Low-external Input Rice Production (IIRR, 292 p.)

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Low-external Input Rice Production (IIRR, 292 p.)

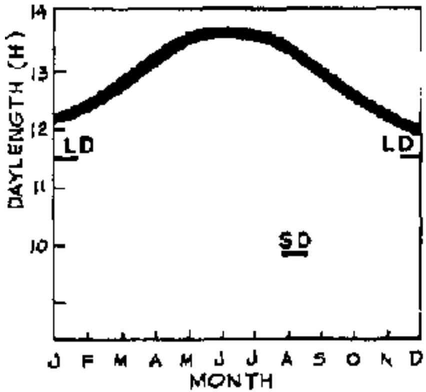
Seeds/seedlings/transplanting

Managing traditional cultivars for optimum outputs

Traditional cultivars possess several attributes which make them indispensable for low-input rice production (LIRP). Among these characteristics include inherent resistance to certain pests and diseases, greater flexibility in the time seedlings can be transplanted, lower requirement for irrigation water and fertilizers and low seed-degeneration rate. Moreover, traditional cultivars have a higher (40%) market price than high-yielding varieties (HYVs). However, traditional cultivars which have characteristics, such as leafiness, tall stature; photoperiod sensitivity and susceptibility to lodge, usually have lower yield potential than HYVs. If a farmer would like to shift from planting HYVs to traditional cultivars, he should modify his practices to receive optimum output. Some

cultural management practices that should be followed are:

1. Proper selection of cultivars. Study site characteristics (soil, climate) in order to select the bestsuited cultivars for the site:



Rice cultivars

· Assuming that there is enough water, select cultivars to fit photoperiodic patterns. In the Philippines, short-day flowering rice cultivars are best planted from August to September while long-day flowering cultivars are best planted December to January.
· Select traditional cultivars which mature only 10-15 days longer than modern rice cultivars if long vegetative period is not wanted.
· Select semi-dwarf traditional cultivars (Pinili, Bengawan, Lubang, Abrigo, Improved Borong, Senador) to avoid lodging in typhoon-prone areas. If tall cultivars are used, some tillers should be cut before flowering to minimize lodging.
· Do not plant tall varieties in:

- soils of inherently high fertility swampy areas

- flood-prone areas
- areas with poor drainage
- sites with high weed infestation. Select for traditional cultivars those which have droopy and long leaves for more effective shading of the weeds. As in HYVs, the field should be kept weed-free 35-45 days after transplanting.

2. Alter the time of planting. Alter planting schedules to fit the climate in the area, specially the occurrence of typhoons and floods. The typhoon season for most parts of the Philippines usually occurs from June to September. Planting late (September) would be beneficial as grain filling and maturity will not coincide with the typhoon season. This also minimizes lodging.

3. Modify plant spacing and populations. Wider row spacing is recommended for traditional cultivars. Wider spacing lessens mutual shading, making plants sturdier end less prone to lodge.

The following row spacings are recommended for traditional cultivars:

Rainy Season	Dry Season
0.25 x 0.25 m	0.30 x 0.20 m
0.30 x 0.25 m	0.25 x 0.20 m

Additionally, a 0.30 x 0.15 m spacing is convenient when rotary weeders are used.

Planting 1-2 seedlings/hill is recommended. This practice produces more productive tillers and tends to make plants less likely to lodge.

4. Practice good water management. Keeping rice continuously flooded makes stems more succulent, thus more susceptible to lodging. Traditional cultivars do not require

continuous flooding during the vegetative period. However, it is beneficial to flood the field at flowering. Water is withdrawn once the hard dough stage is reached.

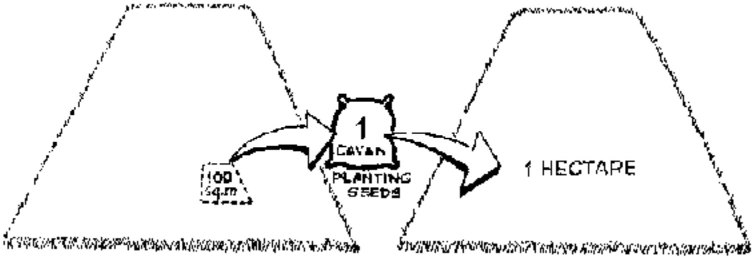
Infields with heavy weed infestation, irrigate the field 2-5 days after transplanting and gradually increase the water level. Water can be withdrawn once canopy closure is reached.

5. Reduce fertilizer use. Traditional cultivars do not require as much fertilizers as HYVs. Large doses of fertilizer make plants tall and prone to lodging.

Producing rice seeds in a farmer's field

Seeds for planting constitute a considerable portion of a farmer's production inputs. Ordinary seeds cost from P5.00-P5.50/kg; certified seeds can cost as much as P8.00-P10/kg. Although the production of rice seeds for planting requires more special care than production of rice grain for food, it is possible for the farmer to produce seeds right in the farm. These simple procedures guarantee reduction in production costs and a steady source of quality seeds for planting.

1. Seed and Area Requirement. Estimate the farmer's production per unit area. For example, if the farmer produces 100 cavans/ha (10,000 sq.m), then he needs 100 sq.m to produce 1 cavan (50 kg). If seeds are of high quality, 1 cavan is often sufficient to plant 1 hectare (for most cultivars). Thus, if the farmer needs to plant 5 hectares, then a 500 sq.m seed production area would be required to harvest 5 cavans of seeds.

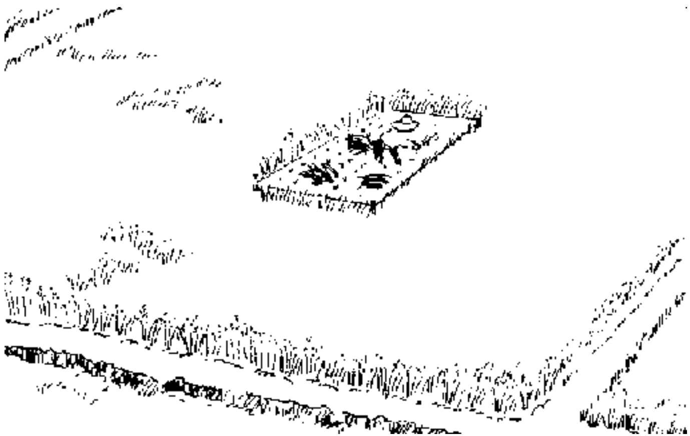


Seed and Area Requirement

2. Site Selection and Preparation. Select the best area within the field for seed production. It should be near the water source, with good drainage and accessible. The soil should be free from weeds, relatively fertile and well-prepared. Mark the required seed production area.

3. Transplanting. If possible, use only seedlings of high quality (high viability, pure, healthy, etc.) seeds. To ensure uniformity of growth end easy identification of off-types, transplant only 1 seedling/hill, in straight rows.

Ideally, plant the whole area with the cultivar of interest to avoid contamination. However, if there are not enough seeds of the desired variety, keep the designated seed production area at least 5 m away from other cultivars.



Transplanting

If using certified seeds, seeds of the same variety which are not certified can be planted around it. However, 4-5 rows surrounding the seed production area should be planted with the same certified seeds. These border rows will act as "screen," but seeds coming from them will not be used for planting.

4. Field/Crop Maintenance. Visit. the area several times during the growing season especially from tillering up to harvesting. Pull out unwanted plants such as off-types (see box), weeds and other crops. Follow regular soil management (fertilization, irrigation, etc.) and crop protection practices to ensure healthy crops.

5. Harvesting. To avoid contamination and possible mixture, harvest the designated seed production area first before the rest of the field. Seeds can be harvested a few days earlier than the usual harvest time without sacrificing quality.

6. Threshing, Cleaning, Drying. Process the seeds produced from the designated seed

production area separately. Be sure to clean the thresher, drying surfaces and seed container properly such that they are completely devoid of other seeds and other contaminants. Keep seeds of different cultivars well-dried and distinctly labeled in separate containers.

PULL OUT THESE OFF-TYPES:

1. All plants growing outside or between the rows -- whether rice or weeds.
2. At tillering stage, all plants not having the same height, average tiller number, stem and leaf color as the majority.
3. At flowering stage, all plants not having the same height, average tiller number, stem and leaf color, average flowering time, flag leaf length and angle as the majority.
4. At harvesting stage, all plants not having the same height, average tiller number, average maturity, color, size, shape of grains end presence of own, flag leaf length and angle as the majority.

Determination of rice seed quality

Knowing the quality of rice seed will enable one to decide the appropriate practices that could help maintain or improve the performance of seedlots.

Seeds on hand can be tested for the following:

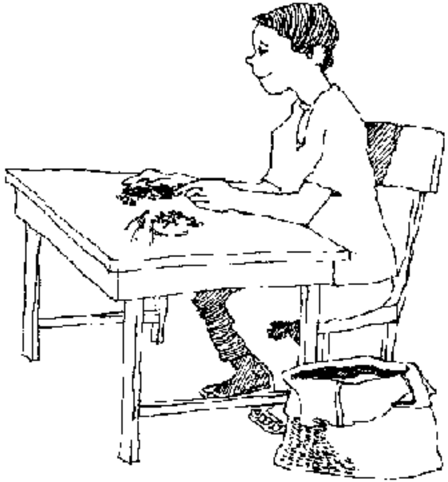
1. Dryness. Most seeds, including rice, store better when dry. High moisture level could result to heating, further accumulation of moisture, active growth of storage insects and fungi and even unwanted germination. Seeds which have not been properly dried are also damaged during processing.

- Sundrying for 3-5 days is often sufficient to bring the moisture content of the freshly harvested seeds down to the safe level (13% or less). If the seeds have been stored for

quite some time or were obtained from other sources, dryness could be checked by biting the seeds. If brittle, the moisture content is 13% or less the desired moisture for planting or storage. The biting test should not be done if seeds have been treated with chemicals. If not sure, simply redry the seeds for 1-2 days.

Dryness

2. Purity and Seed Health. Impurities, such as weed seeds, other crop seeds, other vegetative parts and inert matter, should be removed. These could serve as hosts of crop pests and seed-transmitted diseases or affect seed (and seedling) performance in the field or in storage. Weed seeds could germinate in the field and add to the existing weed population. Seeds of other cultivars, when present, could also lead to genetically impure seedlots.



Purity and Seed Health

- Examine the seedlot for impurities, diseased seeds (symptoms are discoloration and presence of fungal bodies) and infested seeds (seeds with holes or are partially eaten by insects, presence of eggs/egg mass or larva).

- If a large proportion of the sample consists of impurities, the seedlot should be cleaned prior to storage or planting. Cleaning can be done by winnowing or soaking the seeds in water. Defective seeds, weed seeds and other inert matter float to the surface, while seeds that sink are of higher density and are usually of better quality.

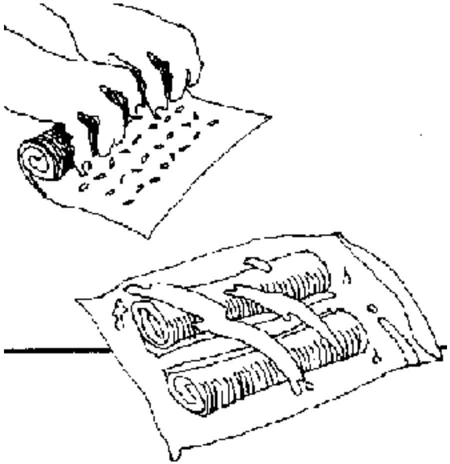
- If the seedlot contains a large proportion of seeds of other cultivars, some form of manual sorting must be done before storage or planting, unless the mixture was intentional.

- Seedlots which contain a large proportion of diseased or infested seeds are not recommended for storage or planting. If the proportion of diseased or infested seeds is minimal, remove such seeds if possible and soak the rest of the seedlot in hot water (5256°C) for 5 minutes (if seeds are wet) or 10 minutes (if seeds are dry).

- Other diseases which do not readily show visible symptoms can be detected only by using special techniques. If these diseases are suspected, have the seeds certified for health at the Bureau of Plant Industry or do not use them for planting. Chances of developing diseases in the succeeding crops are minimized if seeds are harvested from healthy plants and healthy surroundings.

3. Seed Germination and Seedling Health. Germination results could serve as a guide as to whether the seeds could or should still be stored, immediately planted or discarded. Also, they give an idea as to how much seed is required for planting. Seeds with low percentage germination will not keep long and will produce less vigorous plants.

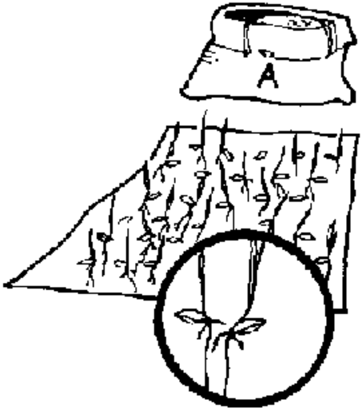
- Sow the pure seeds sampled from the seedlot in moist, clean, absorbent cloth or paper. Roll the cloth or paper loosely (ragdoll method) or keep it on a flat surface covered with the same material.



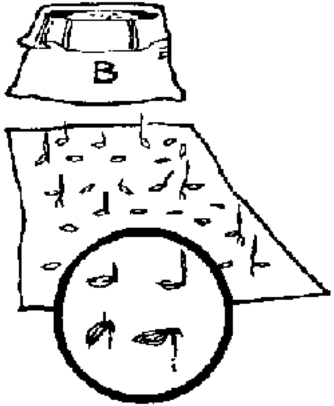
Seed Germination and Seedling Health

Keep the medium constantly moist by watering, taking care not to flood it. Too much water encourages mold and bacterial growth. Alternatively, seeds could be kept moist by carefully dipping the rolled medium in a pail of water, then putting it in a partially opened plastic bag. Keep seeds being tested in the shade and away from mice, ants and rain.

Keep the medium constantly moist



Good germination, good vigor



Poor germination, poor vigor

- Count normal seedlings after 4-5 days. Percentage germination is calculated as

% germination = No. of normal seedlings/Total no. of seeds tested x 100

- If germination is below 80%, but above 60%, use more seeds. Do not use or store seeds if germination percentage is below 60%.

- Observe for seed vigor since germination results alone could not fully predict the performance of seeds especially under stressed conditions. A seedlot with seeds that emerged rapidly and uniformly is considered more vigorous than one with slow and non-uniform emergence and growth, even if germination percentages are comparable.

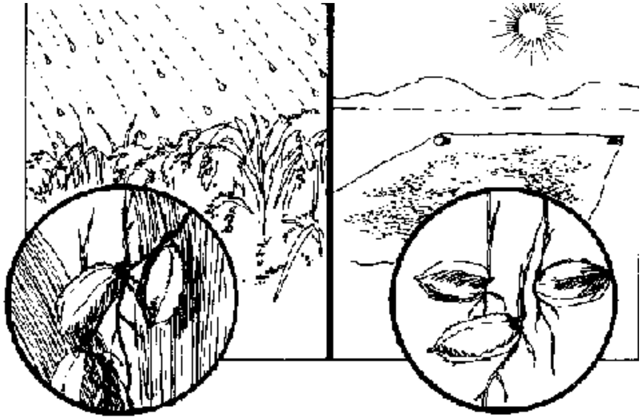
- Growing seedlings should also be examined for lesions, spots, blighting (general death of tissue) and streaking. These are symptoms of potentially serious crop diseases. Treat germinated seedlots showing these symptoms in the same manner as seeds found to be infected or infested.

Rice seed dormancy

Rice seeds that do not sprout when planted in favorable soil and atmospheric conditions are either dead or dormant. Wild and traditional rice cultivars have higher degrees of dormancy than modern ones. Rice seeds may be dormant up to 80 days but most of the cultivated ones have only 2-3 weeks dormancy. A cultivar may be considered slightly dormant (germinates within 15 days from harvest); moderately dormant (germinates within 15-60 days from harvest); or highly dormant (germinates within 60 days from harvest or later). Others, especially many modern varieties, have no dormancy at all. Dormancy is naturally broken through time.

Dormancy can be a plant's natural means to prevent mature seeds in the panicle from

sprouting especially during the rainy season in the tropics. For man, it is an advantage when seeds being dried are rained on as these could sprout and lead to losses. However, dormancy becomes a problem when seeds are purposely planted or assessed for germination.



Traditional and modern cultivars

DETECTION OF DORMANCY:

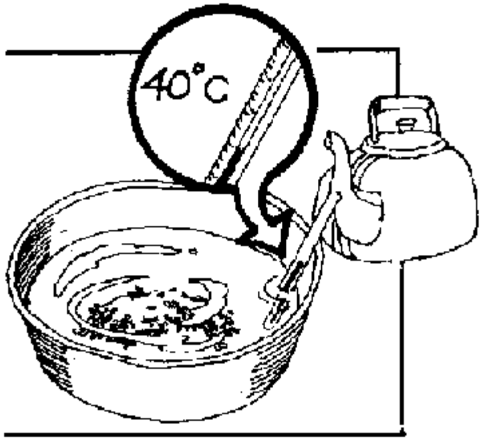
The degree of dormancy of rice seeds are often judged based on previous knowledge about the cultivar and the length of time the seeds have been stored. It can be determined along with the germination rate by sowing mature seeds in moist sand, soil, absorbent paper or cloth. After 5-7 days the seeds are checked and any ungerminated seeds that are not moldy or rotten (easily determined by gently squeezing ungerminated seed) are judged dormant.

BREAKING DORMANCY IN RICE:

Any of the following methods could be used before planting or during germination testing to break dormancy, but their effectivity depends on the cultivar or storage time which determine the degree of dormancy:

· Soak one part seed in 5-10 parts water at 40°C (approximated by allowing boiling water to cool off for 8-10 minutes).

· Heat seeds which have been sundried for 3-5 days (seed moisture content approximately 10%) in an oven at 50-55°C for 7 days.



Soak one part seed in 5-10 parts water

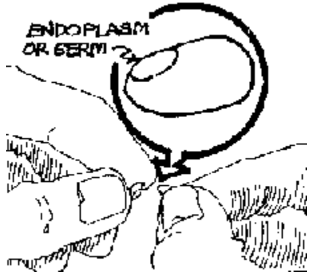
· Soak 1 kg of seeds for 16-24 hrs in 1 liter nitric acid solution (HNO3) prepared by pouring 1 1/4 tsp (6.3 ml) concentrated nitric acid (of 68% purity) into a liter of water (a motor oil can = 1 liter). After soaking, sundry seeds for about 3-7 days.

Soak 1 kg of seeds

Caution: The acid must be poured into the water during the preparation of the solution. Do not pour water into the acid because an explosion could result.

· Soak 1 kg seeds for 24 hrs in 1 liter water containing 1/2 tsp fresh sodium hypochlorite (chlorox, available market grade = 5.25%).

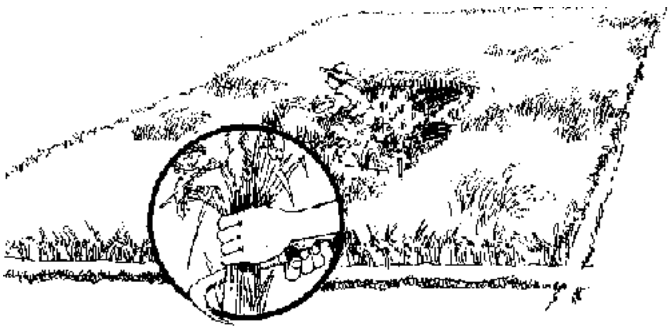
· For a germination test where only a few seeds are used, manually remove hulls. Be careful not to injure the germ or embryo which is the part where the plant develops. This treatment is not applicable to wild rice.



Soak 1 kg seeds for 24 hrs

Rice seed collection and handling

Seeds used for planning require more careful handling than those used for grains (i.e., food or feed). Good quality seed spells good field emergence, seedling stand, crop growth, yields and healthy vigorous seeds. To obtain and maintain good quality seed, the following should be done:



Careful handling

Harvesting: As much as possible, harvest only during sunny days. Do not allow seeds to

become too mature. Generally, it is best to harvest seeds 3040 days after heading in the wet season or 25-35 days after heading in the dry season (depending on earliness of cultivar). Grains in, panicles are yellowish brown at this stage. This allows enough time for the seeds to complete development but not too long that significant deterioration in the field occurs.

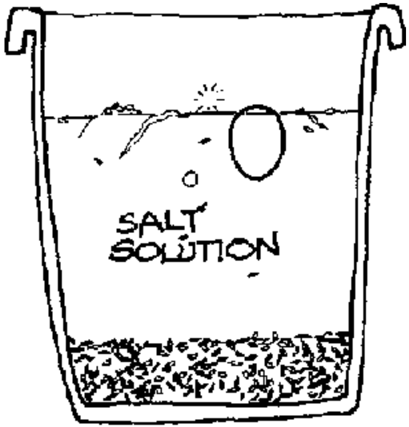
Seed Collection: Collect seeds only from healthy and vigorous plants (health of mother plants largely determines health of seeds produced). These mother plants may have already been identified long before maturity and have been given special care. Avoid plants along borders. Harvest seeds from the main, primary and secondary tillers together (seeds from the different tillers were found to have generally similar yields). If many cultivars are grown together in an area, make sure the seeds from each cultivar are well-identified and separated.

Seed Threshing and Winnowing: The germ or the embryo of the seeds must be protected from mechanical damage especially during threshing. Damaged seeds could result in non-germination or in seedlings which are abnormal. To minimize damage, sundry panicles for a few days before feeding them into mechanical threshers (if used). Clean threshed seeds by blowing or winnowing at least twice using native flat trays (bilao) to separate heavier seeds from light ones and from dust panicles and straw which may contain or attract insects.

Seed Threshing and Winnowing

Seed Storing and Invigorating: A panicle captains seeds which are premature (at the base), mature (at the middle) and over-mature (at the tip). When all the seeds in the panicle are collected, further upgrading is necessary to obtain only high density grains which are known to perform better in the field and in storage than those with lower grain density. Immerse and stir seeds thoroughly in water (1 kg seed/10 liter water). If available, use 6.5% ordinary salt solution (6.5 parts salt to 10 parts clean water, by weight). Alternatively, use 22% ammonium sulfate solution (2.2 parts salt-to 10 parts clean water). Ordinary soil/mud may also be used to increase the density of water. A good approximation of the right mixture (1.08 specific gravity for traditional tropical varieties) is when the blunt end of a fresh chicken egg sticks out by half inch above the surface of the solution. Most modern varieties require only water for effective sorting. Remove all

floating seeds and debris and scoop out seeds that sink to the bottom. The solution may be re-used a few times. When seeds are meant to be stored, rinse the seeds with clean water. Dry-soaked seeds back to original moisture content before planting or storing.

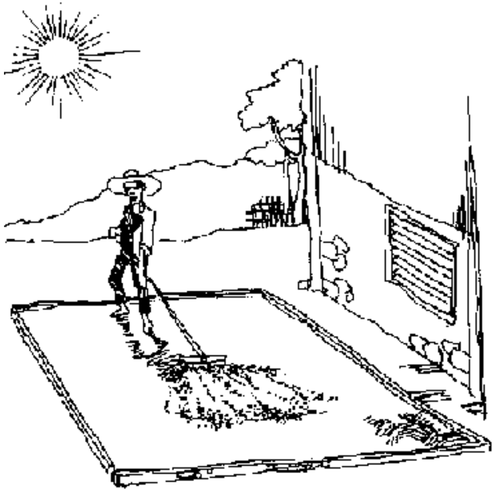


Salt solution

For seeds that have been for quite some time (4-8 months) under ordinary room conditions, treatments may be-done to revitalize already partially deteriorated seeds to extend their storability or to improve performance of seeds to be planted immediately (seeds will germinate faster and more uniformly; plant growth and even yields are also perceptibly improved by approximately 10-20% with invigoration). Soak seeds for 2-8 hours in water (Or in the same salt solution used for storing, then rinse). Dry seeds properly (back to original moisture) before further storage or planting. Fresh seeds or heavily deteriorated ones (less than 60% germination) will not show improvements.

