S PROFESSIONAL WSF	ALLIED BOTANICAL CORP.
PETER'S PROFESSIONAL WSF	ALLIED BOTANICAL CORP.
PETER'S PROFESSIONAL WSF	ALLIED BOTANICAL CORP.
TURBO CROP FOLIAR FERTILIZER	NUTRI GROWTH PHILS., INC.
X-RICE SOIL CONDITIONER	PHILIPPINE ORCHARD CORP

** Fully registered as of December 30, 2001*

Appendix 4.1 List of herbicides that may be used for direct-seeded rice

Herbicide name	Weeds controlled	Rate of application	Time of application	Remarks
Butachlor	grasses,	0.75-1.0 L/ha	2-5 DAS	Apply to moist and puddled
a. Direk 800 + safener	sedges, and broadleaves			soil. Control water normally after applying without
b. Sonic 60 EC		1.0 L/ha		submerging seedlings; spray volume is 200 L/ha.
c. Machete 5G		20 kg/ha	2-4 DBS	Maintain 2-5 cm water after land leveling. Broadcast seeds 4 days after herbicide application. Drain excess water from the field. Irrigate at 6-8 DAS and maintain water at 2-3 cm for 1-2 days.
d. Machete 5G		20 kg/ha	6-8 DAS	Irrigate the field 1 day after application. Maintain water at 2-3 cm for 1-2 days. Do not submerge rice seedlings.
Butachlor + Propanil	annual	1.5-2.0 L/ha	6-10 DAS	Apply on saturated soil, flood
a. Advance	grasses, sedges, and broadleaves			field 1-3 DAA; spray volume is 200 L/ha.
Bentazon	perennial and	2.0 L/ha	weeds at	Weeds need to be above
a. Basagran	annual sedges		2-10 leaf stage	water line and wet; spray volume is 500 L/ha.
Bensulfuron	broadleaves	500-700 g/ha	4-8 DAS	Soil should be fully submerged
a. Londax				when applying and water should be retained for at least 4 days. Compatible with other herbicides; spray volume is 80-60 L/ha.
Oxadiazon	grasses,	1.5-2.0 L/ha	3-5 DAS	Works best with standing
a. Ronstar	sedges, and			water or at least moist soil.
b. Ronstar G	broadleaves			Soil must remain moist after application to maintain activity. Compatible with commonly used herbicides; spray volume is 500-600 L/ha.
Thiobencarb	annual grasses	1.5 L/ha	Pre-emergence	Keep water low enough to
a. Saturn	and sedges		(5-7 DBS) Post-emergence (30 DAS)	avoid submerging the rice plants.
Pretilachlor	grasses, sedges,	1.0 L/ha	0-3 DAS	Apply on saturated soil; spray
a. Sofit	and broadleaves			volume is 160-224 L/ha.

Herbicide name	Weeds controlled	Rate of application	Time of application	Remarks
2, 4-D a. 2, 4-D amine i. Hedonal ii. Planter's 2, 4-D amine iii. Lead Corp 2, 4-D amine iv. 2, 4-D amine EC b. 2, 4-D IBE i. Weedtrol 40 EC ii. 2, 4-D granules iii. Planter's 2, 4-D granules c. 2, 4-D ester i. 2, 4-D ester	annual sedges and broadleaves	1.0-1.5 L/ha	21-28 DAS	Weeds need to be above water line. Reduce water to expose weeds. Re-flood within 2-3 DAA.
Piperophos + 2, 4-D a. Rilof H	annual grasses, sedges, and broadleaves	1.0 L/ha	6-10 DAS	Apply on saturated soil. Flood field 1-3 DAA. Spray volume is 200 L/ha.
MCPA a. Agroxone S	annual sedges and broadleaves	1.5-2.5 L/ha	25-30 DAS	Weeds need to be above water line. Reduce water to expose weeds. Re-flood within 2-3 DAA.
Metsulfuron + Chlorimuron a. Almix 20WP (maroon sachet)	broadleaves and sedges	30 g/ha	20-35 DAS	Apply on saturated soil or in a field with 2-3 cm water. If sprayed on saturated soil, re-irrigate after 3-4 days. Symptoms appear at 5-7 days after spraying. Spray volume is 160 L/ha.
Bispyribac Sodium a. Nominee	annual grasses except *L. chinensis*, sedges, and broadleaves	250 ml/ha	8-15 DAS	Drain excess water before spraying for target weeds to appear one-half part over water surface and re-irrigate during 1-3 DAA.
Cyhalofop a. Clincher	annual grasses	1.0 L/ha	10-15 DAS	Soil must be saturated during application. Re-irrigate 3 DAA.
Bensulfuron-methyl + flufenacet a. Drago	sedges, broadleaves, and annual grasses	170+100 g/ha	2-6 DAS	Soil must be fully covered with water during application (3-5 cm water) and maintained for 4 DAA.
Fentrazamide+ propanil a. Lecspro	annual sedges, and broadleaves	1.5-1.75 kg/ha	4-8 DAS	Soil must be saturated during application. Re-irrigate at 3 DAA.
Clomazone + propanil a. Compro	annual grasses, sedges, and broadleaves	1.0 L/ha	7-10 DAS	Apply on saturated soil. Re-irrigate field 3 DAA. Leaf whitening appears at 5-7 DAA but will soon disappear.

Appendix 4.2 List of herbicides that may be used for transplanted rice in the Philippines.