Seed Drying: Spread seeds thinly over a mat, sack or light-colored sheets laid on concrete

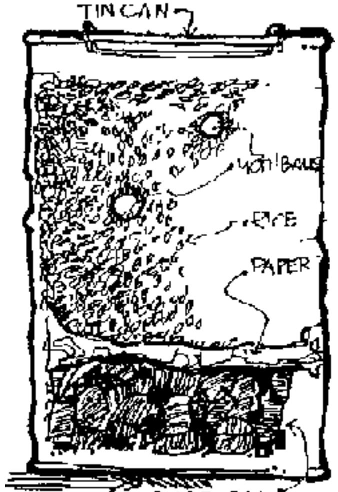
floors or elevated surfaces. Airdry seeds for a day if moisture is relatively high (e.g., seeds wet from soaking or seeds from early harvest). Dry seeds under the sun for 3-5 days (avoid the 10 am - 2 pm heat) and stir constantly. Well-dried seeds (8-10% moisture) split with a cracking sound when bitten between teeth.



Seed Drying

Seed Storage: The three common enemies of a seed in storage are high moisture (or humidity), high temperature and insect pests. For short-term storage (i.e., seeds kept for next planting season), keep dry, clean, healthy seeds in paper or plastic bags and store in a cool shady, dry place in the house or yard away from rodents and birds. Seeds may be kept in the panicles and hung on top of the kitchen stove. For longer keeping, use sealed tin cans or air-tight containers, one-third full of dry charcoal, ash or lime (1 part material/2 parts seeds to completely fill the container). For insect protection, coat seeds

with ash, lime, vegetable oil (1 tsp/kg seed) or incorporate some botanicals, e.g., Gliricidia (kakawate) or other protectants like napthalene balls into the container. If sacks are used for storage, they may be treated with Makabuhay (Tinospora rumphii) or red pepper extract (prepared by cutting fresh material into small pieces then soaking and thoroughly mixing these in water). Sacks are then soaked in this for 4-6 hours, then dried. Do not use the seeds with protectants as food.



Seed Storage

Seed Germination/Sowing:

1. In flooded soil where oxygen is often inadequate for germination, soaking seeds with 40% calcium peroxide could increase germination, seedling survival and even yield.

2. In zinc deficient soil, coating of seeds with zinc oxide (or other forms of zinc) or soaking 2% suspension improves grain yield by 10-20%. Seedlings may also be dipped in the same solution before transplanting.

3. For treatments to break dormancy, see appropriate section. Soaking seeds in 50-56°C for 10-15 mins could break dormancy and at the same time control common pests and diseases.

Common botanicals and other materials in rice seed protection during storage

Botanicals have been used for centuries in rice storage in Asia. This information sheet focuses on the use of plants or its products in the protection of rice seed. Some of the ideas require further testing and development while others have long been tested by rice farmers.

I. Materials Verified Effective as Rice Seed Protectants

Scientific Name	Common Name	Preparation
1. Azadirachta indica	Neem (margosa)	Mix 10-20 9 powdered neem seed per kg seed
2. Acorus calamus	Sweet flag (lubi-lubi)	Mix 10-20 g powdered rhizome per kg seed
3. Mentha spicata	Spearmint	Mix 5-20 9 powdered leaves per kg seed
4. Capsicum frutescens	Red pepper (siring labuyo)	Mix 10-20 9 chillies, per kg seed
5. Curcuma longa	Turmeric (luyang dilaw)	Mix 20 9 powdered rhizome per kg seed
6. Piper nigrum	Black pepper(paminta)	Mix 5 9 powdered leaves per kg seed

Other Materials:

1. Wood ash or paddy husk ash	Mix 10-40 9 per kg seed

1. Wood ash or paddy husk ash	Mix 10-40 9 per kg seed
2. Lime	Mix 10 9 per kg seed
3. Fine sand	Mix 0.5 9 per kg seed

Preparation of Powdered Plants:

Sundry the plant parts (fruit seed, rhizome or leaves) thoroughly. For rhizomes, faster drying can be done if chopped into smaller pieces. Cut the plant parts into finer pieces after sundrying. Grind into powder using a grinder or mortar and pestle. If the powder is not used immediately, store in tightly sealed jars.

II. The following botanicals have been reported effective against cereal pests that could also infest rice seeds. However, there have been no direct reports on actual rice seed storage. You may try them and inform us of your results.

Scientific Name	**Common Name**	**Preparation**	**Reported Effect on Insect**
Acacia concinna	Soap nut	powdered seed	antifeedant
Angelica glauca	Angelica genus	powdered roots	repellent
Annona squamosa	Sugar apple, atis	powdered seeds	anti-insect*
Aphananixis polystachya	Pithraj	dried leaves	anti-insect*
Artemisia maritime	Wormseed	powdered leaves	repellent
Atlantia monophylla		dried stem and leaves	repellent
Atropa acuminata	Indian belladona	powdered rhizomes	repellent
Caesalpinia	Peacock	powdered flowers	insecticidal: contact

pucherrina	flower(caballero)		poison
Calotropis gigantae	Crown plant	powdered flowers	insecticidal
Cassia absus	Four-leaf senna	dried and powdered leaves	anti-insect*
Chrysanthemum cinerariifolium	Pyrethrum	dried and powdered flowers	insecticidal: contact poison
Clerodendron infortunatum	Bhant	dried leaves	anti-insect*
Datura stramonium	Jimson weed	dried and powdered leaves	repellent
Hyptis spicigera	Mint(suob-kabayo)	3 gm dried powdered leaves per kg seeds	repellent
Justicia adhatoda	Malabar nut tree	dried and powdered leaves	antifeedant
Lecothoe grayana	Fetterbush genus	dried leaves, aqueous extraction	anti-insect*
Luffa aegyptiaca	Sponged gourd	powdered leaves	anti-insect*
Mangifera indica	Mango	powdered leaves	repellent
Melia azedarach	China berry	1-2 parts powdered leaves per 100 parts seeds	anti-insect*
Nicotiana sp.	Tobacco	powdered leaves	insecticidal
Pachyrrhizus erosus	Ubas, sinkamas	5-10 parts powdered seeds per 100 parts stored seeds	insecticidal
Pongamia pinnate	Poonga oil tree	powdered leaves	antifeedant
Sapindus marginatus	Florida soap berry	powdered seeds	antifeedant
Scheichera oelasa	Kesambi	5-10 parts powdered seeds per 100 parts stored seeds	insecticidal
Sterculia foetida	Nitas(Calumpang,	1-5 parts dried seeds per 100 parts	insecticidal

	Bobog)	stored seeds	
Swartzia madagascariensis		powdered fruit	repellent
Trigonella foenum-graecum	Fenugreek	leaves and seeds are mixed with seeds	repellent
Vitex negundo	Indian pivet(lagundi)	powdered leaves	insecticidal: contact poison
Xeromphis spinosa		powdered roots and fruits	repellent

REFERENCES:

Handbook of Plants with Pest Control Properties. M. Grainage and S. Ahmed. 1988. United States: John Wiley and Sons, INc.

Natural Crop Protection in the Tropics. Gaby Stoll. 1986. Germany: Margraf Publishers Scientific Books, 188 pp.

The Use of Plants and Minerals as Traditional Protectants of Stored Products. 1980. England: Products Institute, 32 pp.

*** Anti-insect is the general effect and the specific action is not yet known.**

On-farm grain storage

Of the total rice production, an estimated 10-37% is lost in post-production prom harvesting to marketing). About 12-40% an this overall loss is attributable to handling and storage losses which may be minimized at the farm level by observing some simple post-harvest handling practices.

As a general rule, keep storage areas and containers and related harvesting and post-

harvest paraphernalia clean.

The four major areas of concern here are: grain quality before and during storage, storage conditions, insect control and rodent control during storage.

1. Grain Conditions

- Store only mature, whole and healthy grain. Broken grain is prone to insect attack.
- Dry and clean the grain well before storing. Some farmers can determine proper grain dryness by biting a grain sample. If a moisture meter is available, dry grain to 13% moisture content. Otherwise, dry it for about 3 days under good sun.

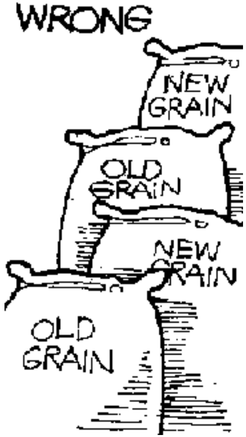
2. Storage Conditions

- Store grain away from wet areas.
- Place stored grain containers where the wind can help cool the containers.
- Do not place sacks of grain near the walls nor place them directly on floors as moisture from the ground may dampen the grain.
- Jute sacks or baskets/bins woven from local palm or bamboo material are ideal grain storage containers.

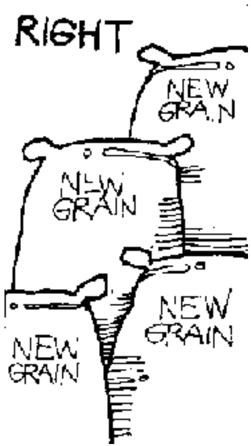
Storage Conditions

3. Insect Control

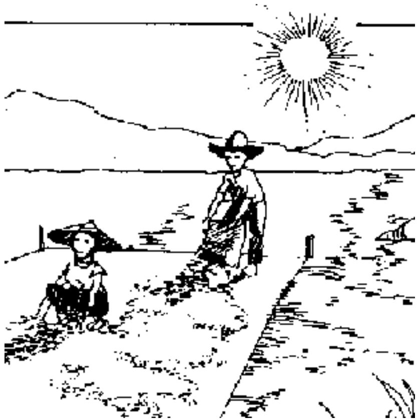
- Do not store grain from a new crop near grain from an older crop to avoid insects from the old grain from infesting the new crop.
- Mix with the grain dried leaves of neem (Azadirachta indica) and kakawate (Gliricidia septum), chili, pepper and other local plants that have insecticidal effects.
- Check the grain often especially for insect presence.
- Sunning: Occasionally subjecting stored crop to high temperature, especially when a large number of insects is present, helps keep insects away (but may not kill their eggs/larvae).
- Keeping grain above the stove (for small quantities) can help in keeping moisture and insects out.


WRONG
NEW
GRAIN
OLD
GRAIN
NEW
GRAIN
OLD
GRAIN

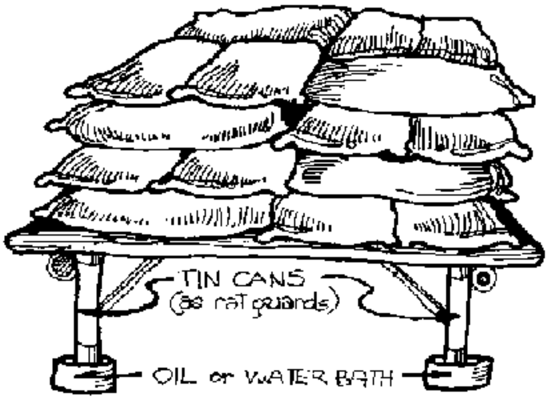
Wrong


RIGHT
NEW
GRAIN
NEW
GRAIN
NEW
GRAIN
NEW
GRAIN

Right



Check the grain



Rodent Control

4. Rodent Control

- Keep the storage area and its surroundings clean to keep rodents from nesting and hiding in them.
- Keep the grass trimmed around the storage/farm building.
- Store grain sacks off the floor on bamboo platforms and place rat guards made of tin cans around the platform legs to keep rats from climbing. An oil or water bath for the platform legs will keep crawling insects away from the grain as well.
- Keep a cat or a dog.

Clonal propagation: a method of seed multiplication

What will a farmer who would like to plant a certain rice cultivar for the coming season do when he or she only has a limited amount of seeds? Clonal propagation can be resorted to.

Clonal propagation is a method of multiplying rice plants from a single grain, an aged seedling or a rice stubble. This method, developed by R. H. Richharia in India, has several advantages over the conventional seed-crop multiplication:

- applicable to any rice cultivar
- ensures genetic purity of multiplied material
- could be easily adopted by farmers
- except for labor, the system entails minimum costs to farmers.

PROCEDURE:

1. Germinate seeds in a pot or en isolated paddy. Initial plant materials or mother plants are best placed in pots for protection and easier maintenance.

2. Seeds germinate and grow and form tillers at approximately 12 days after planting

(DAP). At 20 DAP, or when tillers possess new roots, tillers could be separated. Carefully detach these using a razor blade or a thumb's nail.

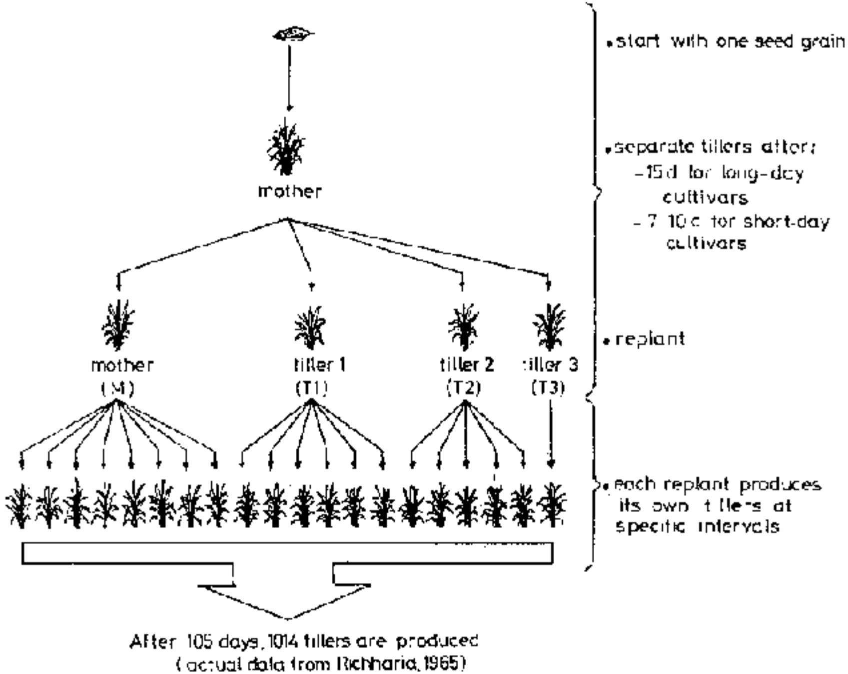
3. Plant the separated tillers and the mother plant immediately. If the procedure is done in the field, use wide-planting distances 0.20 x 0.20 m to encourage tillering.

4. The individual plants (clones) grow again and produce tillers. Rooted tillers could again be separated after 15 days. Replant the tillers after separation. Fifteen days after replanting, all the plants are uprooted and the tillers are again separated. In the case of short-duration varieties, the separation of tillers and replanting have to be done earlier (7-10 days).

Germinate seeds

At 70-80 days after sowing, maximum tillering occurs (or 3-4 primary tillers are formed) for all plants. Separation of tillers can be continued up to this point. The separated primary

tillers thereafter serve as the new mother plants for subsequent splits. Further separation can be repeated until a sufficient number of seedlings are produced for field transplanting. During multiplication, pests should be controlled to prevent losses.



Multiplication

Note: The rate of multiplication is genotype-specific. In general, medium- and late-maturing cultivars tend to produce tillers longer due to a time lag between vegetative and reproductive stage. Hence, more tillers are produced. The number of initial plant material,

therefore, has to be adjusted, i.e., more seeds should be supplied for early-maturing cultivars to compensate for lesser production of tillers.

Raising seedlings by the wetbed method

ADVANTAGES:

· Less seeds are required per unit area transplanted.
· Transplanting of seedlings can be delayed. Transplanting older seedlings shortens the crop's stay in the field, thereby reducing crop exposure to field risks.
· Gives the rice seedlings a headstart over the weeds after transplanting.

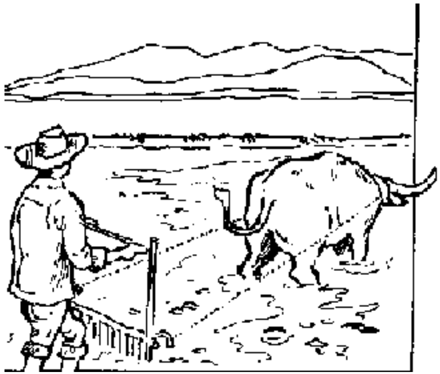
DISADVANTAGES:

· It requires larger areas for the seedbed.
· Preparation of seedbed, care of seedlings and pulling of seedlings are laborious.
· Seeds are easily carried away by raindrops if heavy rain occurs shortly after sowing.

PROCEDURE:

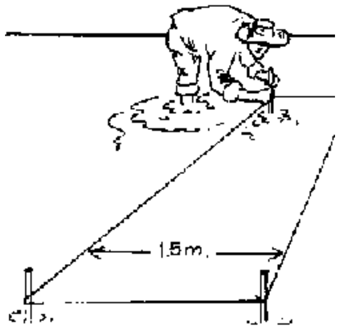
1. Locate an area near a water source which is exposed to full sunlight. A total of 350-500 sq.m of seedbed area is needed to grow enough seedlings to plant 1 hectare of rice paddy.

2. Prepare the seedbed 30-35 days before the scheduled time of transplanting. Plow and harrow the field thoroughly



Prepare the seedbed

3. Construct raised seedbeds -- 1.5 m wide, 4-5 cm high and of any convenient length.

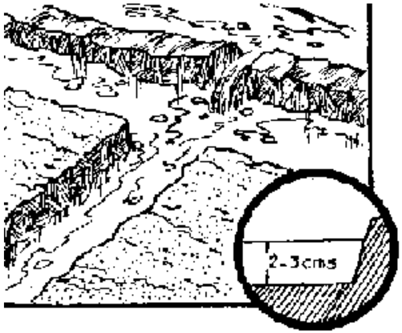


Construct raised seedbeds

4. Sow the pregerminated seeds uniformly at 1 kg/10 sq.m.

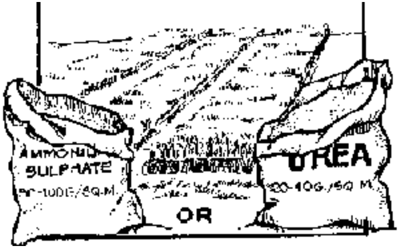
Sow the pregerminated seeds

5. After 4 days, irrigate the seedbed about 23 cm deep end gradually increase the water level to 5 cm to control weeds and to make pulling of seedlings easier.



Irrigate the seedbed

6. If you observe nitrogen deficiency (yellowing of the lower leaves) broadcast 50-100 9 ammonium sulfate/sq.m or 2040 9 urea/sq.m of seedbed 10 days after sowing. Protect the seedlings from carabaos, rats and birds.

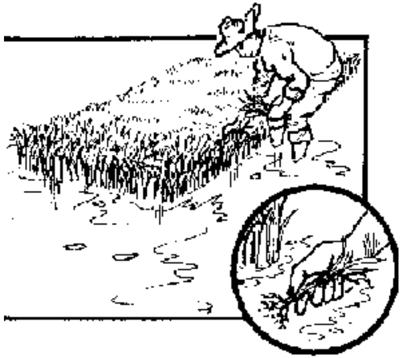


Protect the seedlings

7. The seedlings are ready for transplanting at the following days:

- 16 days for varieties which mature in 115 days
- 20 days for varieties which mature in 116-125 days
- 25 days for varieties which mature in 126 days or more

Increase the water depth to 10 cm the day before pulling the seedlings. When pulling, hold the seedlings close to the base to avoid injury. Wash the roots carefully and do not strike the seedlings against hard objects to remove the mud as this will shock them.



Increase the water depth to 10 cm

The dapog method of raising rice seedlings

ADVANTAGES:

· requires less space for raising seedlings
· seedlings can be planted early (9-14 days)
· labor required for removing seedlings from seedbed is less than 1/4 compared to the wetbed method
· easy to transport seedlings from seed bed to the rice paddy

DISADVANTAGES:

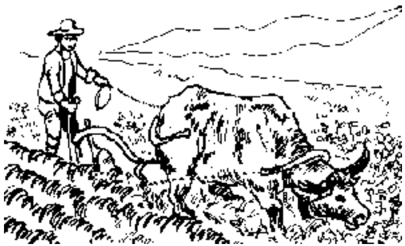
· Uses more seeds than the wetbed method.
· Produces smaller, younger seedlings which
- can only be used on farms where good water management is possible
- have a greater chance of being smothered by Azolla.

PROCEDURE:

1. Locate an area in the field near a water source.

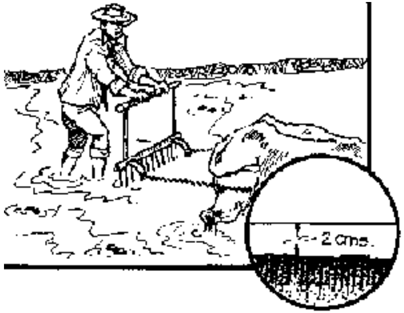
Locate an area

2. Irrigate the field. Plow and harrow it twice to puddle the soil and bury the weeds.



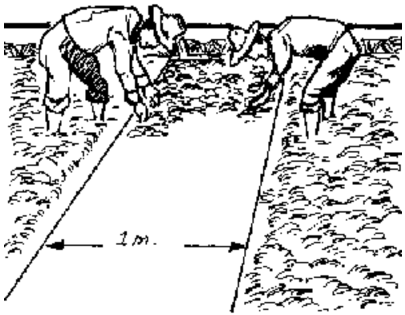
Irrigate the field

3. Flood the area 2 cm above the soil surface to facilitate levelling.



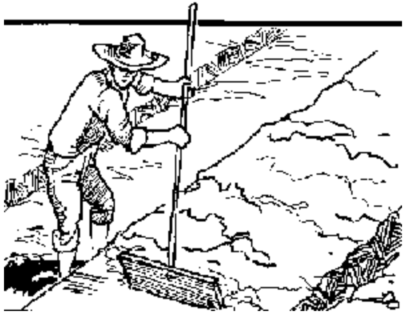
Flood the area

4. Prepare puddled seedbeds 1 m wide end of any convenient length. The seedbeds are raised 3 cm by taking some soil from the footpath.



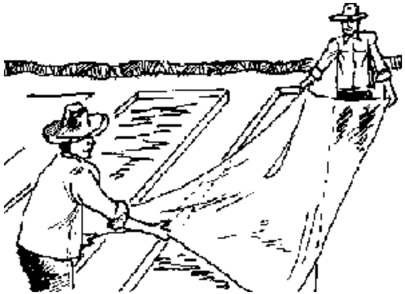
Prepare puddled

5. Carefully level the seedbed and allow the soil to settle for a day.



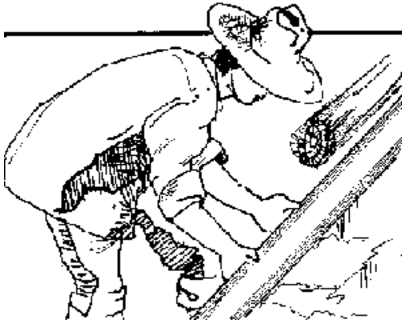
Carefully level the seedbed

6. Cover the seedbed with plastic sheets or banana leaves. These materials are used to prevent the roots of the seedlings from penetrating into the soil.



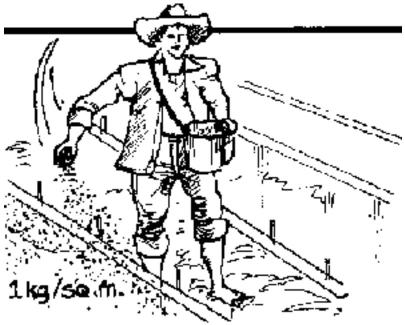
Cover the seedbed with plastic sheets

7. Peg sliced banana bracts along the sides of the seedbeds to prevent the soil and the seeds from being washed away.



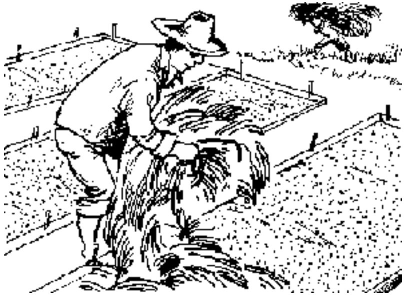
Peg sliced banana bracts

8. Sow the pregerminated seeds directly onto the plastic sheet or banana leaves. Use 1 kg seeds/sq.m. Seedlings from 60 kg seeds will be enough to plant 1 hectare.



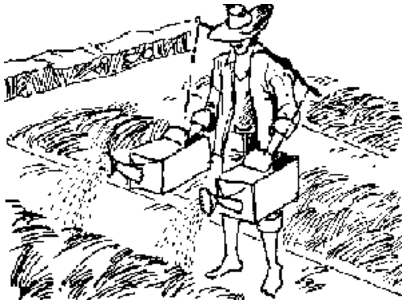
Sow the pregerminated seeds

9. Cover the seedbeds lightly with dry rice strew to protect the seedlings from birds. The straw should be disease -- and insectfree. (Remove the straw on the sixth day when the seedlings are large enough that birds will no longer eat them.)



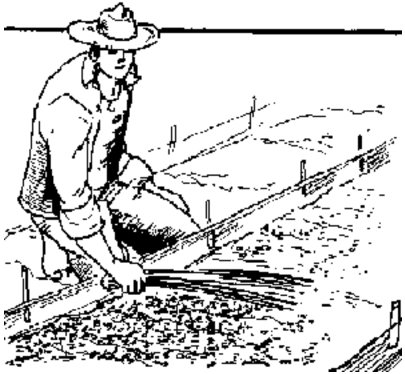
Cover the seedbeds lightly with dry rice

10. Water the seedbeds three times daily to keep them moist.



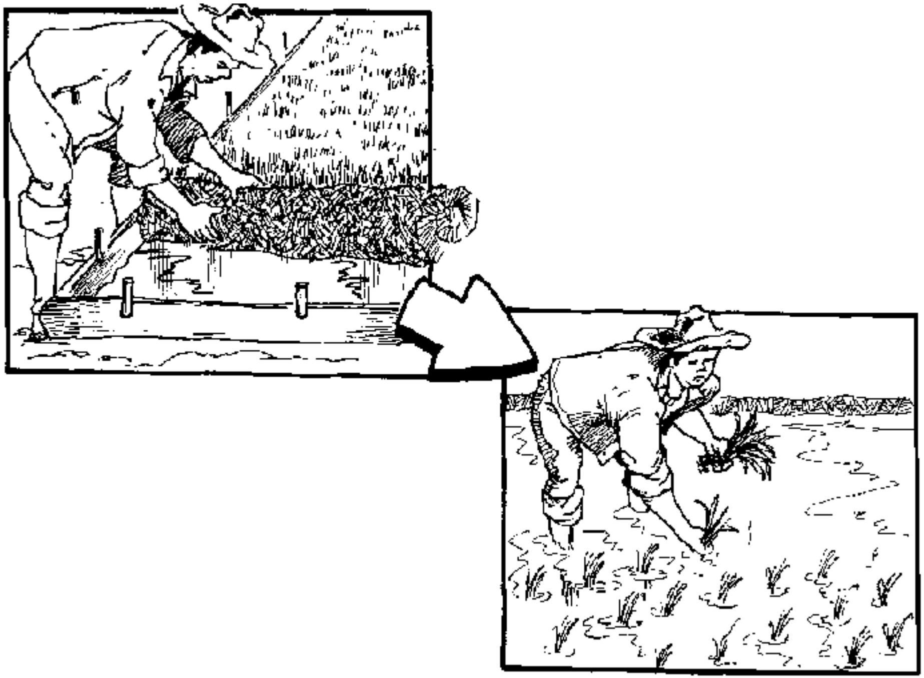
Water the seedbeds three times daily

11. Tap the seedlings lightly with a broom at least two times a day to make sure that all the rice seeds come in contact with the base of the seedbed.



Tap the seedlings lightly with a broom

12. The seedlings are ready for transplanting 1014 days after sowing. Simply roll up the seedlings as you would a mat and carry them to the paddies for planting.

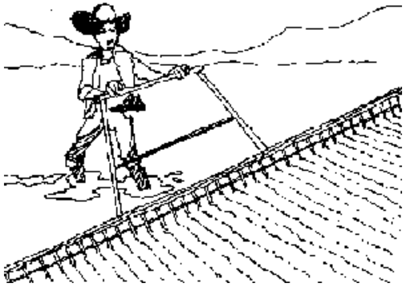


Roll up the seedlings

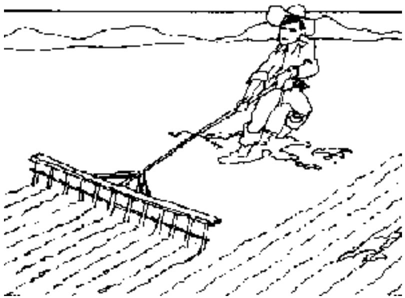
Line markers for rice transplanting

Planting rice in straight lines facilitates rotary weeding, reduces time needed for other management practices and assures optimum plant populations. Labor costs for transplanting are higher when using straight-line planting. However, due to lower weeding costs and higher yields, straight-line planting is more profitable than not planting in straight lines.

Line marking tools make it much easier to plant in straight lines. Below are two common markers used by farmers. A farmer can choose from among them, based on materials available and the size of paddies to be lined.



Harrow type



Rake type

A. Harrow-type Marker

- **Used in wide paddies**
- **Can be constructed with bamboo or wood to look like a harrow**

· Paddies are lined by first pulling the marker in an East-West direction (being sure to keep the lines straight), and then pulling the marker in the North-South direction, making small squares throughout the paddies (1 man-day needed to mark 1 hectare of land).

B. Rake-type Marker

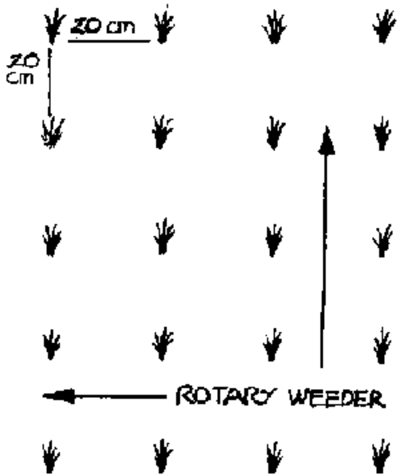
· Used in narrow paddies where the harrow type marker, being wider, would not fit
· Can be constructed with either wood or bamboo
· Marking is done in the same way as for the harrow-type marker (1-1.5 man-days/ha).

Straight-row planting using the square and triple-row spacing

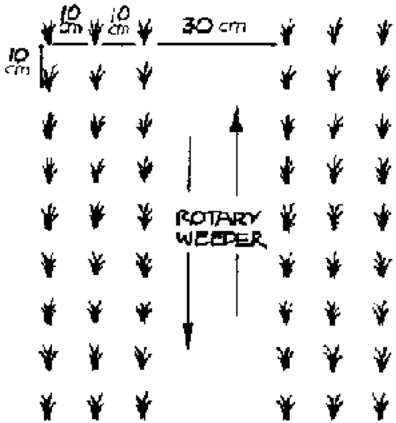
ADVANTAGES OF STRAIGHT-ROW PLANTING:

1. Easier to apply production inputs and implement management practices
2. Possible to use rotary weeder
3. Promotes optimum plant population and uniform nutrient uptake

The most common straight-row planting method used by farmers is the square method ranging from 20 cm to 30 cm, planting 2-3 wet bed grown seedlings or 4-6 dapog seedlings.



Square

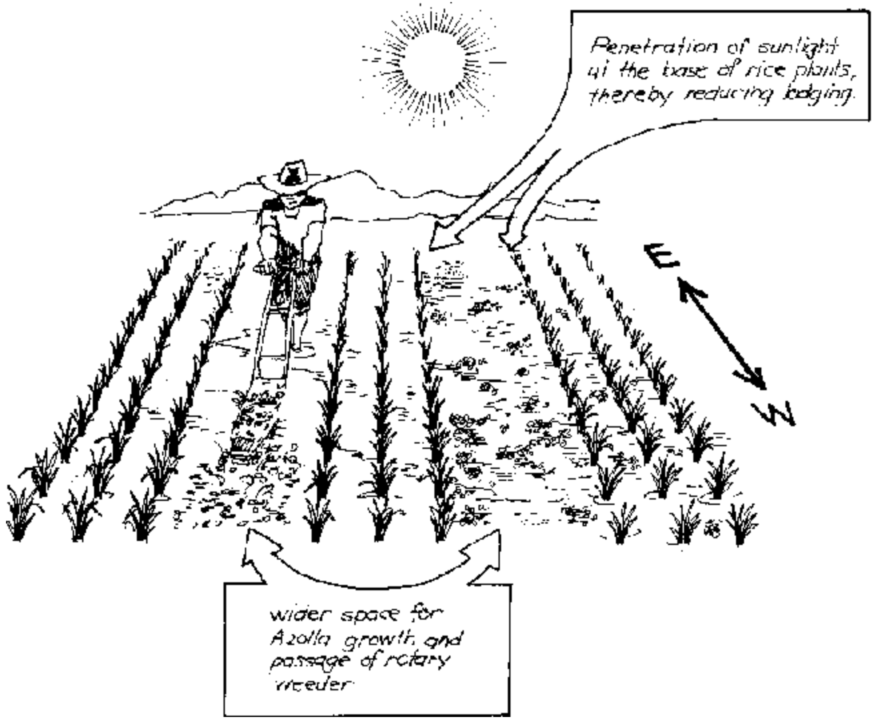


Triple rows

Another planting system which has increased yields above those using the square method i the triple-row system.

Trials conducted in Navarro, General Trias, Cavite, using IR70 rice variety, gave the following figures (average of 2 cropping seasons):

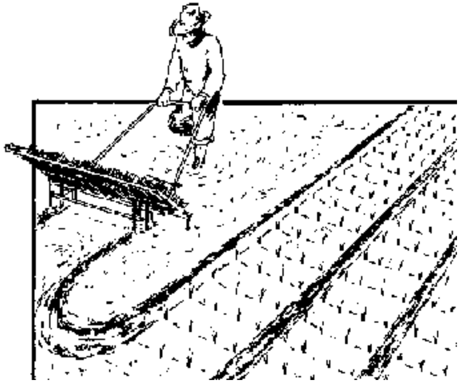
Spacing Method	Amount of Seeds(kg/ha)	Transplanting(manhours/ha)	Grain Yield(T/ha)
Square Method (20 x 20 cm)	60	120	4.1
Triple-row Spacing	180	300	5.0



Advantages of the triple-row spacing system

Note: Rows are oriented in an East-West direction so that leaves can receive the maximum amount of sunlight.

A manually operated rice transplanter



A manually operated rice transplanter

The transplanter is applicable where:

1. Farm labor is becoming insufficient to:

· urban migration
· simultaneous planting time among many farmers in an area.

2. Farmers wish to cut down on transplanting costs

BASIC INFORMATION ON THE TRANSPLANTER:

1. Two people can transplant 1 hectare in about 3 days. (The two will alternately operate the machine and replace seedlings onto the tray.)

2. The rice seedlings are planted in rows (to facilitate other cultural management practices like weeding) and, therefore, there is no need to hire line markers.

3. The transplanter is relatively simple to operate and maintain and is made from locally available materials.

4. A unit costs about P4,500 (as of June 1990).

5. For efficient and effective use of the transplanter, minor modifications on the dapog or wetbed method of seedling preparation have to be made.

6. The transplanter owner can earn additional income by custom-hiring the machine.

A simplified cost comparison between manual transplanting and using the transplanter is shown below:

	Manual Transplanting	**Transplanter**
Labor requirement to transplant x 1 hectare	25 mandays (ma)	6 mandays (ma)
Estimated transplanting cost/ha/yr for 2 croppings*	(25 ma/cropping x 2 croppings x P50/md) + (P100 for line marking) = P2,600.00	(6 ma/cropping x 2croppings x P75/md) + (P900 depreciation cost) = P1800.00**

*** Assuming P50/md for manual transplanting and P75/md for operator of transplanter.**
**** Assuming P4500 cost of transplanter and a lifespan of five (5) years. Note: Aside from the P800 savings on transplanting costs, the owner can custom-hire the unit to earn additional income.**

For details and technical assistance, contact:

1. Agricultural Engineering Department IRRI, Los Baos Laguna, Philippines

2. Agricultural Mechanization Development Program CEAT, UP at Los Baos College, Laguna, Philippines

A drum seeder for direct seeding

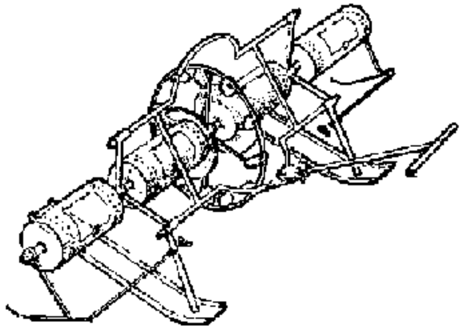
In areas where broadcast seeding is practiced, the drum seeder offers several advantages:

· reduces seeding rate to about 50-100 kg/ha without compromising yield (broadcast seeding rate requires 100150 kg/ha). Savings in seed costs are realized.

· uses pregerminated seeds as traditionally practiced by farmers.

· increases yields due to:

- better weed control (i.e., facilitates use of mechanical weeders)
- better fertilizer and sunlight distribution due to less crowded pants
- in general, labor requirements for the following farm operations may be decreased. weeding, fertilizer application and harvesting.



A drum seeder for direct seeding

SOME TRADE-OFFS IN THE USE OF THE DRUM SEEDER:

· increase in labor requirement for land preparation (especially in soil levelling to ensure uniform seed distribution) and planting operations
· cannot adapt well to wet season planting as heavy rains will destroy the planting line
· water depth control during seeding operation is essential
· a drum seeder unit costs approximately P1750 (as of December 1989) and has an expected life span of about 5 years.

The drum seeder is being adapted in some areas of the province of Oriental Mindoro and the following tables present a comparative study conducted by UPLB, IRRI and the government of Oriental Mindoro with 11 farmer-users.

Table 1: Effect of drum seeding on some farm operations as compared to broadcast seeding (1987 Dry Season, Oriental Mindoro).

Farm Operations	Increase (+) or Decrease (-) in Labor Requirement	Number of Farmer-Respondents (Total of 11 Farmers)
Land preparation	+ 0.7	2
Planting	+ 11.9	11
Weeding	- 61.5	9
Fertilizer application	- 1.0	3
Chemical control	- 2.3	4
Harvesting	- 7.6	3

Table 2. Effect of drum seeding on seed input and yield compared to broadcast seeding

(1987 Dry Season, Oriental Mindoro).

Input

Increase (+) or Decrease (-) in Amount (kg/ha)

Number of Farmer-Respondents
(Total of 11 Farmers)

Seed requirement

- 62

11

Yield

+ 824

10

For more technical assistance (drawings and fabrication techniques), contact:

1. Agricultural Engineering Division International Rice Research Institute (IRRI) Los Baos, Laguna, Philippines

2. Agricultural Mechanization Development Program (AMDP) College of Engineering and Agro-Industrial Technology (CEAT) University of the Philippines at Los Baos (UPLB) College, Laguna, Philippines

Inoculating rice seedlings with Azospirillum

Azospirilla are a genus of bacteria which live and can colonize the roots of forage and grain grasses and exert beneficial effects on their growth. This grass-bacteria symbiosis differs from the legume-rhizobium symbiosis in that the former does not have root nodulation as a manifestation of the association. These organisms reside mainly at the zone of root elongation, bases of root hairs and root interior.

Some work has been done in rice particularly in India and now in the Philippines. One recent test in India yielded 6.5 T/ha with Azospirilla vs. 4.4 T/ha without it. In experiments in Cavite and Negros provinces, the use of Azospirilla in combination with 40 kg N increased rice yields by 24% and 55%, respectively, while Cavite experiments using only Azospirilla increased rice yields by 18%.

The exact cause for the yield increases is not yet clear. However, it is known that a higher percentage increase in yield occurs under conditions where lower amounts of fertilizer N is used.

Aside from the nitrogen fixation, several benefits can be derived from azospirillum inoculation: it promotes root hair development and branching -- increasing the uptake of NPK and microelements; improves water status of plants; and increases dry matter accumulation and grain yield. Inoculating plants with azospirillum can reduce the required nitrogen fertilizer from 1/3 up to 213.

HOW TO INOCULATE RICE SEEDLINGS:

1. Mix the inoculant with water. About 750-1000 9 inoculant is required to treat seedlings needed to plant 1 hectare.

2. Put the mixed inoculant in a container for dipping the seedlings. If a big container is not available, prepare a bunded piece of land and line this with plastic

3. Soak the seedlings into the mixture for at least 3 hours. If possible, inoculate/soak the seedlings overnight before transplanting.

Mix the inoculant with water

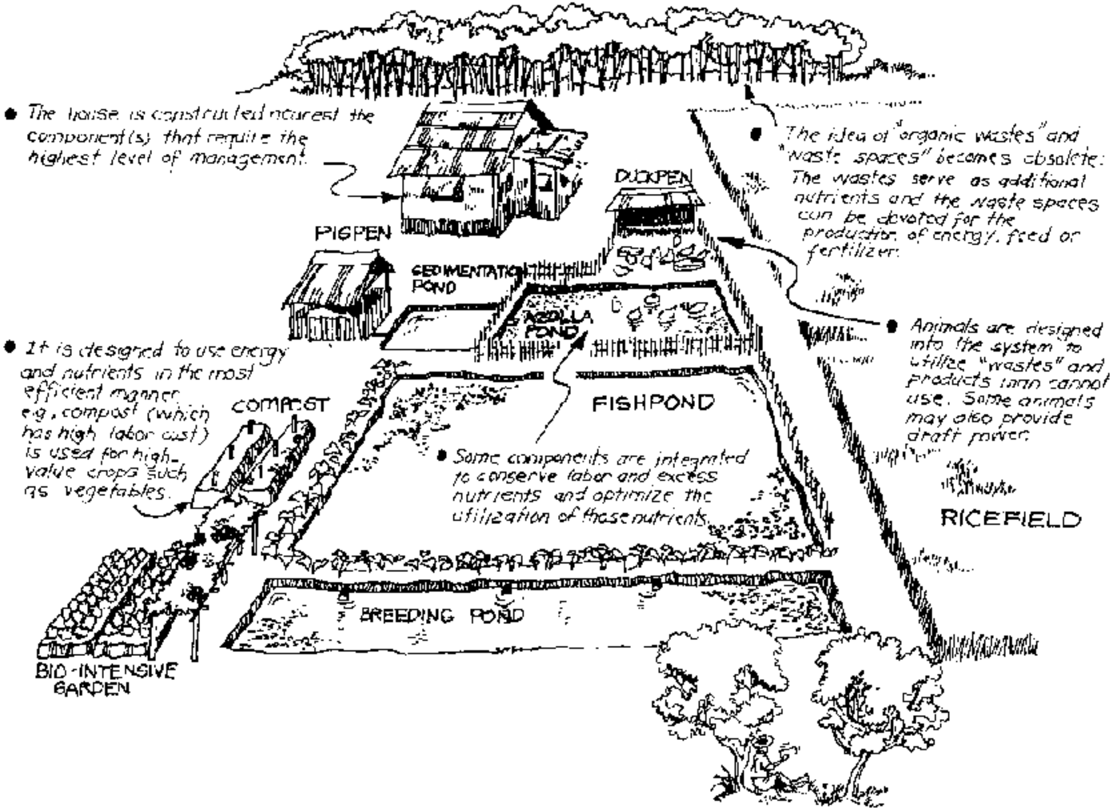
Put the mixed inoculant in a container


LOW-EXTERNAL INPUT
RICE PRODUCTION (LIRP):
TECHNOLOGY INFORMATION KIT

Low-external Input Rice Production (IIRR, 292 p.)

Integrated nutrient cycling

Integrated nutrient cycling in lowland rice production: an ecosystem approach



Basic features

OTHER FEATURES:

· Each component introduced into the system should contribute toward the goals of regenerating the land and sustaining the farming system.

· The system exhibits redundancy: each function meets more than one need, each need is met by more than one function.

· It starts simply and through careful observation and analysis of the area's resources, it evolves into a more complex, stable system.

TECHNICAL PROFILE:

As an example, a small area of marginal land near a water source (irrigation canal, creek or spring) can be used for the components below:

· Pig pen (2m x 4m) -- Good for 2-3 heads of upgraded breed. Use local materials like bamboo for pen enclosure, cogon or nipa for roofing. Cement the flooring.

· Sedimentation pond (2m x 4m) -- One meter deep. Install spill pipe in the dike 30 cm above pond floor for excess water going to the Azolla pond.

· Azolla pond (3m x 4m) -- Maintain 30-40 cm water depth. Install another spill pipe in the dike for excess water going to the fish pond and to control water depth in the Azolla pond to 40 cm above floor level.

· Duck pen (1.5m x 3m) -- Constructed near the Azolla pond for 1 male and 8-10 female ducks.

· Fish pond (10m x 3m) -- Maintain 100 cm water depth for 600 Tilapia nilotica or other fish species fingerlings.

· Fish breeding pond (2m x 10m) -- Maintain 65-70 cm water depth for 8-10 female and 2

male Tilapia or other fish species breeders.

· B.l.G. plots (1.5m x 3m) -- For production of various indigenous vegetables.

POTENTIAL PRODUCTION:

· Pig pen -- Gross sales in the amount of P6,000.00 for 3 upgraded (75%) pigs in 6-7 months using low-cost feed combinations.
· Sedimentation pond -- Ready source of sludge for the garden and material for composting.
· Azolla -- Provides fresh or cooked feed for swine, ducks and fish or can be used as green manure or composting material.
· Ducks -- Regular source of meat and eggs for the family after 6 months.
· Fish pond -- 50-55 kg of Tilapia can be harvested within 6 months.
· Garden -- 1-1/2 kg of various vegetables can be produced daily throughout the year.
· Compost --1.5-2.5 tons of compost can be produced annually.
· Woodlot -- Fast-growing shrubs or trees can provide the fuel needs of the household. When planted along the paddy dikes and other waste spaces, the woodlot can also be a good source of wood for fence posts, trellises, etc.

EXERCISE TO INCREASE FARMER AWARENESS OF INTEGRATED NUTRIENT CYCLING:

While rice-based lowland farm systems are principally devoted to rice production, they also can involve a variety of production components and complex integrated systems. Small farmers have traditionally managed these complex farming systems and have an acute awareness of the cycles and flows of nutrients which occur on their farm within a cropping season or throughout the year.