Herbicide name	Weeds controlled	Rate of application	Time of application	Remarks
Butachlor a. Machete EC b. Sonic 60 EC c. Lambast EC d. Blade 60 EC e. Weeder 60 EC f. Paragrass 60 EC g. Blade 60 EC	grasses, sedges, and broadleaves	0.75-1.0 L/ha 1.0 L/ha	2-5 DAT	Apply to moist and puddled soil. Control water normally after applying without submerging seedlings; spray volume is 200 L/ha.
h. Machete 5G		20 kg/ha	2-4 DAT	Apply in the field with 3-5 cm water. Maintain water until 4-5 DAA for better weed control.
i. Machete Express		1.0 L/ha	2-4 DAT (Dapog) 0-4 DAT (Wetbed)	Apply in the field with 3-5 cm water. Maintain water until 4-5 DAA for better weed control. If applied on saturated soil, irrigate immediately; maintain 2-3 cm water for 4-6 DAA.
Butachlor + Propanil a. Advance	annual grasses, sedges, and broadleaves	1.5-2.0 L/ha	6-10 DAT	Apply on saturated soil. Flood field 1-3 DAA; spray volume is 200 li/ha.
Bentazon a. Basagran	perennial and annual sedges	2.0 L/ha	weeds at 2-10 leaf stage	Weeds need to be above water line and weeds are wet. Spray volume is 500 L/ha.
Bensulfuron + Flufenacet a. Drago	broadleaves	500-700 g/ha	4-8 DAT	Soil should be fully submerged when applying and water should be retained for at least 4 days. Compatible with other herbicides. Spray volume is 80-160 L/ha.
Oxadiazon a. Ronstar b. Ronstar G	grasses, sedges, and broadleaves	1.5-2.0 L/ha	3-5 DAT	Works best with standing water or at least moist soil. Soil must remain moist after application to maintain activity. Compatible with commonly used herbicides. Spray volume is 500-600 L/ha. Can be used in upland or dry-seeded rice.
Thiobencarb a. Saturn	annual grasses and sedges	1.5 L/ha	Pre-emergence (5-7 DBT) Post-emergence (30 DAT)	Keep water low enough to avoid submerging the rice plants.
Pretilachlor a. Rifit	grasses, sedges, and broadleaves	1.0 L/ha	0-3 DAT	Apply on saturated soil. Spray volume is 160-224 L/ha.

Herbicide name	Weeds controlled	Rate of application	Time of application	Remarks
2,4-D a. 2,4-D amine i. 2,4-D amine ii. Hedonal iii. Planter's and 2,4-D amine iv. Lead Corp 2,4-D amine v. 2,4-D amine EC b. 2,4-D IBE c. 2,4-D ester i. 2,4-D ester	annual sedges and broadleaves	1.0-1.5 L/ha	21-28 DAT	Weeds need to be above water line. Reduce water to expose weeds. Re-flood within 2-3 DAA.
MCPA a. Agroxone, Hedonal	annual grasses, sedges, and some broadleaves	1.0 L/ha	25-30 DAT	Reduce water to expose weeds. Re-flood within 2-3 DAA.
Anilofos + Ethoxysulfuron a. Rice Guard 22 SC	annual grasses, sedges, and broadleaves	1.0 L/ha	6-10 DAT	Apply on saturated soil. Flood field 1-3 DAA. Spray volume is 200 L/ha.
Piperophos + 2,4-D a. Rilof H	annual grasses, sedges, and broadleaves	1.0 L/ha	6-10 DAT	Apply on saturated soil. Flood field 1-3 DAA. Spray volume is 200 L/ha.
Thiobencarb + 2,4-D	grasses, broad-leaves, and sedges	1.0-1.5 L/ha	6-10 DAT	Apply on flooded field and retain water for at least 3 days.
Metsulfuron + chlorimuron a. Almix 20WP (maroon sachet)	grasses, broadleaves, and sedges	30 g/ha	20-35 DAT	Apply on saturated soil or in a field with 2-3 cm water. If sprayed on saturated soil, re-irrigate after 3-4 days. Symp-
b. Almix 20WP (golden sachet)		40 g/ha	5-8 DAT	toms appear at 5-7 days after spraying. Spray volume is 160 L/ha.
Bispyribac Sodium a. Nominee	annual grasses except L. chinensis, sedges and broadleaves	250 ml/ha	8-15 DAT	Drain excess before spraying for one-half part of target weeds to appear over water surface. Re-irrigate during 1-3 DAA.
Cyhalofop a. Clincher	annual grasses	1.0 L/ha	10-15 DAT	Soil must be saturated during application. Re-irrigate at 3 DAA.
Bensulfuron + Flufenacet a. Drago	annual grasses, sedges, and broadleaves	170 + 100 g/ha	2-6 DAT	Soil must be fully covered with water during application (3-5 cm water) and retained for 4 DAA.
Fentrazamide + propanil a. Lecspro	annual grasses, sedges and broadleaves	1.5-1.75 kg/ha	4-8 DAT	Soil must be saturated during application. Re-irrigate at 3 DAA.

***DAA -** days after application**; DAT -** days after transplanting**; DBT -** days before transplanting*

PHILRICE

The Philippine Rice Research Institute (PhilRice) is a government-owned and controlled corporation created through Executive Order 1061 approved on Nov. 5, 1985, which was amended by EO 60 dated Nov. 7, 1986 and EO 76 dated March 4, 2002 to help develop high-yielding technologies so that farmers can produce enough rice for all Filipinos. PhilRice accomplishes this mission through research, technology promotion, and policy advocacy, which are implemented through a network that includes 57 agencies and 95 seed centers strategically located nationwide.

Its interdisciplinary programs include the following: (1) direct-seeded and (2) transplanted irrigated lowland rice; (3) hybrid rice; (4) rice for adverse environments; (5) rice-based farming systems; (6) policy research and advocacy; and (7) technology promotion. With these programs, PhilRice aims to develop and promote technologies that are ecosystem-based, location- and problem-specific, and profitable to the Filipino farmers.

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