However, resources can oftentimes be more intensely optimized by allowing farmers to

critically analyze their farm nutrient flows in a systematic manner. This process can be implemented using a simple exercise with farmers. This exercise also helps field workers improve their skill in eliciting indigenous knowledge from farmers through the use of farmer's diagrams.

1. Explain the entire process to the farmers or ask them to help you (the technician) understand their systems -- an important reversal for those who are usually telling farmers what to do.

2. Farmers are asked to list the individual components which make up their farm, i.e., paddy, fishpond, carabao, etc.

3. Farmers discuss the concept of nutrient flows within the farm. Linkages between the different components should be emphasized. The technician or farmer-leader can facilitate the discussion with leading questions.

4. Farmers are shown a design of the nutrient flows of an actual farm and asked if they could produce a similar design for the conditions found on their farm. Many may answer negatively, stating that they cannot draw such a "professional" design ("I can't draw like that.").

5. The farmer-leader or technician should then begin drawing a design using newsprint and pens.

6. The farmers are then provided with sheets of newsprint and pens and are asked to attempt to diagram the components of their farm and the nutrient flows which integrate those components. Exhaust all enterprises for possible inputs and outputs. Include all plots and land types that farmers have access to, even community resources.

7. The farmer-leader or technician should then assist the farmers and guide them in

mapping out their individual farm design. All attempts at drawing should be validated -- anyone can draw to some extent.

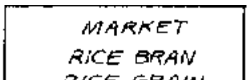
8. Upon completion, the farmers are asked to present their designs for peer review and discussion by their farmer colleagues.

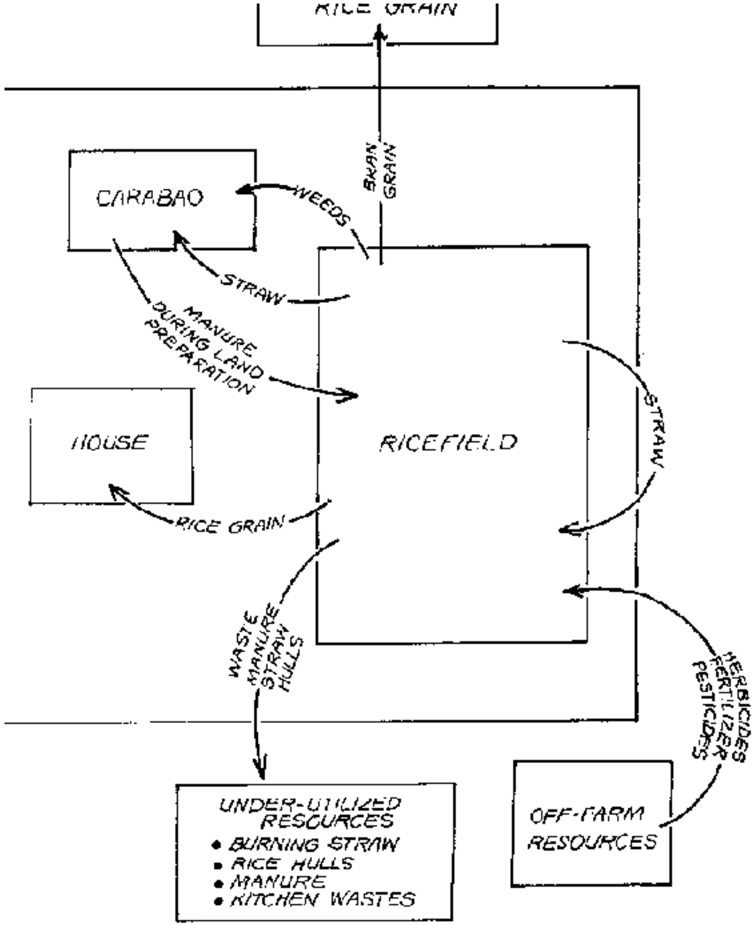
9. Finally, if desired, an artist can draw the design, based on the farmer-drawn diagram, to give the reproductions a "professional" touch.

This exercise provides a valuable methodology for farmer interaction. It is a learning process for farmers showing alternative uses of farm wastes and by-products being used by other farmers. The visual presentation reinforces what a farmer learns long after the exercise is completed. It is a learning process for technicians and field workers who learn about traditional knowledge. It helps to build a more equal relationship between farmers, extensionists and researchers. It helps to build self-reliance and confidence among farmers to make changes and adaptations of their farming systems, as well as validating farmer knowledge among farmers.

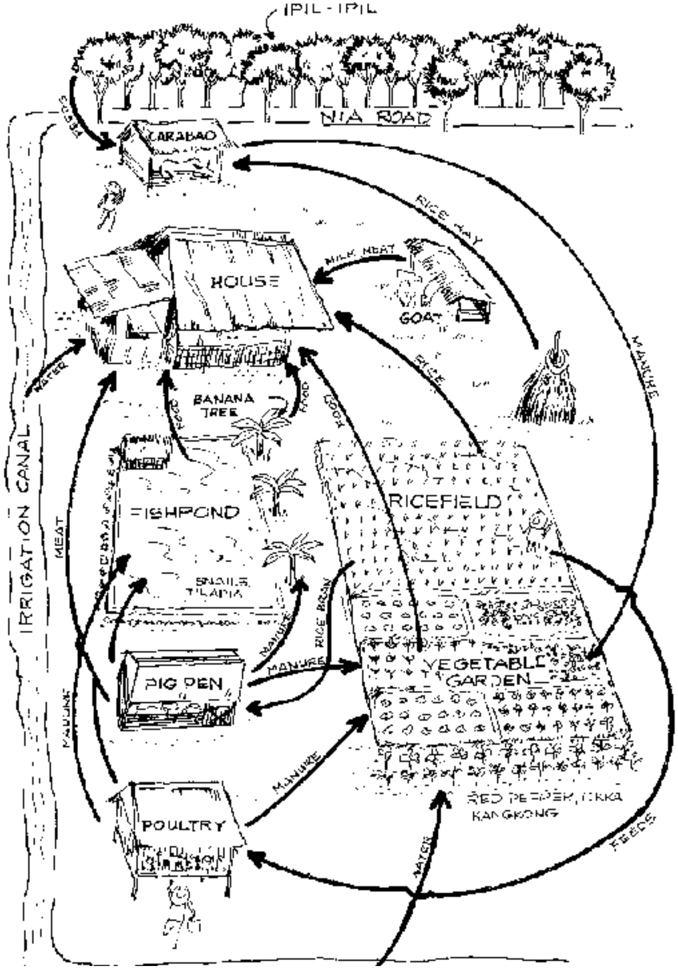
The following pages present artist reproductions of rice-based farming systems. The first design depicts a "typical" rice farm with little integration, under-utilized resources and costly offfarm resources. The other four are actual farmer designs of rice-based farming systems from the Philippines. All of these designs were developed using the exercise outlined above and have helped farmers to increase their own awareness of nutrient flows within their farm.

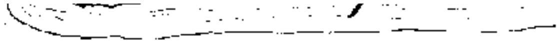
Nutrient cycling on a basic irrigated or rainfed rice farm



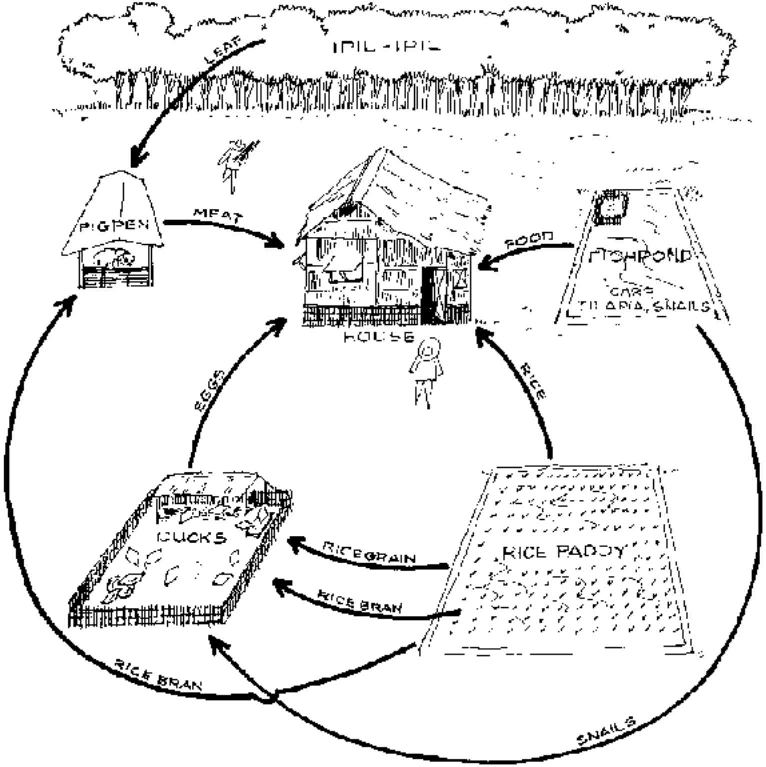


Nutrient cycling on a basic irrigated or rainfed rice farm

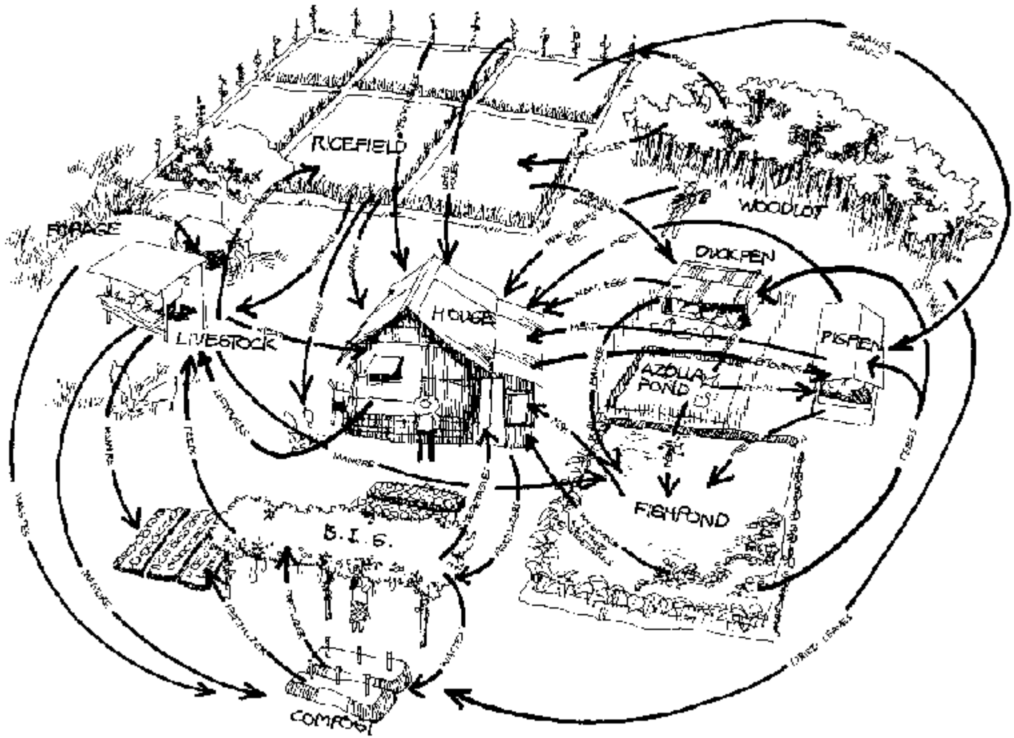

IPIL - IPIL
NIA ROAD
CARABAO
HOUSE
MILK MEAT
GOAT
RICE HAY
RICE
MANURE
WATER
BANANA TREE
FOOD
FISHPOND
SNAILS, TILAPIA
RICEFIELD
MEAT
MANURE
RICE BRAN
VEGETABLE GARDEN
PIG PEN
POULTRY
RED PEPPER, OKRA
KANGKONG
FEEDS



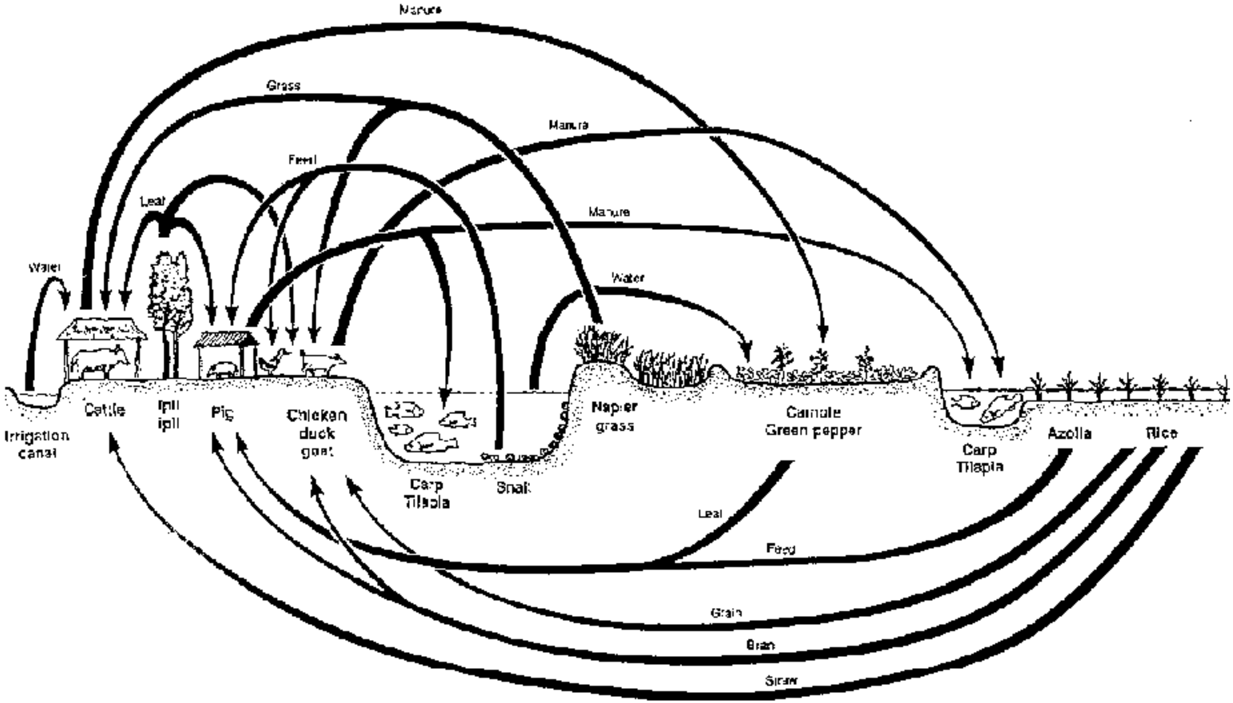
R. Primero, Novarro, Gen.Trias Cavite, Philippines



V Pakingan, Niuqan, Sn. Francisco Cavite, Philippines

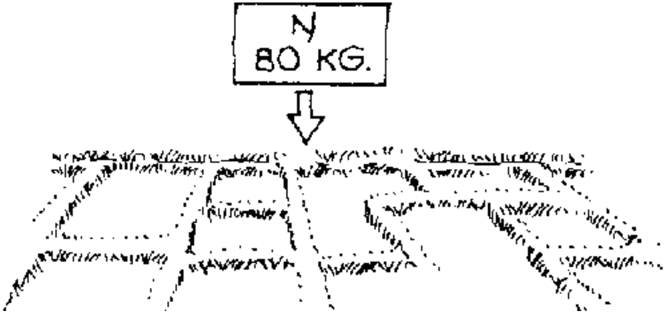


D. Martinez, Aglipay, Quirino Philippines

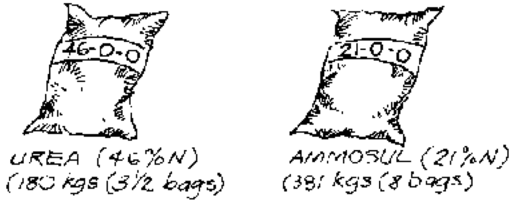


L. Ignacio, Sn. Francisco Cavite, Philippines

SOME POTENTIAL NITROGEN SOURCES FOR LOWLAND RICE THAT COULD SUPPLY 80 KG N/HA.



One hectare lowland



Chemical fertilizer

AZOLLA (40%N)
10-15 tons fresh biomass/ha

SESBANIA ROSTRATA (2.51%N)
should be grown and incorporated into the soil
* 40-day growth (60 kg seed/ha) = 80 kg N/ha.
* 60-day growth (15 kg seed/ha) = 95 kg N/ha.

GLIRICIDIA SEPIUM (2.9-4.3 %N)
8-10 tons/ha. (fresh

LEUCAENA LEUCOCEPHALA (4.8%N)
8-10 tons/ha (fresh)

Green manure

CARABAO MANURE (1.09 % N)
1339 Kg./ha
(dry manure from 2 carabaos/year)

SWINE MANURE (2.11 % N)
9791 kg./ha
(dry manure from 5 pigs/year)

CATTLE MANURE (2.41% N)
3319 kg./ha
(manure from 1 cow/year)

DRY BROILER MANURE (3.17% N)
2524 kg/ha
150-200 broilers/year

Animal manure

Using soil test values to determine fertilizer needs for rice

Soil test values are a good guide to determining plant nutrients to be added in the form of organic and inorganic fertilizers. Many nutrients when limited can be major factors in reducing crop yields -- even when they are needed in very small quantities.

Interpreting soil-test data

Soil Test Value	Fertilizer Need
1. Soil pH greater than 6.5	Zinc is needed.
2. Organic matter content:	
a. Less than 1.7%	Nitrogen need is high.
b. 1.7 - 3.4%	Nitrogen need is moderate.
c. More than 3.4%	Nitrogen is not needed.
d. More than 5.0%	Zinc is needed.
3. Available phosphorous (Olsen P in ppm):	

3. Available phosphorous (Olsen P in ppm):	
a. Less than 5.0	Phosphorous is needed.
b. 5.0 - 10.0	Phosphorous is probably needed.
c. More than 10.0	Phosphorous is not needed.
4. Exchangeable potassium	
a. More than 0.2 meq/100 g.	Potassium is not needed.

———————————————————————————————————

SOURCE: Ponnamperuma, 1984.

DEFICIENCY SYMPTOMS:

Observing deficiency symptoms in the standing crop itself is another useful method of determining plant nutrients which might be lacking.

1. Nitrogen Deficiency

· yellow to yellowish-green color, appearing first on older leaves
· stunted and spindly growth
· reduced tillering
· if deficiency persists until maturity, the number of grains per head is reduced.

2. Phosphorous Deficiency

· reduced tillering
· stunted growth
· decreased grain formation
· older leaves show orange or purplish discoloration.

3. Potassium Deficiency

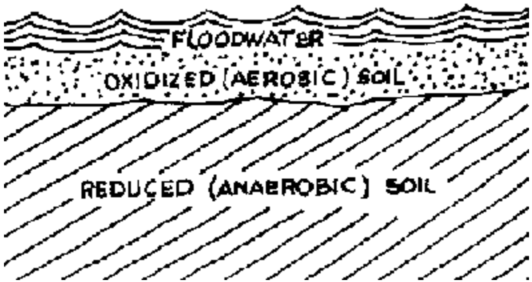
· low tillering and stunting
· in severe cases, includes a yellowish-orange to yellowish-brown discoloration starting at the tip of older leaf blades and gradually moving toward the base
· necrotic spots may appear on the leaf blades
· short, droopy and dark green leaves.

4. Zinc Deficiency

· brown spots appear on older leaves
· the spots enlarge and coalesce, giving the leaf a brown color
· low tillering and stunted growth
· the midribs of the younger leaves, especially the base, become chlorotic.

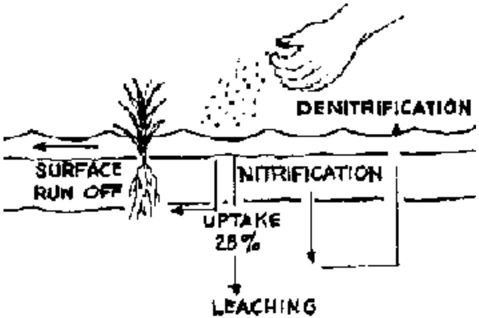
Fertilizer placement in wetland rice

Paddy soils are characterized by two distinct layers: 1) a surface oxidized layer a few millimeters to a centimeter present at the soil interface; and 2) an underlying reduced layer (anaerobic) which is the principal zone of root development. The fate of applied N and its efficient use depend on where it is placed.



Paddy soils

Broadcasting ammonium-based fertilizer in the oxidized layer is an inefficient method of fertilizer application. In this method, nitrogen is lost by a combination of nitrification-denitrification, ammonium volatilization, leaching and surface run-off. As a consequence, a maximum of only 28% of the total applied nitrogen is eventually taken up by the plant.

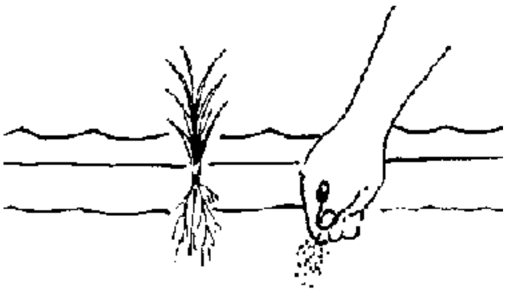


Broadcasting ammonium-based fertilizer

DECREASING N-FERTILIZER LOSSES IN PADDY SOILS:

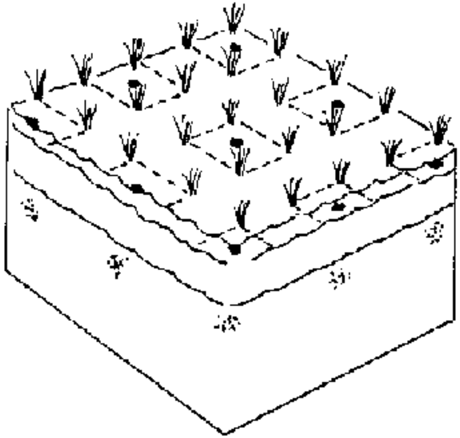
N-availability could be increased by applying fertilizer in soils without standing water or by deep placement into the reduced zone. The following are methods by which this could be accomplished:

1. Apply N in split. Broadcast the first split to a puddled field without standing water, thoroughly incorporating it into the soil and introducing water 4 days after transplanting. The final top-dressing of N should be made at 5-7 days before panicle initiation into floodwater not exceeding 5 cm. Thorough incorporation could also be done by using a rotary weeder.



Apply N in split

2. Another method is deep placement or applying fertilizers into the reduced zone. This method limits N losses and assures longer availability of nitrogen for the plant. A maximum of 68% of the total N applied can be obtained by the plant.



Applying fertilizers

Deep placement could be accomplished by manually placing fertilizer 10-15 cm deep from the soil surface and between alternate rows and hills after transplanting or just before or at panicle initiation. Prilled urea or a pinchful of urea may be used for this method. However, no data are available for urea. The mudball could also be used. This technique, developed by the Japanese, consists of covering a certain amount of urea with mud and then placing it 10-15 cm from the soil surface. Although the mudball technique is known to increase plant recovery of N. this has not been widely adapted because it is too labor-intensive.

A less laborious procedure is applying N fertilizer between rows right after transplanting or at panicle initiation and then incorporating it using a rotary weeder.

Using limited nitrogen fertilizer with HYVs

Even when using biofertilizers, farmers often use small amounts of chemical nitrogen (N) fertilizer to obtain increased yields. One of the simplest, lowest-cost ways to increase the effectiveness of these small amounts of fertilizers is by applying them at the right time and in the right manner. With good fertilizer management, yields can be increased by 0.50.8 ton/ha over poor management practices even when using small amounts (15-30 kg N/ha) of fertilizer.

Using limited nitrogen fertilizer

· Best split method.

The best method of fertilizer application for lowland rice is still the best Split where 2/3 of the nitrogen and all the phosphorous and potassium fertilizers are broadcast and incorporated thoroughly into the soil without standing water during final harrowing. The remaining 1/3 is top-dressed 5-7 days before panicle initiation (DBPI) of the crop. This should be practiced if the rate of application is 60 kg N/ha or more.

· Time of application if less than 60 kg N/ha is available.

Considering the limited availability of fertilizers due to high costs, the rates of application

may be as low as 13 kg N/ha. The table on the other page shows how to use limited N fertilizer with the commonly grown high-yielding rice varieties.

· Procedure when basal application of nitrogen fertilizer is missed.

Topdress one half of the total N requirement at 10-15 days after transplanting for early-maturing varieties (100-1 15 days) and 20-25 days for medium-maturing varieties (116-135). The remaining half should be applied 5-7 DBPI.

· Use of green manure in combination with chemical fertilizers.

Research has indicated that in addition to supplying the green manure N. using green manure can also increase the efficiency of chemical fertilizers used. When using minimal amounts of chemical N (30 kg/ha N or less) with a green manure, all chemical N should be applied 5-7 DBPI.

REFERENCE: Rice Production at Cost-Reduced Technology. Compiled by: Damaso Callo, Jr., Rizalino Dilag, Jr., Jesus Sumangil and Rustica Bautista.

FERTILIZER MANAGEMENT:

Amount of Nitrogen	**Method of Application**
If only 30 kg/ha N (or less) is available (1 1/2 bags 45-0-0 or 3 bags 21-0-0)	No basal application should be made. The entire amount should be applied into 5 cm of water at 5-7 days before panicle initiation(5-7 DBPI).*
If only 40 kg/ha N is	20 kg N/ha (1 bag 454-0 or 2 bags 21-04) should be applied to a puddled field

available(2 bags 45-0-0 or 4 bags 21-0-0)	with or without any standing water and thoroughly incorporated into the soil and water is introduced 4 days after transplanting (DAT). The remaining 20 kg N/ha is to be applied into 5 cm of water at 5-7 DBPI.
If only 50 kg/ha N is available (2 1/2 bags 45-0-0 or 4 bags 21-0-0)	30 kg/ha (1 1/2 bags 45-0-0 or 3 bags 21-0-0) should be applied to a puddled field without any standing water and thoroughly incorporated into the soil and water is introduced 4 DAT. The remaining 20 kg N/ha is to be applied into 5 cm of water at 5-7 DBPI.
If only 60 kg/ha N is available(3 bags 45-0-0 or 6 bags 21-0-0)	40 kg N/ha (2 bags 45-04 or 4 bags 21-0-0) should be applied to a puddled field without any standing water and thoroughly incorporated into the soil and water is introduced 4 DAT. The remaining 20 kg N/ha is to be applied into 5 cm of water 5-7 DBPI.

Note: Beyond 40 kg N/ha, always split the application of fertilizer.

Treatment for zinc deficiency in lowland rice

Many farmers in lowland areas mistakenly identify zinc deficiency symptoms (yellowing of rice plant during vegetative stage, stunted growth and reduced tillering) as tungro disease resulting in heavy usage of pesticides and serious damage to ecological systems.

Zinc deficiency generally only occurs in those ricelands where water is present year-round or where soil pH is above 7.0. Locations in the Philippines where zinc deficiency has been reported include Agusan del Norte and del Sur, the Bicol region, Cebu, Davao, Ifugao, Laguna, Leyte, Misamis Oriental, Negros, Quezon and Pangasinan. It causes a significant reduction in yield where it occurs and is easily and inexpensively remedied.

By familiarizing themselves with the symptoms of rice tungro virus and zinc deficiency, farmers can quickly determine if tungro-like symptoms appearing in their fields are due to zinc deficiency. This will help aid them in correcting the problem accordingly.

When tungro-like symptoms appear in the farmers' fields in the locations listed above, farmers can compare the symptoms of zinc deficiency and rice tungro virus to aid them in correcting the problem.

ZINC DEFICIENCY	TUNGRO
1. First symptoms appear 2-4 weeks after transplanting.	Symptoms occur at any stage of rice growth including seedling stage.
2. No presence of green leafhopper or zigzag leafhopper.	Presence of green leafhopper and zigzag Ieafhopper.
3. In each stage patches of affected plants are found throughout the ricefield.	In early stages, individual infected plants are scattered throughout the rice seedbed or field.
4. Rusty brown discoloration on the old leaves and chlorosis at the base of the younger leaves. Interveinal chlorosis or stripping at the base of the emerging leaf.	Leaf color changes from green to light yellow to orange-yellow to brown-yellow, starting from the tips of older leaves young leaves are often mottled or have pale green to white strips of dfflerent lengths running parallel to the veins.
5. When zinc deficiency is severe, NP fertilization significantly lower yields or even kills plants.	No negative response to NP fertilization.

Since zinc deficiency is caused by prolonged submergence, the problem can often be reduced by simply draining the field for several days. However, this is only effective in soils with pH below 7.

For succeeding crops, zinc deficiency should be treated directly by applying zinc to the soil or by dipping rice seedlings in a zinc oxide solution.

HOW TO TREAT ZINC DEFICIENCY:

Option No. 1

1. Evenly broadcast zinc sulfate at 3-5 kg/ha just before the final harrowing. The zinc sulfate can be mixed with other basally applied fertilizers (if being used).
2. Harrow/level the rice field and transplant rice seedlings the next day.

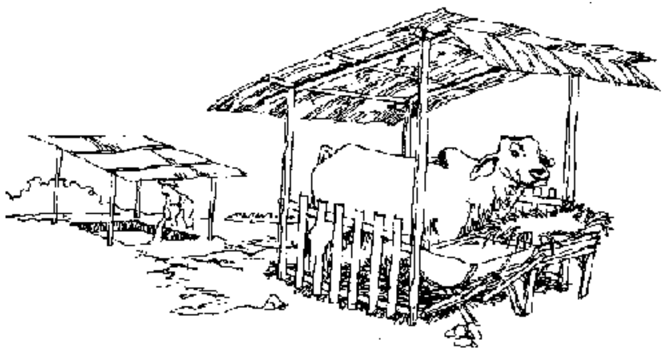
Option No. 2

1. If zinc sulfate is not available or if zinc oxide is cheaper, zinc oxide can be used. Mix 1 kg of zinc oxide with sufficient water to make a solution of large enough volume to soak the seedlings needed to plant 1 hectare.
2. Put the mixed solution in a container for dipping the seedlings, or if no available container is large enough, the seedlings can be soaked in the field by preparing a shallow dipping pond lined with plastic.
3. Soak the rice seedlings in the mixture for at least 3 hours (or overnight) before transplanting.

Note: For safety reasons, read the label before using zinc oxide.

Fertilizer from livestock and farm wastes

The usual method of handling livestock wastes results in the loss of most of the nutrients found in the urine. The use of bedding materials helps minimize the loss by absorbing the urine and capturing those nutrients. Moreover, these materials contain residual plant food, adding to the overall nutrient value of the compost.



Fertilizer from livestock and farm wastes

PROCEDURE:

1. Chop or shred the materials (dried rice straw/rice stubbles, grass clippings, uneaten green feeds, etc.) so that they are easier to spread and will decompose faster. Coffee hulls and saw dust can also be used.

2. Spread a six-inch layer of litter bedding over the floor space. Allow manure and urine to accumulate.

3. After 34 days, the bedding materials will have been fully soaked with urine. Mix them so as to incorporate the manure. Put the bedding in a pit or a pile fully covered to conserve the nutrients. The compost is ready for use in one and a half months or less.

4. Provide fresh bedding materials as in #2.

TECHNOLOGICAL PROFILE:

· Cattle with an average initial weight of about 150 kg can produce a total of 2.23 tons of fresh manure over a fattening period of 180 days.
· On the average, a cattle or carabao excretes fresh manure equivalent to about 7.5% of its body weight.
· By wise management, animal manure can return to the soil 70% of N. 75% of P and 80% of K.
· Excess nitrogen from the digested protein is excreted in the urine as urea in cattle and goats.

- Fifty percent of the value of the waste is contained in the urine.
- Urine contains 2/3 of the N and 4/5 of the K discharged by an animal.
- Elements in urine are more quickly available because they are in solution.
- Urine is also an especially good activator for converting crop residues to humus.

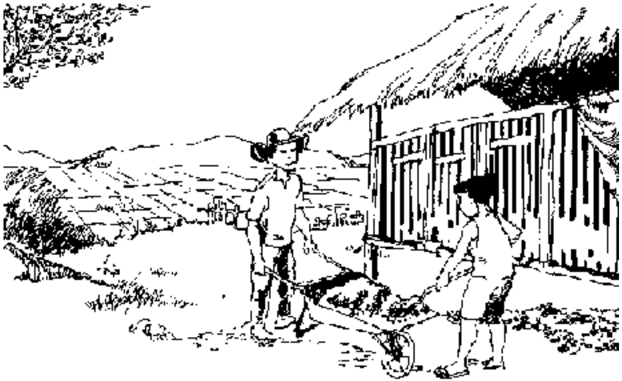
REFERENCES:

P.S. Faylon and M.R. Deriquito. Livestock Manure as Fertilizer: Waste Not, Want Not.

J.F. Rodale. The Complete Book of Compost.

Chicken manure for lowland rice

The prohibitive costs of inorganic fertilizers have led farmers to look into less expensive substitutes. Among those with good potential, chicken manure is preferred because it is readily available and has a higher nutrient composition. A fresh litter can contain as high as 3.17, 3.05, and 2.35 percent of N. P and K, respectively. In addition, chicken manure slowly builds up the organic maker of the soil and supplies trace amounts of some micronutrients (Cayton et. al, IRRI).



Chicken manure for lowland rice

Micronutrients	Contribution in kilogram per 100 kg. dry chicken manure
Mg Magnesium	1.08
Fe Iron	1.17
Zn Zinc	0.055
Mn Manganese	0.175
Ca Calcium	0.25
Cu Copper	0.010

1. Studies show that raising chickens year-round can assure the farmer a steady supply of fertilizer for his farm. One hundred (100) birds reared in 42 days (6 batches/yr) is expected to reduce requirement for urea by 27.4 %/ha/yr (2 croppings).

2. The birds are raised following the all-in-all-out method, with two weeks interval between batches to allow for thorough cleaning of the poultry house. This also prevents

possible pest outbreaks.

3. The birds fed with commercial feeds are known to produce 0.045 kg./bird/day with 3.17, 3.25, 2.35% of N. P. K, respectively.

4. Two batches with 100 birds per batch (3% mortality) could provide 366.66 kgs. chicken manure equivalent to 11.62 kg N, 11.92 kg P and 8.61 kg K.

Savings from substituting urea (45-0-0) with chicken manure from two batches of broiler chicken at 100 birds per batch.*

	First Cropping**
· Average kg urea (45-0-0) applied/ha	127.50
· Multiplied by N content of urea	x 0.45
· Computed kg N applied/ha	57.38
· Less kg N from chicken manure	11.62
· Kg N required from urea	45.76
· Divide by N content of urea	- 0.45
· Kg urea that still needs to be applied	101.69
· Total kg urea substituted by chicken manure	25.81
· Savings using chicken manure (total kg x price of urea P4.00)	103.24

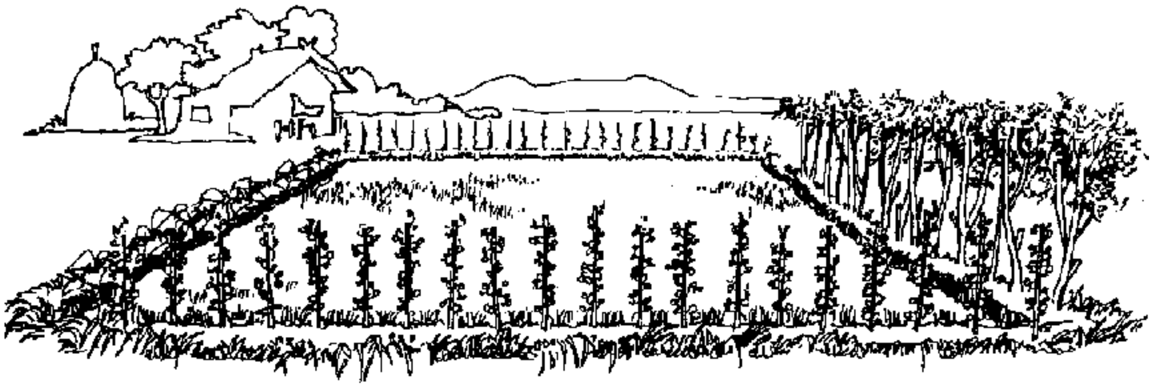
Note: To avoid possible negative effects on the rice crop, chicken manure should be incorporated in the field during land preparation.

*** Savings can be increased as the amount of chicken manure applied to the field is increased.**

**** All cost data were taken from the baseline survey on Navarro farmers conducted by the Research Division, IIRR (2 croppings) in Navarro, General Trias, Cavite.**

Food, fodder, fertilizer and fuel from paddy dikes

Throughout Asia, trees, shrubs and grasses have been grown on dikes to supply the needs of many families. Using paddy dikes or bunds to produce food, fodder, fertilizer and fuel saves both time and labor. Space is used that would otherwise be wasted.



Food, fodder, fertilizer and fuel from paddy dikes

· Time and Labor Saving. Instead of having to go long distances to get firewood or fodder for livestock, the farmer can harvest these right on the farm and eliminate problems of transporting them. Fertilizer also can be grown right where it is needed.
· Space Saving. Production on dikes and marginal areas allows more productive land for crop use. For tenant farmers, the produce from the dikes may be theirs without sharing with the landowners.

1. FOOD

· Bananas. Commonly planted along borders and canals, they provide food for humans, feed for pigs and cattle and windbreaks for crops growing in the paddies.
· Pigeon Pea or Kadios (Cajanus cajan). Pigeon pea can yield more than 1 kg of dry beans in 4 months for every 10 linear meters of dike planted (using no fertilizers or insecticides). This crop, when cut back and allowed to regrow, can provide 1 kg fodder (fresh weight/linear meter) plus a second crop of dry beans. It can be grown throughout the dry season to provide high protein fodder for livestock. (Data from trials in Cavite using highyielding varieties from ICRISAT in India.)
· Pole Sitao (Vigna unguiculata). Can produce as much as 1 kg green pods/linear meter.

2. FODDER

On days that draft animals are used for plowing, they oftentimes do not have enough grazing time to eat all they need. Night-feeding with grasses from dikes supplements this. In the dry season when grasses have died and rice straw is the main feed available for cattle and carabaos, leguminous trees grown on the dikes can provide high- protein fodder.

· Trees and Shrubs. The following species of shrubs and trees have exhibited excellent growth on paddy dikes: kskawati (Gliricidia septum), kadios (Cajanus cajan), Sesbania sesban, katurai (Sesbania grandiflora), kupang (Enterolobium cyclocarpum), acacia (Samanea saman) and Flamengia macrophyllum. Other species with good- fodder production which have been reported to do well include: acacia hapon (Acacia auriculiformis), Arundinaria ciliate, karikut-ritkut (Codariocalyx gyrans), Erythrina poeppigiana, ipil-ipil (Leucaena leucocephala), Sesbania bispinosa (Desmodium species) and pongam (Derris indica).

· Grasses. Fast-growing grasses planted on dikes have excellent potential for supplying

topquality fodder for livestock. Napier or elephant grass (Pennisetum purpureum) has shown yields of more than 3 kg dry matter production/10 linear meters every 30 days during the rainy season. Seven hundred and fifty (750) linear meters planted to grasses would be enough to meet the entire fodder needs of one draft animal.

3. FERTILIZER

Asian countries have a strong tradition of growing trees, particularly nitrogen-fixing trees on dikes or in waste areas to provide fertilizer to the rice crop. The nitrogen they provide can supply more than half the fertilizer requirements of one rice crop.

· Four-year old Gliricidia septum in India produced more than 18 kg leaves/shrub/year. Based on the nitrogen content in those leaves (1/2 kg N), 100 shrubs would produce more than 50 kg N/yr. which is equivalent to two sacks of urea. Recent trials with Derris indica on paddy dikes in Negros have also borne promising results.

· All the trees grown for fodder can supply fertilizer as well. In addition, other trees which tolerate poor drainage can be grown to provide green leaf manure.

· In an adaptation of the above practice,seeds of green manures (which will later be grown directly in the paddies) can be produced on the dikes.

4. FUEL

All the trees planted for fertilizer and fodder provide wood for fuel as well: the leaves provide the first two products, the stems and branches provide the fuel. In one farmlot in Cavite, 5 Samanea saman, 1 Pithecellobium dulce and 1 Tamarindus indicus harvested on a two-year cycle produced enough wood to meet the fuel needs of two households.

5. OTHER PRODUCTS

Trees and shrubs planted on dikes also provide fence posts. Neem (Azadirachta indica) and Pongam (Derris indica) may be used as botanical pesticides and Sesbania grandiflora has been used as a wood substrate for mushroom growing in Thailand.

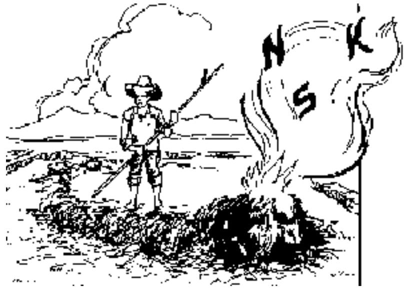
When planting on dikes, certain practices should be followed:

· Keep trees pruned when crops are growing in the paddies to minimize shading of the crop.
· Periodically check dikes for potential seepage caused by tree roots. Do not plant trees on fish pond or rice/fish paddy dikes.
· Practice good weed management around the trees to discourage rats from colonizing the dikes.

Using rice straw for lowland rice farming

The increased cost of energy-dependent fertilizer and the need to conserve plant nutrients by recycling them have focused attention to organic material sources of fertilizers. One of the cheapest and most available organic substances is rice straw.

In the tropics, the straw mass corresponding to 1 ton of sundried paddy rice is 1.5 tons which contains about 9 kg Nitrogen (N), 2 kg each of Phosporous (P) and Sulphur (S), 25 kg Potassium (K), 70 kg Silicon (Si), 6 kg Calcium (Ca) and 2 kg Magnesium (Mg) . (F. N. Ponnamperuma, IRRI, 1984). Because straw yields are usually not available, this is a rough guide to the nutrient content of the straw of a paddy crop. Rice straw is thus a good source of those macronutrients.



Burning straw

Burning straw, a usual practice in most farms in the Philippines, destroys most of the nitrogen and sulfur and some of the potassium and makes silicon less available.

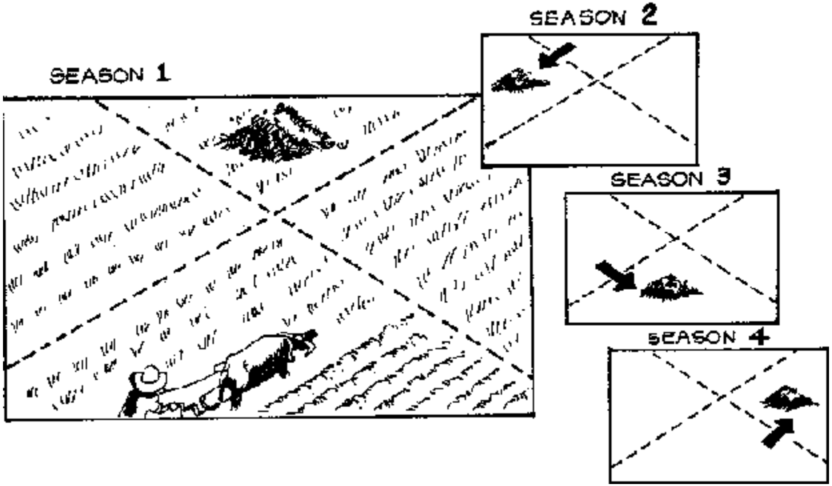
MAKE USE OF RICE STRAW

· To return the nutrients of straw to the soil, cut rice stalks higher during harvest time. More stubbles are then incorporated into the soil during land preparation.

· Threshed straw can be fed to animals or can be conserved for feeding livestock (mandala) during fodder shortage. Some of the straw nutrients are subsequently returned to the soil as animal excrete.

Cut rice stalks higher during harvest time

· Pile straw in mounds in successive quadrants in the field each cropping season to even out nutrient distribution. The straw will decompose slowly when incorporated into the soil during land preparation. The practice of piling and spreading straw saves labor but reduces the area planted to rice. Incorporating the straw produced in situ achieves fertilizer savings and aids nutrient recycling.



Pile straw in mounds in successive quadrants

· The effect of time of straw incorporation on grain yield depends on temperature, cultivar and amount of straw. In warm regions, one month after straw incorporation, all the rice straw produced in a field could be plowed in immediately before transplanting without adverse effects. The application of chemical N and P enhances the benefit of straw incorporation.

· The initial yellowing of leaves of the rice seedlings caused by the decomposition of straw can be checked by the addition of chemical N and P. Fertilizer N is used by the rice at the early stage of growth. The peak of N absorption from straw comes in the middle growth stage, coinciding with peak crop demands.

· The incorporation of straw reduces the incidence of tungro, rice blast and blight.

· The benefit of straw incorporation on rice yield appears during the season of application and increases with subsequent incorporations of straw.

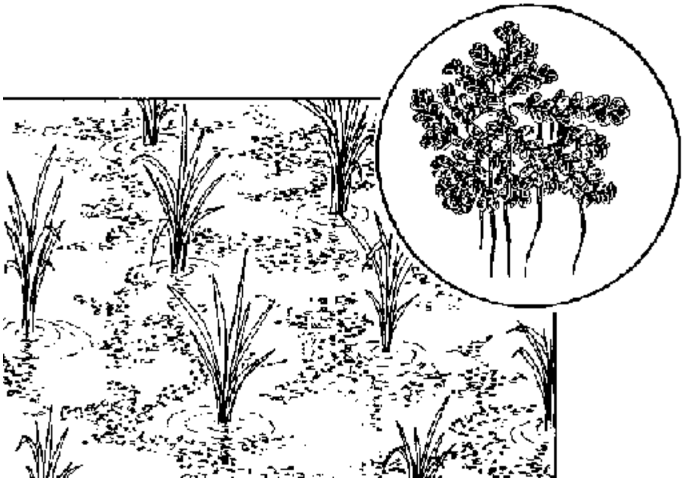
REFERENCES:

1. Principles and Practices of Rice Production, IRRI, Los Baos, Laguna.

2. Rice Production Manual, Philippines. UPLB. Rev. Edition, 1983.

3. F.N. Ponnamperuma. Straw as a Source of Nutrients for Wetland Rice. IRRI, Los Baos, Laguna. 1984.

Azolla: green manure profile



Azolla: green manure profile

CHARACTERISTICS:

· Azolla is a small aquatic fern (usually 1-5 cm large) which can also grow on saturated or moist soils. It is capable of doubling its weight in 3-5 days.

· A blue-green alga (Anabaena azollae) lives in the cavities of Azolla leaves and fixes nitrogen from the atmosphere. The daily nitrogen-fixing rate of the Azolla-algae complex is 3-7 kg N/ha.

Azolla contains 4% nitrogen on a dry-weight basis (dry weight is 5% of fresh weight); 0.5-0.9% phosphorous; and 24.5% potassium.

· Azolla is not really new. It has been used as a green manure for rice in Northern Vietnam and Southern China as early as the 11th century. Use of Azolla is an Asian, indigenous technology.

IMPORTANCE AS FERTILIZER:

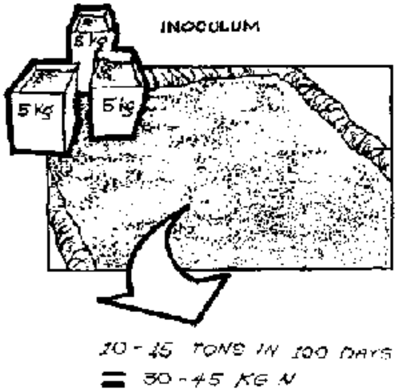
· Azolla is an excellent source of nitrogen fertilizer for rice which can cut down or even eliminate the use of chemicals. It can increase yield equivalent to that produced by 30-60 kg. nitrogen (N) fertilizer/ha. Residual soil N is increased. Protein content of the grain is also increased.

· Azolla increases available potassium (K) by absorbing water- soluble K from the irrigation water and returning it into the soil upon incorporation.

· The large amount of biomass produced (10-15 tons/ha/incorporation) increases soil organic matter (OM) content dramatically, improving soil physical structure and increasing phosphorous availability.

· The OM from Azolla also contains micronutrients.

HOW TO USE AZOLLA AS FERTILIZER:



Under optimum conditions, a 15 kg inoculum can multiply to become 10-15 tons

· Ideally, Azolla multiplication must be initiated 1 month before transplanting.

· Under optimum conditions, a 15 kg inoculum can multiply to become 10-15 tons of biomass in 100 days. (When incorporated, this should provide 3045 kg N/ha). About half of the total N is available in 3 weeks and 80% in 6 weeks.

· Incorporate the Azolla into the soil before transplanting. Subsequent incorporations can be timed with the regular weeding operations.

· At any time, only 75% of the Azolla is turned under. The remaining 25% is allowed to multiply again for the following incorporation.

REQUISITES FOR GOOD AZOLLA GROWTH:

· Azolla is a fern, thus water is the most critical requirement for its survival. The water situation in which Azolla can grow ranges from nearly saturated soils to deep standing waters.

· The soil should have at least 30 ppm phosphorous. If soil test indicates a lower level, apply 16-200 or 0-18-0 at kg/ha/wk.

· Optimum temperature is 25°C or less. Temperatures above 30°C can cause slow growth rate and insect problems.

· Conduct site suitability test to determine the Azolla species or strains most tolerant to local constrainsts.

OTHER BENEFITS FROM AZOLLA:

· An optimum Azolla cover between the rice plants reduces weed growth by 50% or more.
· Azolla can be a good compost material.

Using azolla as fertilizer for lowland rice

The agronomic importance of azolla arises from its capability to fix nitrogen through its symbiotic relationship with the blue-green algae, Anabaena azollae. The azolla-anabaena association can fix nitrogen proportional to the biomass produced. Chemical analysis showed that azolla contains 4-5% N. 1-1.5% and 2-3% K on a dry weight basis.

When azolla is grown in paddies and then incorporated into the soil as green manure, its nitrogen content is released upon decomposition and can be used by the crop. Azolla can replace at least 50% of the inorganic nitrogen requirement of rice.

There are three methods of producing and utilizing azolla on a one hectare lowland rice farm: the tatluhan, dalawahan and isahan methods. The choice of which method to use depends on the water supply, drainability of paddies, doubling time of azolla and cultural practices on the farm.

TATLUHAN METHOD:

If the ricefield has a steady supply of water, good drainage, enough phosphorous and the farmer adapts the transplanted, straight-row method, the best way of producing and utilizing azolla is the tatluhan method. The azolla is grown with the rice crop and incorporated into the soil three times -- during the first and second weedings and during land preparation for the next crop.

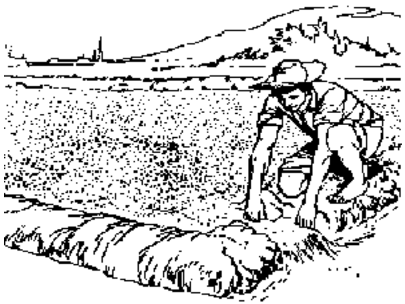
1. Make sure that the paddies are flooded and then plowed and harrowed once every 3 weeks before transplanting.

Tatluhan

2. Twenty days before transplanting of rice seedlings, gather the azolla from the inoculum pond and broadcast it evenly on the one hectare area. Leave at least 10 kg in the pond for future use.

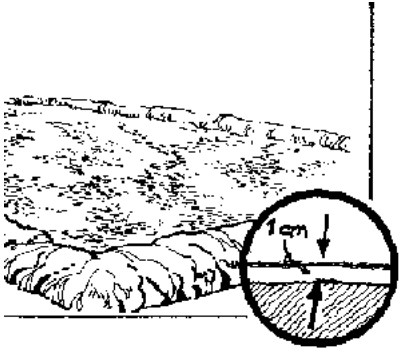
Gather the azolla

3. One day before transplanting (DBT), drain most of the water from the paddies and apply basal fertilizer. (Note: Half of the nitrogen requirement of the crop will be supplied from urea or other inorganic nitrogen fertilizer.)



Drain most of the water

4. Make sure the paddies are flooded about 1 cm deep to float some of the azolla and prevent all of them from being turned under during harrowing. The azolla will have increased to about 1,600 kg.



Make sure the paddies are flooded about 1 cm deep

5. Transplant the seedlings in straight rows.

Transplant the seedlings

6. Let the azolla grow. Twenty days after transplanting, incorporate the azolla in the soil with a rosary weeder. The incorporation should coincide with the first weeding. Allow the remaining azolla plants to grow and if necessary, re-seed the field with azolla from the

inoculum pond.

Let the azolla grow

7. Forty days after transplanting, drain the paddies and incorporate the azolla in the soil with a rotary weeder during the second weeding. Let the surviving azolla plants multiply further until harvest time. Turn them under during land preparation for the next cropping.

Forty days after transplanting

DALAWAHAN METHOD:

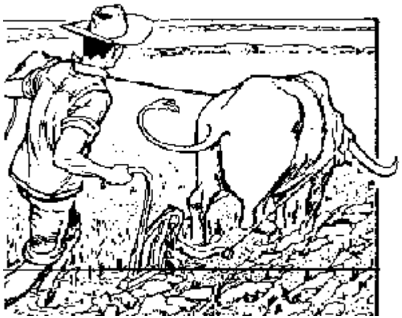
The dalawahan method is best used when only one weeding of the field is needed and/or when the growth of azolla is below normal because of insufficient phosphorous. The azolla is grown with rice and incorporated during weeding 20 days after transplanting and then again during land preparation for the next crop.

1. Follow steps 1-5 in the tatluhan method.

2. Allow the remaining azolla to multiply further and re-seed the field with azolla from the inoculum pond to increase biomass production.

Allow the remaining azolla to multiply

3. Incorporate azolla into the soil during the land preparation for the next cropping.



Incorporate azolla into the soil

ISAHAN METHOD:

In the isahan method, the azolla is grown with the rice crop but it is not incorporated during cropping. It is best used where doubling time of azolla is slow, where paddies cannot be drained, where water supply is inadequate or where direct seeding is practiced.

The biomass is incorporated only once -- during land preparation for the following crop. It is this next crop that will directly benefit from the azolla.

1. Prepare the land, apply basal fertilizer end transplant the seedlings.

2. Seven days after transplanting, gather azolla from the inoculum pond and broadcast it uniformly over the one hectare area. Leave at least 10 kg in the pond to multiply for future use.

Seven days after transplanting

3. If the doubling time of azolla is 7 days, after 56 days the 50 kg azolla will have increased to about 13 tons. Maintain the rice crop and control the weeds with rotary weeder or handweeding. Do not drain to prevent dehydration and death of azolla.

4. Allow the azolla to proliferate until harvest time or as long as there is moisture. Incorporate it during land preparation for the next cropping.

Allow the azolla to proliferate

Isahan Method for direct seeded rice

1. Prepare the land according to the approved cultural practices in lowland rice culture.
2. Drain most of the water, leaving at least 1 cm deep to facilitate levelling of the soil.
3. Apply basal fertilizer and broadcast the rice seeds uniformly.
4. Two weeks after germination, broadcast azolla evenly into the field. Leave at least 10 kg in the pond for future use.
5. Allow azolla to proliferate until harvest time and incorporate it during the land preparation for the next cropping.

Table 1. Environmental Factors Affecting Growth of Azolla (Summary).

FACTORS	RANGE
Temperature	20°C - 25°C
Light	50% full sunlight
Relative Humidity	85 - 90%
Water	5 - 12 cm

pH	4-7
Salinity	90 -1 50 mg/li

Table 2. Guide in Using the Isahan, Dalawahan or Tatluhan Methods.

CONDITION IN FIELD			METHOD		
Water Supply	Drainage	Azolla DT	1st Choice	2nd Choice	3rd Choice
Good	Good	Fast[1]	Tatluhan	Dalawahan	Isahan
Good	Good	Moderate[2]	Dalawahan	Isahan	-
		to Slow[3]			
Good	Poor	Fast to Slow	Isahan	-	-
Poor	Good or	Fast to Slow	Isahan	-	-
	Poor				

[1] Fast -- 4 to 6 days

[2] Moderate -- 7 to 9 days

[3] Slow -- more than 9 days

SOURCE: National Azolla Action Program, UPLB, Los Baos, Laguna, Philippines.

Multiplying the azolla

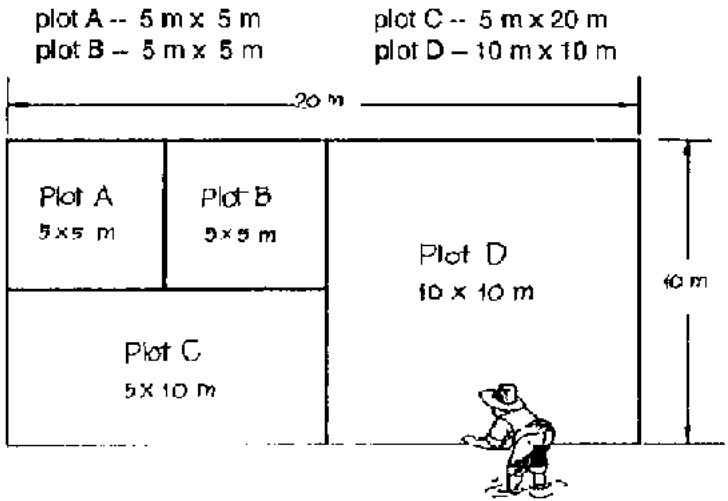
Azolla grows best under conditions of 50% full sunlight and slowly flowing water. Therefore, the multiplication pond should be located near the water source (but in a paddy which is protected from potential flooding) where partial shade can be provided. The pond should be protected from wind to minimize the piling up of Azolla.

FIRST WEEK:

1. Construct a 200 sq.m (10m x 20m) pond. The dike surrounding the pond should be at least 15cm high end screens placed in the wafer inlet and outlet. The screens will prevent both the entry of snails which eat Azolla and the escape of Azolla with the exiting water. Plow the land and harrow it twice.

Any pond size can be used depending upon the amount of Azolla needed. A 200 m pond will produce enough Azolla for 1 hectare of rice paddy when the Isahan method of Azolla utilization will be used.

2. Divide the pond into four plots with the following dimensions:



Divide the pond into four plots

The pond is subdivided to reduce the amount of water and fertilizer needed in the first week of multiplication, as well as the time needed to manage the pond.

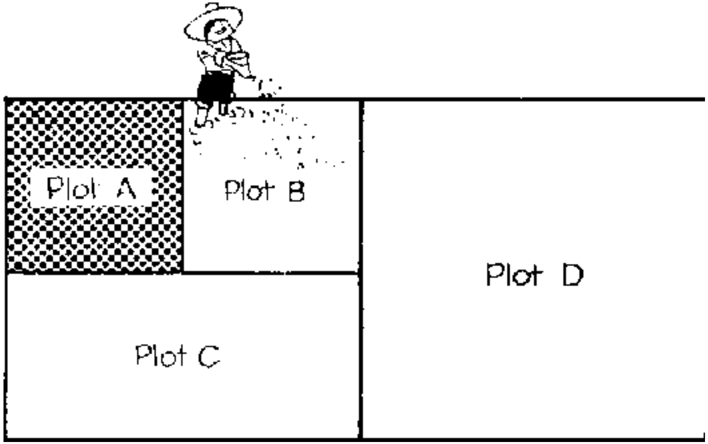
3. Flood plot A with 5-7 cm of water. This is about midway between the second and third lines of the middle finger.

4. Broadcast 40 g (or 3 level tbsp) phosphorous* fertilizer on the standing wafer of plot A. Then broadcast 5 kg (or 1 kerosene can, 20 liter) Azolla evenly on the water. The Azolla should be weed, disease- and insect-free and should be of the type that is adapted to local conditions. (Please see the separate sheet on selecting Azolla varieties.)

5. For insect control, use only those insecticides recommended for Azolla and only if necessary. Based on IIRR's experience, once a variety which has been selected locally is well-established, it tolerates higher levels of pest populations and usually does not require insecticides. Occasionally, in the early stage of multiplication, insecticides may be needed. If insect pests remain a problem, another variety or species should be selected.

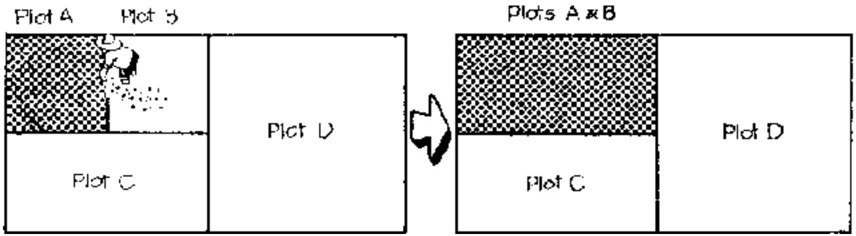
SECOND WEEK:

6. At this time, the surface of plot A will be fully covered with Azolla. Broadcast the phosphorous Fertilizer (40g) on plot B.



Second week

7. Remove the dike separating plots A and B to allow the Azolla to spread evenly on the two plots. After one week, plots A and B will be fully covered with Azolla.

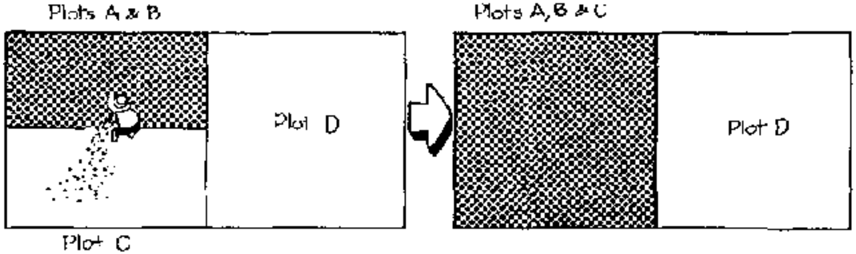


Remove the dike separating plots

THIRD WEEK:

8. Broadcast the phosphorous (150g or 3-4 handsful) on plots A, B and C.

9. Remove the dike separating plot C from plots A and B to allow the Azolla to spread evenly on plots A, B and C combined. After 1 week, plots A, B and C will be fully covered. (Illustration next page.)



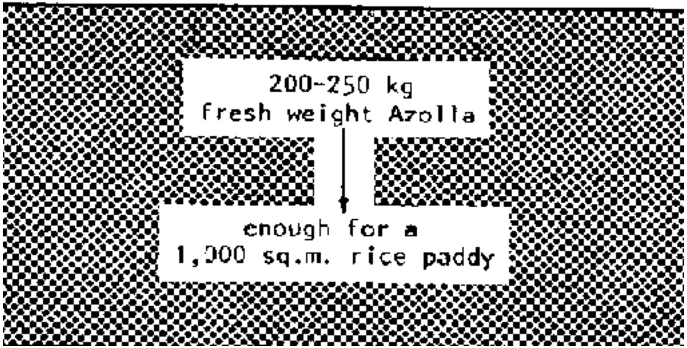
Third week

FOURTH WEEK:

10. Broadcast the phosphorous (150 g) on plot D.

11. Remove the dike separating plot D from plots A, B and C to allow the even spread of the Azolla. After one week, plots A, B. C and D will be covered fully with Azolla weighing approximately 200250 kg (fresh weight).

Plots A, B, C & D (200 m²)



Fourth week

FIFTH WEEK ONWARDS:

12. Apply 5 kg (or 1 liter) superphosphate or 16-20-0 once a week for 1 hectare of land (or 500 9/1,000 sq.m).

13. Remove one-half of the Azolla biomass each week and tap the remaining Azolla with a broom to stimulate vegetative growth.

14. If the Azolla is to be used for rice, introduce (inoculate) it to the paddies after the first plowing (land preparation) when the land is still rough and maintain a low water level to keep them from piling up.

Note: This material was adapted from a publication of the National Azolla Action Program (NAAP) in Los Baos. Modifications relate to some technical content and the presentation format.

Troubleshooting common problems in azolla production

1. Slow growth

Slow growth of Azolla is usually due to phosphorous deficiency, insect/snail damage, high temperature, intense sunlight or herbicide use.

a. Phosphorous deficiency

· Concentrate the Azolla into one or two paddies for better management.
· Apply 5 kg/ha monoammonium phosphate (16-20-0) or superphosphate (0-18-0) weekly. Mudpress or other locally available substitutes can be used.

Slow growth

b. Insect/snail damage -- Symptoms are the presence of snails, caterpillars, or moths. Other symptoms include a purplish or brownish color (caused by Azolla snout beetle); silken threads (Azolla moth); or segregated rootless plants (snails).

· Use varieties that are relatively resistant to prevailing major pests. Conduct tests for your location.
· Use insect/snail-free inoculum. (One way to clean Azolla of insect pests which the Chinese and Vietnamese use is to pile the Azolla seed material into a heap and plaster it

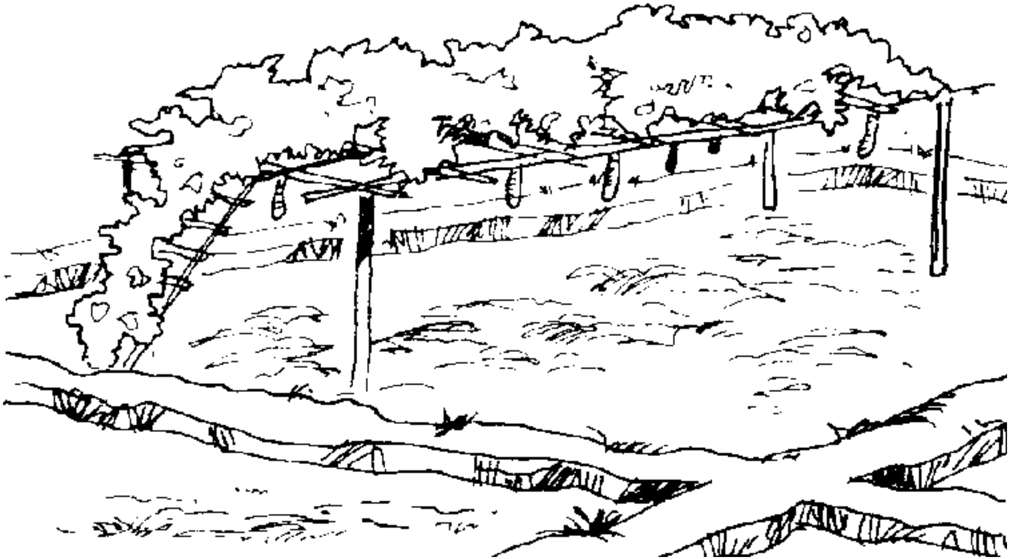
with mud. This treatment will suffocate the insects. After 2-3 days, the Azolla can be used in the seedbed or in the field.)
· Do not allow the Azolla to overlayer as this increases the chances of insect infestation and damage.
· Use appropriate insecticide if there are plenty of caterpillars, but only if it is absolutely necessary.

c. High temperature/intense sunlight -- A brick red color of the Azolla indicates high light intensity. Too much heat will cause the Azolla to turn brown/reddish pink. The loss of the plant's green pigment (chlorophyll) will retard photosynthesis, consequently causing slow growth and multiplication.

· Select a heat-tolerant variety.

· A slight flow of water through the pond is essential in summer.
· Partially shade the Azolla by growing Sesbania or gabi in the multiplication pond. Growing a trellised crop over the pond will also help.
· Allow the Azolla to grow on saturated mud which is cooler than the water

Allow the Azolla to grow on saturated mud



Partially shade the Azolla

d. Herbicide contamination of water -- Symptoms are slow or no growth Azolla is extremely sensitive to herbicides Drainage water from neighboring farms where herbicide have been used can stunt or kill the Azolla

2. Piling up of Azolla at one end of the paddy/smothering of rice plants

- **Introduce Azolla into the paddies 2-3 weeks after transplanting**
- **Begin initial Azolla multiplication in paddies that are relatively protected from the wind.**
- **Maintain only a minimal water level to allow the Azolla to partially anchor itself to the**

soil.

· Using small-leafed species such as A microphylla and A. caroliniana also helps prevent smothering (esp when dapog seedlings are used)

3 "Escape" of Azolla during flooding

· Double screen "gates" placed at the water outlets coupled with good dike maintenance The circular screen increases surface area for water to pass through, at the same time prevents clogging of the outlet pipes.

Double screen

4. Weeds in Azolla

· Allow the Azolla to grow thick as this can cover and shade out small grasses and sedges. (Caution: Extreme crowding of Azolla is conducive to insect infestation.) Uproot broadleaf weeds. Never use herbicides because Azolla is sensitive to them.

5. Oxygen deficiency in the roots of rice plants

· If Azolla (in dual culture with rice) becomes too thick, the Azolla mat cuts off the oxygen supply from the atmosphere, thereby suffocating the rice roots. Incorporate the Azolla as needed, or use for other purposes, e.g. Animal Feeds, compost, etc.

CREDITS: AZOLLA PRIMER by Manzoor Khan.

Green leaf manuring in lowland rice

INTRODUCTION:

Green leaf manuring (using the leaves of leguminous trees for lowland rice) has been used in South Asia for centuries with yield increases of up to 2 T/ha compared to unfertilized rice fields. Recent work with farmers in Negros and Cavite has shown that green leaf manuring works in the Philippines as well.

Advantages of using green leaf manures (GLM) include:

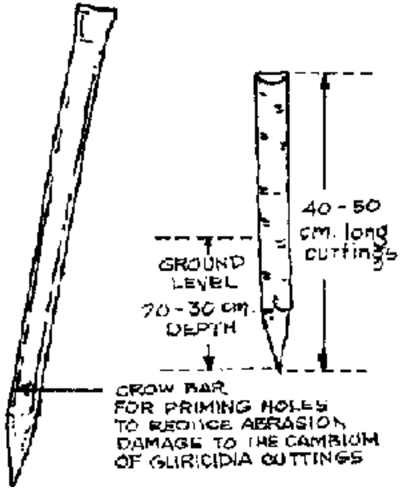
· Up to 4 tons dry leaf matter (equivalent to 120 kg N) can be produced from 400 trees spaced 2 m apart on the bund.
· No need to replant green manure crops. The trees are perennial and provide leaves for GLM 2-3 times/year.
· Woody branches can be used for firewood.
· Easy to use. No complicated cultural practices for production or use are needed.

GLM trees can be integrated into almost any rice farm. Three options are described here based on planting systems used in Negros and Cavite with Gliricidia septum (kakawate or madre de cacao).

Option No. 1 -- Gliricidia is planted along the paddy bunds. Spacing is 50 cm-2 m between plants.

Option No. 2 -- Gliricidia is planted around field boundaries. Distance is 2 m between plants. Dikes should be 50-75 cm wide and 40-50 cm high.

Option No. 3 -- Cut-and-carry system: Gliricidia is planted in areas away from the field. The major disadvantage of this system is the transport of biomass from the growing area to the field.



Green leaf manures

HOW TO USE GREEN LEAF MANURE:

The practice of GLM is very simple. Any fast-growing leguminous tree species which tolerates poor drainage can be used. The leaves are lopped regularly (every 6 mos) and applied to the rice paddies during final land preparation as green leaf fertilizer. In order to

reduce the labor requirements, the trees should be established at or near the rice production site.

1. One day before transplanting, cut branches of Gliricidia (with leaves). Chop the tender stems. The woody ones can be used as firewood.

2. Scatter the leaves evenly throughout the field. There should be no standing wafer in the paddy in order to fully incorporate the leaves.

3. Incorporate the leaves into the soil during the last harrowing/leveling of the field.

4. Transplant rice seedlings immediately after incorporation.

NOTES ON THE USE OF GLIRICIDIA:

· Two loppings are recommended per year. If there will be no second crop to put the GLM on, the second cutting should be done 1-2 mos before the onset of the dry season. This stimulates new growth which can survive a 6-month dry season without dropping its leaves. The loppings could be used as fodder.

· Gliricidia may have pesticidal properties against major pests of rice.

· Gliricidia can serve as living stakes for climbing plants like pole beans. It is also an excellent source of firewood, building materials for livestock pens and fence materials.

Two methods of establishing trees for GLM are used: seeds and cuttings. Recent work at IIRR has shown that the method of planting cuttings greatly affects the establishment and growth rates of trees. The recommended method of planting cuttings of Gliricidia is described below:

OTHER SPECIES RECOMMENDED FOR GLM FOR RICE

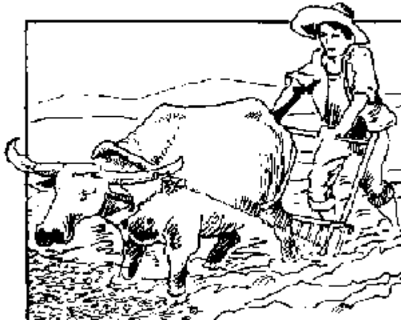
Species	**Local Names**	**Quantity of Leave Recommended/ha.**
1. Leucaena leucocephala	Ipil-ipil	1,000-8,000 kg/ha(freshly cut)
2. Samanea saman	Acacia	- do -
3. Acacia auriculiformis	Japanese Acacia	
4. Pithecellobium dulce	Kamachile or Kamunsil	- do -
5. Derris indica* Pongamia indica	Bani or Balok-balok or ponggam	- do -

*** Please note that this is not Derris elliptica or Tubli. Gliricidia septum (kskawate) has the same quantity of leaves recommended/ha as the GLM species given above.**

Green manure utilization in lowland rice

With the range of green manures and short-duration grain legumes available today, it is possible to grow or substitute at least one-half of the chemical nitrogen used by farmers in their rice crops. In irrigated rice-growing areas, nearly all the crop nutrient requirements could be met by big-fertilizers with good planning and management.

Even for farms wherein sufficient chemical nitrogen fertilizer is affordable, green manure (GMs), green leaf manures (GLMs) and grain legumes (GLs) provide the following benefits that chemical fertilizers cannot:



Green manure utilization in lowland rice

· GMs and GLs improve the rice crop's performance in drought as compared to the unmanured crop.

· They have a long-term cumulative effect on soil fertility in addition to the short-term effect. The long-term effect occurs in small increments but does result in noticeable yield increases by the third or fourth year of green manuring.

· Part of their production can be used to provide food for humans or feed for livestock.

· Weed reproduction is reduced by planting an otherwise fallow area.

· In soils low in phosphorous (P), rice yields are higher when P fertilizer is applied to the GM and GL than if the same amount of P fertilizer is applied directly to the rice crop.

In order to produce his own fertilizer at minimal labor and capital cost, the farmer needs to know what GMs and GLs are available, their characteristics and how they might best be used on his farm. He needs to be able to identify those times of the year when GMs and GLs could be grown.

CHARACTERISTICS DESIRABLE IN LEGUME GREEN MANURE CROPS:

· Multipurpose
· Short duration, fast-growing, high-nutrient accumulation ability
· Tolerance for shade, flood, drought and adverse temperatures
· Wide ecological adaptability
· Efficiency in use of water
· Early onset of biological nitrogen fixation
· High N accumulation rates
· Timely release of nutrients
· Photoperiod insensitivity
· High seed production
· High seed viability
· Ease in incorporation
· Ability to cross-inoculate or responsive to inoculation
· Pest and disease resistant
· High N sink in underground plant parts

Information needed includes the approximate dates of the beginning and ending of the rainy season, maturity times. For all crops being considered products desired by the farmers, e.g., fodder, grain or sale or consumption, fertilizer, etc. Additionally, water availability from irrigation, if any, and soil drainage pattern should be known.

In lowland rice, water availability and soil drainage play major roles in determining the types of green manures to use. A GM planted at the beginning of the dry season, for example, needs to be able to withstand drought. Planted before or with rice, it will need to be flood-tolerant. Soils that drain well can be planted to desirable crops which are susceptible to flooding or waterlogging. What is important is to fit the crop to the agro-ecology of the farm.

A large number of legumes have been tested for their potential as green manures in rice. Some grow well in waterlogged conditions; some do well in very dry conditions; and a few, in both. Many serve dual purposes: by producing food as well as fodder and/or green manure.

Ecology	GM Species
Flooded soil	Aeschynomene afraspera, A. americana Phaseolus semierectus and all Sesbania sp.
· Sown in standing rice before harvest to be grown throughout dry season (Drought-tolerant)	Intercropped with grain legume
	Dolichos lablab
	Indigofera sp.
	Cnavalia ensiformis
	Crotalaria quinquefolia
	Mucuna pruriens
	Stylosanthus guayanensis
	Pueraria species
	Monocropped
	Crotalaria juncea
Saline soil	Sesbania serecea and S. aculeata
Low temperature	Astragalus sinicus

(Modified from Vacchani and Murty, 1964)

Lowland rice-based cropping systems can be classified into any number of types (according to cropping patterns and water availability) but in the Philippines, the four general ones are:

- **Fully irrigated: 2-3 rice crops**
- **Partially irrigated or rainfed with standing water throughout crop cycle: 2 crops**
- **Rainfed: 2 rice crops**
- **Rainfed: 1 rice crop**

Systems vary from country to country but in any location, determining what GM to use and when to use it would greatly depend on the cropping pattern and more importantly on water availability (which would include water source, the amount and length of time water is available and the degree of regularity of the water supply).

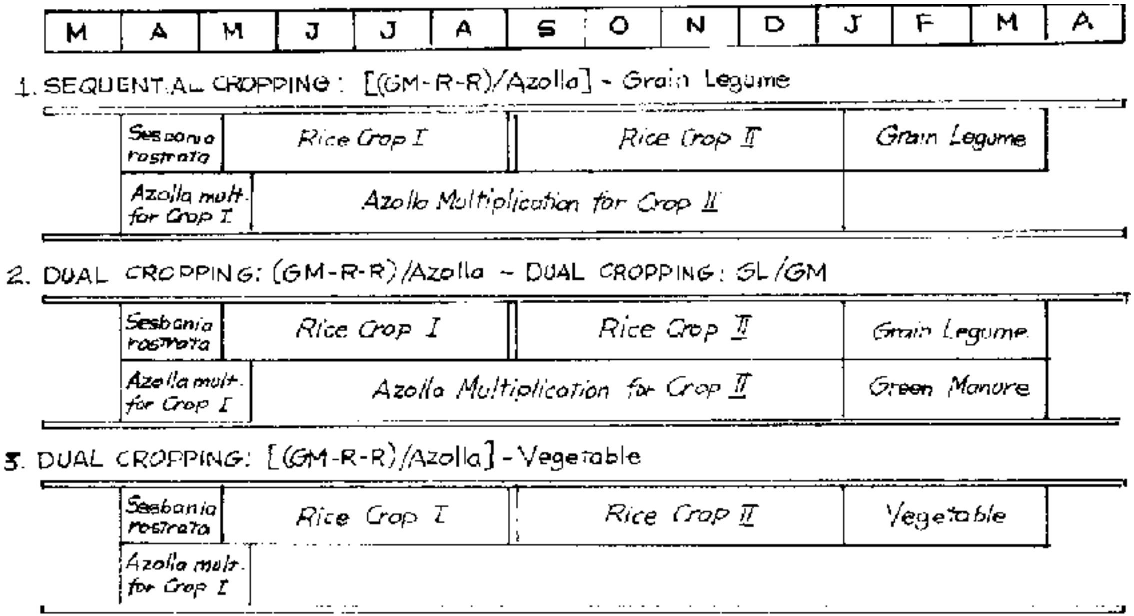
It should be noted that, as the amount of water and the length of time it is available increases, farmers have more options regarding what GMs to use; total biomass and N production will be higher; thus, yields will likely be higher (or the amount of fertilizer N substituted by GM will be higher).

Described below are some options for multiple, relay and intercroppings under different regimes. They illustrate the possibilities for intensifying production of food, fodder and fertilizer by using grain legume and green manures.

FULLY IRRIGATED:

Options 1 and 2 are the most flexible. Sesbania rostrata or another waterlog-tolerant GM can be grown before rice to supply the basal N to crop 1. Azolla is multiplied during S. rostrata's growth for incorporation with rotary weeder at 20-25 days after transplanting

(DAT). Nitrogen becomes available by panicle initiation. Azolla is also incorporated three more times for the second crop: at post-harvest incorporation of crop l's stubble, 1 day before transplanting (DBT) of crop 11 and 25 DAT crop 11 (using the rotary weeder). GL is intercropped with GM in the dry season. The 3-day option is the same as 1 and 2 but a vegetable or other cash crop is grown during the dry season.

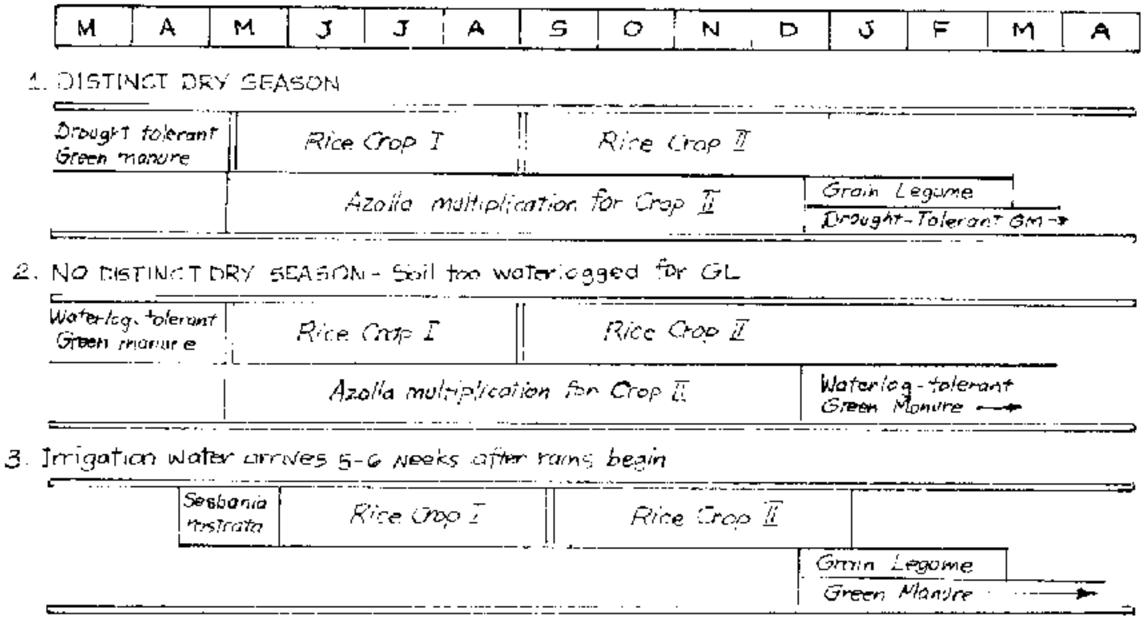


Fully irrigated

PARTIALLY IRRIGATED (OR RAINFED WITH STANDING WATER):

Azolla can be grown throughout the rainy season but should be regarded as the N source

for the second cropping season only. In this system, Azolla is multiplied during the first cropping season (and provide some weed control) and incorporated during post-harvest plowing. Enough Azolla is left to serve as inoculum for the second incorporation 20-30 DAT of crop 11, which coincides with the rice weeding operation. Azolla supplies about 60-70 kg N/ha to the second crop.



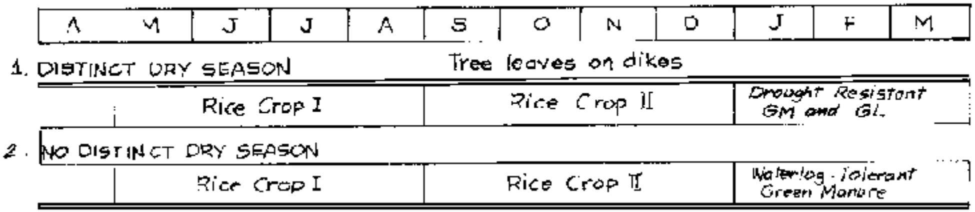
Partially irrigated

The N source for the first crop can come from the GLs intercropped with drought-resistant green manures relay-planted into the second rice crop from the previous year to grow on

residual moisture (1). Where there is no distinct dry season, a waterlog-tolerant GM like S. rostrata could be grown (2). In areas where there is a long lag time between the first rain and the arrival of irrigation water, S. rostrata can be planted. Some small amounts of chemical N and P for the Azolla may have to be applied.

RAINFED -- TWO RICE CROPS:

Options are fewer here. Azolla is not feasible and usually a pre-rice GM is not either. In areas with a distinct dry season, a combination of drought-resistant GM and grain legume can be relayed into the second crop. Rice straw mulch will help conserve moisture. In areas with no distinct dry season, a waterlog-tolerant GM can be used. Trees can be planted on paddy dikes or in waste spaces to provide green leaf manure to supplement chemical fertilizers in both crops.



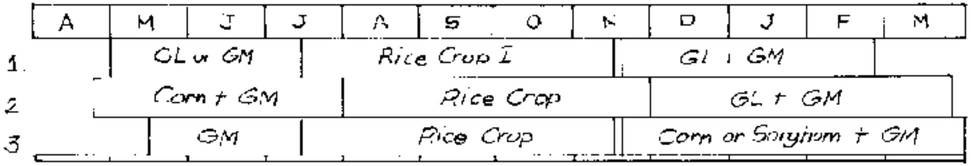
Rainfed - two rice crops

RAINFED -- ONE RICE CROP:

Depending upon the topography and soil texture (if a field is well-drained), GLMs or vegetable legumes plus a GM are possible both before and after the rice crop. If an upland grain crop such as corn or sorghum is grown before or after rice, a GM can be intercropped.

GLMs provide an additional fertilizer source for use when in-situ green manure production is inadequate for the rice crop's needs.

For all but the most fibrous GMs, rice should be transplanted as soon as possible after incorporation to minimize loss of GM-nitrogen. Transplanting one day after incorporation is ideal.



Rainfed - one rice crop

Sesbania aculeata: a bio-fertilizer source for lowland rice

CHARACTERISTICS:

· S. aculeata (Willd.) Poir is referred in some literature as S. bispinosa (Jacq.) W. F. Wright and S. cannabina (Petz.) Poir. Its common name is dhaincha or daincha.

· S. aculeata is a leguminous, shrubby annual with thick, hairy stems and large (35 cm) feather-like leaves.

· Its flowers are yellow. It seeds easily and is self-pollinated.

· Although it can accumulate a lot of biomass and nitrogen (N), it has not received much attention as a green manure crop.

ADAPTABILITY:

· It is suitable for wet, waterlogged areas and heavy soils. It is well adapted to saline soils and has been successfully used to rehabilitate salt-infected soils.

· Although adapted to dry, arid conditions, its growth and biomass production are less than S. rostrata.

· Requires 600-650 mm rainfall.

· It can withstand temporary waterlogging. However, its nodulation and N2 fixation may be impaired.

· It is useful as a short-duration pre-rice green manure.

ADVANTAGES AS BID-FERTILIZER:

· Leaflets degrade rapidly in most soils. About 50% of accumulated N is released within 4 weeks after incorporation.

· After 75 days of growth, it can provide 20-26 T/ha fresh biomass with an N concentration of 0.43%.

· Before blooming, the average composition is 28% organic matter, 0.47% N. 0.05% P and 0.35% K.

· 21.1 tons of fresh biomass is equivalent to the addition of 133 kg N/ha. Incorporating biomass resulted in a 207% increase in rice grain yield as compared to no application. Furthermore, under continuous green manuring using S. aculeata, soil N increased from 0.079% to 0.141%.

HOW TO USE S. ACULEATA AS BID-FERTILIZER:

· N content reaches a peak and starts to decline 45-50 days after planting. Incorporation at this period is recommended.

· When the field is submerged with enough water for land preparation, incorporation is better ensured by using an animal-drawn slicer.

The first pass of the slicer flattens the S. aculeata and slices off its branches. A second pass at a right angle to the first further slices branches into smaller portions and drives it down to the mud. Subsequent operations follow without significant additional effort.

SOME DISADVANTAGES IN USING S. ACULEATA:

1. Difficulty in collecting seeds: Dhaincha is small-seeded and pods easily shatter.
2. Stems are hard and difficult to plow.

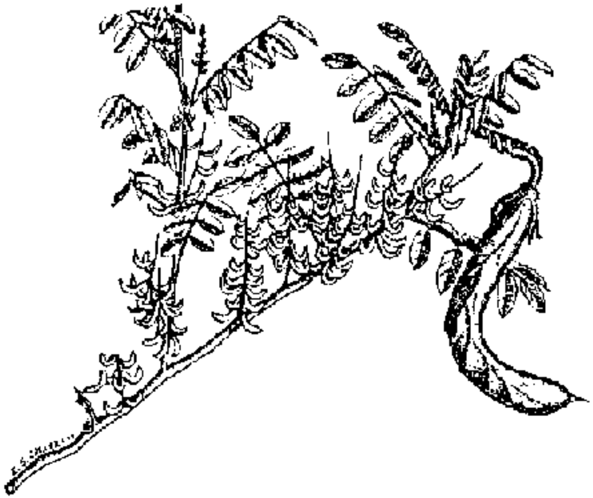
OTHER USES:

Leaves of S. aculeata may be utilized as fodder and stems may be used as poles and as a source of fiber.

Indigofera: green manure profile

Indigofera tinctoria, commonly called Indigo, Tayum, Tagum or Tayung, is a shrubby herbaceous plant, 1-2 m tall with erect and copiously branched stems. Leaves are pinnate and 8-15 cm long. The small rose, purple or white flowers are borne in spikes or clusters. The seeds, usually 6-12/pod, are much longer than broad. Pods are 1.5-2.5 cm long.

In Northern Luzon, Indigo has been integrated in farmers' systems since the late 19th century. It has been used as a green manure and grown as a post-rice crop, cultivated in combination with other crops.



Indigofera

ROLE OF INDIGO IN RICE FARMING:

· The Indigo can be planted as a monocrop after rice harvest. When planted as a sole crop, a seed rate of 6-8 kg/ha is needed.

· It can also be planted in between the standing crop after the last interrow cultivation at 30-50 days after planting (DAP). The seed is dibbled in the furrows created during the hilling-up operation. (This is the most common method used by farmers in the Ilocos region.)

· It is not suited as a short-duration pre-rice green manure due to its slow initial growth. It needs 45 months to accumulate high amounts of biomass and N.

· It can be grown after rice (Oct-Nov) as a companion crop to upland crops, such as corn, mung bean and tobacco. As an intercrop, it has not been observed to exert a yield-depressing competitive effect on its companion crop. It can be grown in combination with any of a number of food crops like mung bean, cowpea, peanut, corn, etc., because its slow, initial growth does not allow it to compete for sun or water.

· Indigo is plowed under at the start of the wet season to serve as a big-fertilizer for the rice crop.

· Under saturated conditions, the Indigo seeds plowed under were not observed to emerge. Therefore, the plant does not appear to be a significant weed problem in rice.

· It can withstand a long dry season (6 months or more), thereby providing soil cover during dry months.

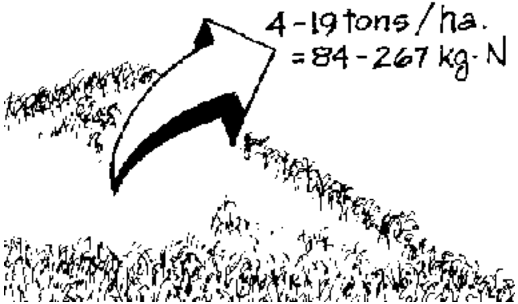
IMPORTANCE AS FERTILIZER:

· At 45 DAP, total N accumulated by Indigo was estimated to be equivalent to 45 kg N/ha.

· When planted as an intercrop prior to wet season rice, it can produce a biomass of 4-19 T/ha, equivalent to 84-267 kg N.

· Average amount of N required by rice can be reduced by one-half to two thirds when preceded by Indigo.

· Only a single application of fertilizer at 45-53 days after transplanting need be applied to rice when Indigo is incorporated.



Produce a biomass

HOW TO USE INDIGO AS FERTILIZER:

Indigo may be:

· broadcast after fields are drained. The field is then harrowed to cover seeds. Furrowing to accomodate the intercrop can subsequently take place. In llocos, an average of 6-8 kg/ha of Indigo seeds are broadcast.
· pre-soaked and dibbled between rows of a standing post-rice crop after interrow cultivation (3050 DAP).
· planted after harvesting the post-rice crop in the same furrows in which these crops were planted.

The Indigo. is incorporated once the field accumulates enough water for land preparation for the rice crop. A pegtooth harrow drawn in one direction is usually used to flatten the stand. Then the Indigo is plowed under in the same direction as it was flattened. Harrowing and transplanting follow very soon after in order to avoid loss of nitrogen from the decomposing biomass.

SEED PRODUCTION:

For a dependable harvest of good quality seeds, planting of seeds should be done in October-November so that pods mature in March or April, ahead of the early rains. In areas where there is still some soil moisture, January or February is also a good time to plant for seeds. Harvesting is done by clipping the clusters of pods. For high-quality seed, individual pod picking is recommended. Seeds can be stored without using special equipment. Eight months after storage, seeds are still capable of good germination (70-80%).

OTHER USES:

Indigo can be used as fuelwood and the leaves can be processed into dyes.

Crotalaria: green manure profile

CHARACTERISTICS:

· There are eight species of Crotalaria which are considered potential green manures.
· Most of these species are short-lived, hollow stemmed, fast-growing and produce dense foliage.
· Species differ in leaf form (simple, trifoliate), flower color, growth rate, plant height and other morphological characteristics.
· Pods contain 5-8 seeds.

Crotalaria

ADAPTABILITY:

· More adapted in dry areas which are not waterlogged, C. juncea is more adapted to areas with low rainfall than S. aculeata.
· Requires full sun for maximum growth and cannot tolerate partial shading.
· Adapted as a short-duration pre-rice green manure.

IMPORTANCE AS FERTILIZER:

· Crotalaria leaves decompose within 1-3 weeks after incorporation.

· It ranks next to Sesbania in N yield and green matter production. It is capable of

supplying up to 100 kg N/ha.

· Among the Crotalaria species, C. juncea and C. usaramoensis gave consistently the highest N yields. After 45 days, total N acculumation was 169 kg N/ha (3.75 kg N/ha/day).

· In India, Crotalaria biomass production was estimated to be 20-28 T/ha. The biomass had a total N content of 0.43%. This is equivalent to 134 kg N/ha. When incorporated in the soil, rice grain yield was 128% higher than yields obtained without incorporation.

· Continuous addition of Crotalaria green manure increased soil N from 0.079% to 0.109%.

HOW TO USE CROTALARIA AS FERTILIZER:

There have been no conclusive results published on the best time and age for incorporating Crotolaria in wetland rice. However, faster release of N was observed when 30-day old Crotalaria was incorporated.

· Provided there is enough water, Crotolaria may be planted 30-40 days before plowing wetland rice. Stems should be cut using either manual or animal labor. These will be incorporated into the soil by plowing and subsequent tillage operations.

· For upland crops, Crotalaria may be incorporated during hilling-up by uprooting it, spreading it near the plant base and then covering it with soil.

DIFFICULTIES OBSERVED IN USING CROTALARIA:

· It is susceptible to insect infestation when planted in the same area for more than 3 years.
· Seed setting could be a problem in certain areas. However, enough seeds could be

obtained despite reports of insect pests (particularly pod borer).

OTHER USES:

Crotalaria can be processed into fiber. It is very palatable, hence, a highly acceptable source of fodder.

Lablab bean: cover crop/green manure profile

CHARACTERISTICS:

The lablab bean, commonly called bataw or jarabilla, is widespread throughout the tropics. It has so many uses, so many varieties and wide adaptability.

· There are two botanical types: (a) the garden type which is viny and has to be grown on support; and (b) the field type which is erect and bushy.

· There are more than 200 recognized genotypes with pods, seeds, flowers, leaves differing in size, shape, texture and color. Each variety has physiological differences like seedling vigor, drought tolerance, day-length sensitivity, flowering time, maturation time, pest- and disease-resistance and seed viability.

Lablab bean

· It is remarkably adaptable to diverse conditions like soil of low pH and is affected by low soil nitrogen content.

· The plant establishes easily. Its dense growth suffocates/reduces weed growth.

· Dry seeds contain 20-28 percent crude protein. It is one of the best sources of iron (155 mg/100g of leaves dry weight). Yields of dry seeds gives as high as 4 t/ha.

USES OF LABLAB BEAN:

Food

· Young pods make an excellent table vegetable.

· Dried seeds are a wholesome palatable food, either cooked and eaten directly or processed to bean cake.
· Leaves and flowers are cooked and eaten like spinach.
· Sprouts are comparable to soybean or mung bean sprouts.
· Protein concentrate can be made from the seeds.

Forage

· The plant is grazed by different types of animals.
· Bean hay is palatable. It also makes good silage.

Other Uses

· Excellent green manure.
· Effective for soil erosion control and soil protection.
· Can be used as a nitrogen-fixing crop grown alone, interplanted with field crops or grown in rotation with these crops.
· Good cover crops for plantations.
· Often planted as a second crop in ricefields after the harvest of paddy.

ADAPTABILITY:

The lablab bean is remarkably adaptable. Its various strains thrive in a number of different areas and under diverse conditions. There are varieties for:

· arid, semi-arid and humid regions (that is, for range of 200 - 2,500 mm of annual precipitation);
· warm-temperate, subtropical and humid rainforest regions where mean summer temperature ranges from 22 to 35°C;
· lowlands and highlands (It is grown widely up to 2,100 m altitude.);

· many types of soil, including some of the poorest and most toxic soils;
· both mechanized, large-scale farming and labor-intensive, small-farm agriculture;
· field agriculture and home gardens; and
· resistant to pests and diseases (especially root diseases).

IMPORTANCE OF LABLAB IN RICE FARMING:

· It is best grown as a post-rice harvest crop during fallow periods in the dry season for marketable pods and nitrogen rice biomass.
· It can be intercropped with rice in dryland areas (with clippings so as not to depress the rice yield).

HOW TO USE LABLAB AS FERTILIZER:

· Plant lablab seeds either in furrows or broadcast after the rice harvest (towards the dry season).
· Allow the lablab to grow and cover the ground until the rainy season starts. Allowing the plants to cover the soil suppresses the growth of weeds and protect the soil from direct exposure to sunlight.
· Before plowing the soil for the next planting, either chop the plants by passing a slicer or pull every plant then allow to wilt.
· Incorporate the herbage into the soil by plowing.

Rice bean: green manure profile

The rice bean (Vigna umbellata) is an important crop because of its potential as a post rice crop.

CHARACTERISTICS:

· It is an annual that bears clusters of 5-20 bright yellow flowers that produce narrow pods containing 7-10 seeds.
· It is adapted to high temperature and humidity as well as to heavy soils.
· Some varieties are resistant to major insect pests and diseases.
· It produces easy to cook, good tasting seeds.
· Seeds are rich in protein and contain high amounts of calcium, iron and phosphorous.
· Immature pods and seedlings are excellent green vegetables and the plant makes forage which are eagerly consumed by livestock.

Rice bean

VARIETIES:

Cultivars of rice bean vary from short-stemmed, erect plants to twining plants that may grow up to 3 meters long and need stakes or other support for maximum yield. Seeds of these different cultivars have either black, red-violet, greenish, brownish or mottled seeds.

ROLE OF RICE BEAN IN RICE FARMING:

· Rice bean as a post rice crop can benefit the rice by improving the nitrogen and humus contents of the paddy soil.
· It is particularly valuable because it provides fodder at a time when other sources of feeds are scarce.
· It can be used as a green manure before the planting of the first rice crop and can be grown as a cover crop during times when the ricefield is left idle.

USING RICE BEAN FOR GREEN MANURE/COVER CROP:

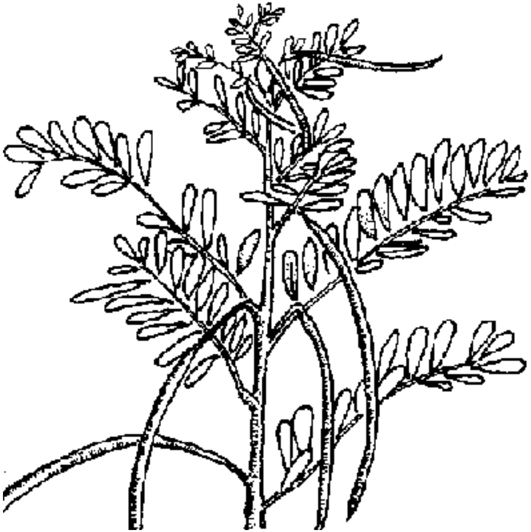
· Plant the seeds either in furrows or broadcast them after the rice harvest towards the dry season.
· Allow to grow (take over the field) until the onset of the rainy season.
· Before plowing for the first planting of rice, either chop the plants by using a slicer or bolo or uproot the whole plants and allow to wilt.
· Incorporate the herbage by plowing and allowing it to decompose before planting the rice.

LIMITATION:

· Rice bean is sensitive to day length. Flowering and seeding are initiated only when days are short. When planted at other times, the crop produces masses of vegetation but little seed.

Sesbania spp.: green manure profile

Sesbania, such as S. rostrata, S. aculeata or S. sesban, are green manure crops which are fast-growing even in flooded conditions. Unlike most other legumes, they fix nitrogen even when the soil contains high amounts of nitrogen (N). A 45-60 day growth of Sesbania can yield the following:



Sesbania spp.

Field	Condition	Tons/ha Kg N/ha
Flooded	25-30	100
Dry	30-35	115

Sesbania can be incorporated during land preparation. It also decomposes quickly. Rice can be transplanted the day after incorporation. The herbage cited above can result in rice yields of 0.52.0 T/ha.

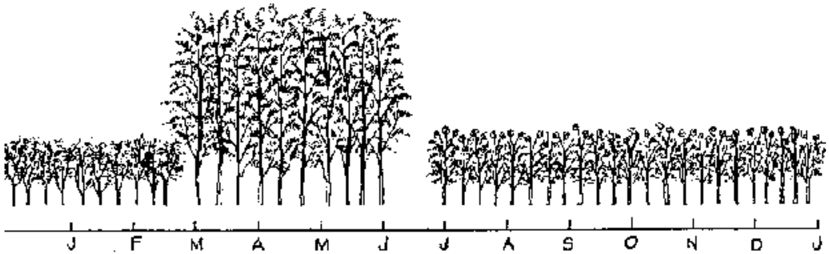


Figure 1. The comparative vegetative growth of Sesbania at different planting dates.

Sesbania is photoperiod sensitive. Flowering is triggered by short daylength. Flowering and seed production suppress the plant's vegetative growth.

To maximize herbage production (and therefore N accumulation), the best time to plant Sesbania as pre-rice green manure is during longer photodaylength periods -- from March to July in the Philippines.

The best time to plant for seed production is from November to mid-January. The short daylength induces early flowering (3-4 wks after emergence). Seed production during the dry season has less pest problems and eliminates seed germination in the pod.

Table 1. Seed Production of S. rostrata on the Rice Paddy Bunds (Navarro, General Trias, Cavite, 1987 DS)

PLANTING DENSITY/ SPACING	Date of Priming and Actual Seed Harvested (kg)				Production Cost*

	First Priming	Second Priming	Third Priming	Total	
Plant/m row	1.868	2.341	1.968	6.177	52.50
2 Plant/m row	3.001	3.846	2.688	9.535	74.37
3 Plant/m row	5 546	6.0	5.127	16.673	96.25

*** Cost of seeds + harvesting costs. Hired labor is P25.00/day.**

CULTURAL MANAGEMENT:

For Green Manure

1. Planting Methods:

· Broadcasting or row-seeding after conventional land preparation (1 plowing and 1-2 harrowings)
· Direct seeding under zero tillage conditions using a suitable seeder
· Broadcasting onto weed-free field (untilled) and covering lightly with straw

2. Sesbania nodulates freely in most soils without inoculation. However, to ensure root nodulation, apply inoculant to seeds before planting.

3. S. rostrata is the species which nodulates both on its roots and stems. Stem nodulation can be easily induced if it has not yet started by doing the following:

· Collect nodules from the stems of any available S. rostrata plant.
· Crush these, mix with water and filter the mixture.
· Spray the filtered water on the stems of the S. rostrata The tiny light green dots are the locations where the nodules will form.

4. The seeding rate ranges from 20-40 kg/ha. A 45-60 day growth may provide the N requirement of a wet season rice crop. The larger the amount of seed planted, the fewer days are needed to produce sufficient green manure.

5. Plants should first be slashed or chopped if the incorporation will tee done by animal-drawn plow and harrow.

6. With the use of scythe or bolo, the standing plants can be chopped into short pieces from the top to the base. Plants that were cut and partially cried are tougher to chop than the fresh plants. Slashing may not be necessary if a power tiller or hydrotiller will be used in the incorporation. Transplanting of the rice should be done as soon as possible after the incorporation of Sesbania to minimize N losses which begin within 2-3 days after incorporation.

For Seed Production

1. Planting methods:

· Planting Sesbania separately from the rice crop during rainy season or at early dry season
· Relay planting into the last rice crop (by broadcasting Sesbania seeds before rice harvest)
· Planting on rice paddy dikes either by direct seeding or transplanting during the rice crop season
· Planting and growing it together with the rice crop.

Little is known about the quantity of seed produced using the last two methods. For the first two methods, during rainy and dry seasons, seed production of about 12 and 9 kg/100 sq. m respectively can be attained.

2. Seeding rate is 16 kg/ha or about 300,000plants/ha. Seeds should be planted in rows 40-75 cm apart at 1 5-20/linear m.

3. Some insect pests may attack the pods and seeds; except with very high infestations, no insecticide is needed.

4. Harvesting and cleaning the seed is time-consuming; one person can pick and clean approximately 5-7 kg seeds/day. Three or more primings will be needed to harvest all the seeds.

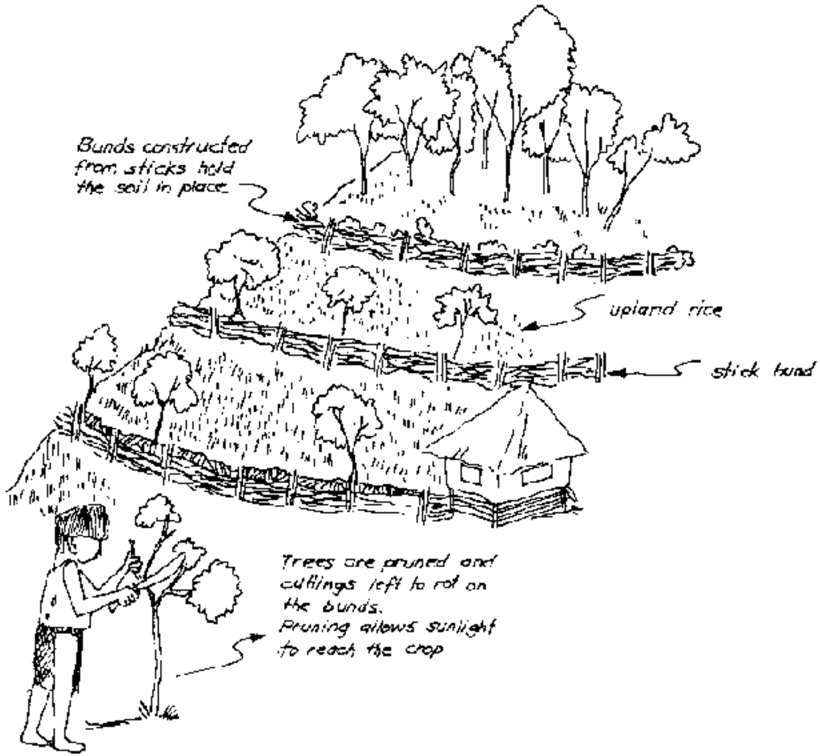
COMBINING SEED PRODUCTION WITH OTHER USES OF SESBANIA:

1. The woody stem of the mature plant can be used as firewood or as trellis for climbing vegetables.

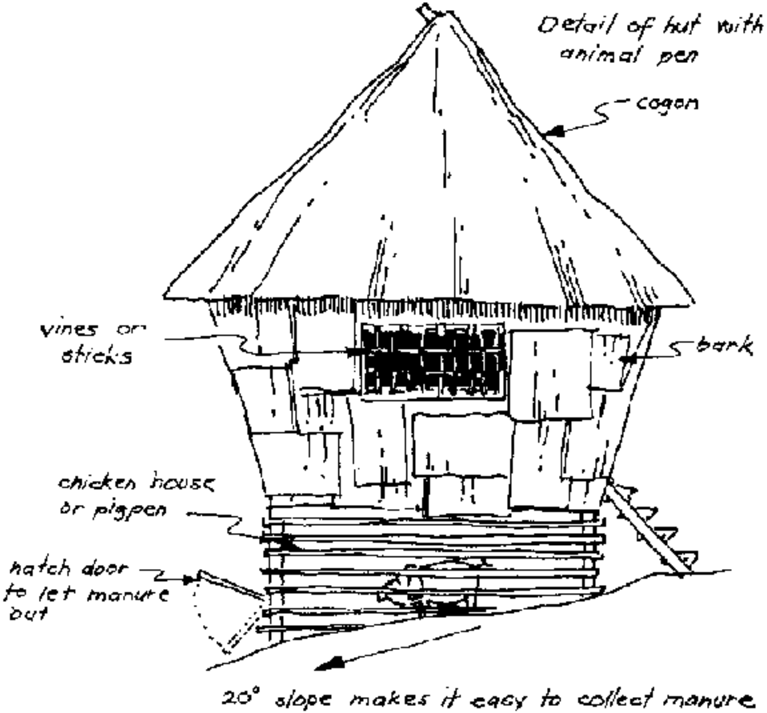
2. If water is available, the plant can be ratooned to provide green manure for the next rice crop.

Animal and green manure practices among the Mangyans (Alangan tribe in Mindoro)

Pigs and chickens are housed underneath the home over bedding of cornstalks, straw, etc. Decomposed beddings serve as fertilizer.



Animal and green manure



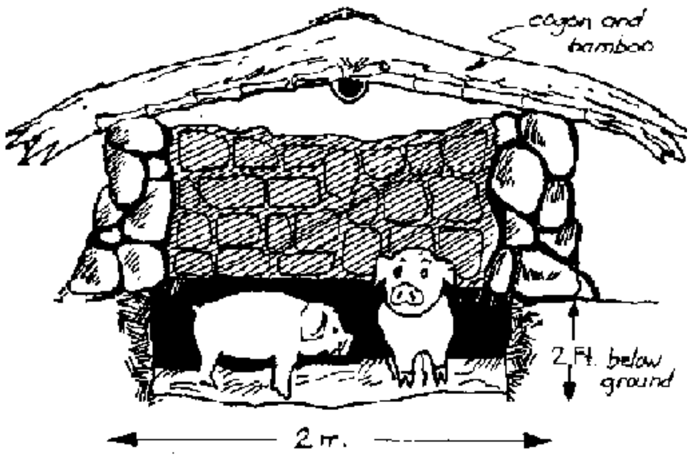
Decomposed beddings

Waste management practices (Tuwal and Ayangan tribes in Ifugao)

DUG-OUT PEN SERVES TO RESTRAIN THE PIG.

The following materials are laid on the earth floor:

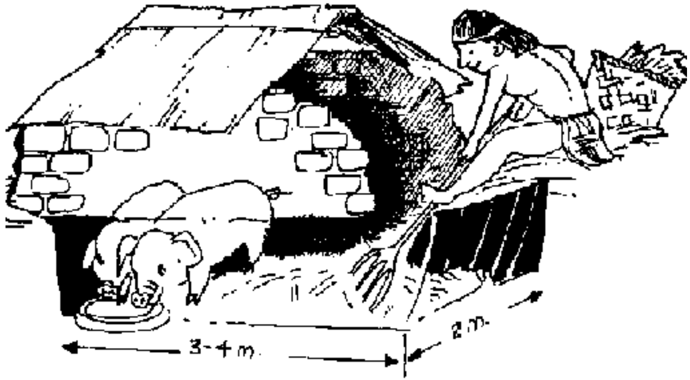
- rice straw and hulls
- kitchen refuse
- grass cuttings
- carabao dung
- chicken manure
- other organic matters



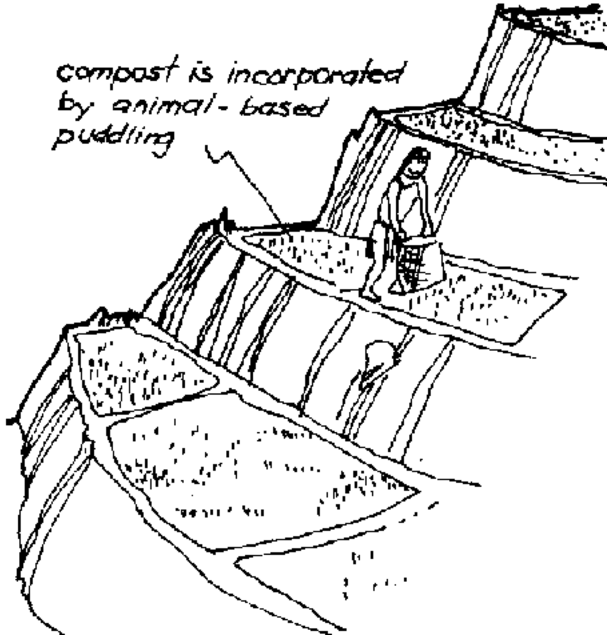
Dug-out pen

COMPOST COLLECTION METHOD:

The old bedding is collected and used as fertilizer to be incorporated into the rice terraces. New materials are laid on the pit floor.



The old bedding is collected



Bedding is collected and used as fertilizer

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Low-external Input Rice Production (IIRR, 292 p.)
Pest/weed control
Major rice insect pests, their natural enemies and economic threshold levels

Low-external Input Rice Production (IIRR, 292 p.)

Pest/weed control

Major rice insect pests, their natural enemies and economic threshold levels

There are about 800 species of insects in the ricefields. Of these, about 100 species attack rice and the rest are all friendly insects. Out of the 100 pest species, only 7 are major pests in Philippine rice farms.

There is a new strategy of controlling these major pests in rice. This method is based on ecologically sound practices in reducing pest populations and is called Integrated Pest Management (IPM). IPM is a pest management system that, in the context of the associated environment and the population dynamics of the pest species, utilizes all suitable techniques and methods. This is done in a manner that maintains the pest population at levels below those causing economic injury.

By thoroughly understanding a given crop, its pests and other elements of the agroecosystem, IPM tries to maximize natural pest control factors and minimize the need for outside measures like chemical pesticides. IPM explicitly means:

· use of chemicals based on need
· utilization of economic threshold levels
· use of resistant varieties
· knowledge of cultural practices
· enhancement of biological agents

IPM can help farmers increase profits and reduce health hazards and pest outbreaks by maintaining the pest-natural enemy relationship in the field. In maintaining such relationships, insecticide use is "need-based". In practice, the farmer has to know the Economic Threshold Level (ETL) for a particular pest. ETL refers to the pest population level where control measures are needed.

The information in this paper is designed as a quick guide for identifying major pests of rice and their natural enemies and to help determine the economic threshold level for each pest.

RICE BUG (L. oratorius)

· ECONOMIC THRESHOLD LEVEL (ETL)

10 bugs in 20 hills

· SAMPLING METHOD

Sample early in the morning or late in the afternoon from 20 randomly chosen hills from flowering to hard dough stage. Sample twice a week.

· **INSECTICIDE**

Monocrotophos EC
Nuvacron USC

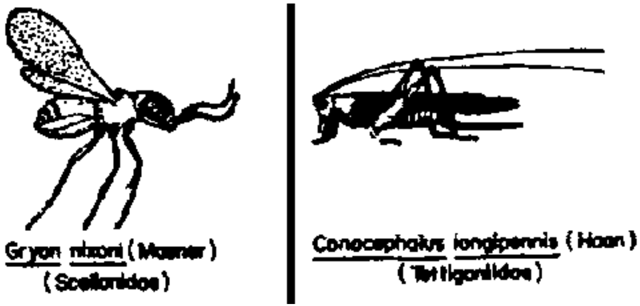
· **DOSAGE (kg ai/ha)**

0.4 each

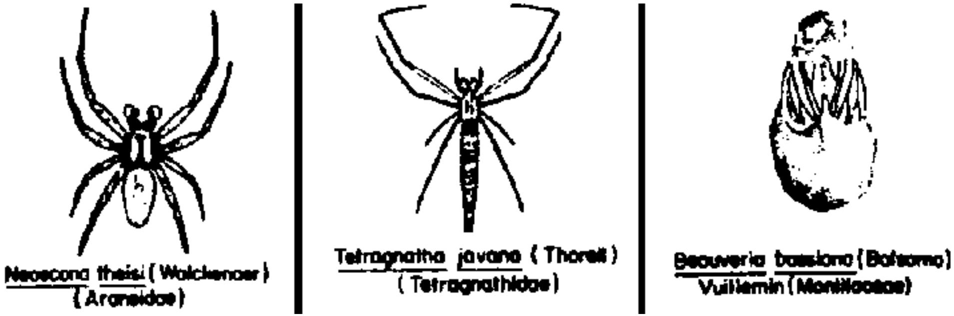
· **METHOD OF APPLICATION**

Spray in the morning

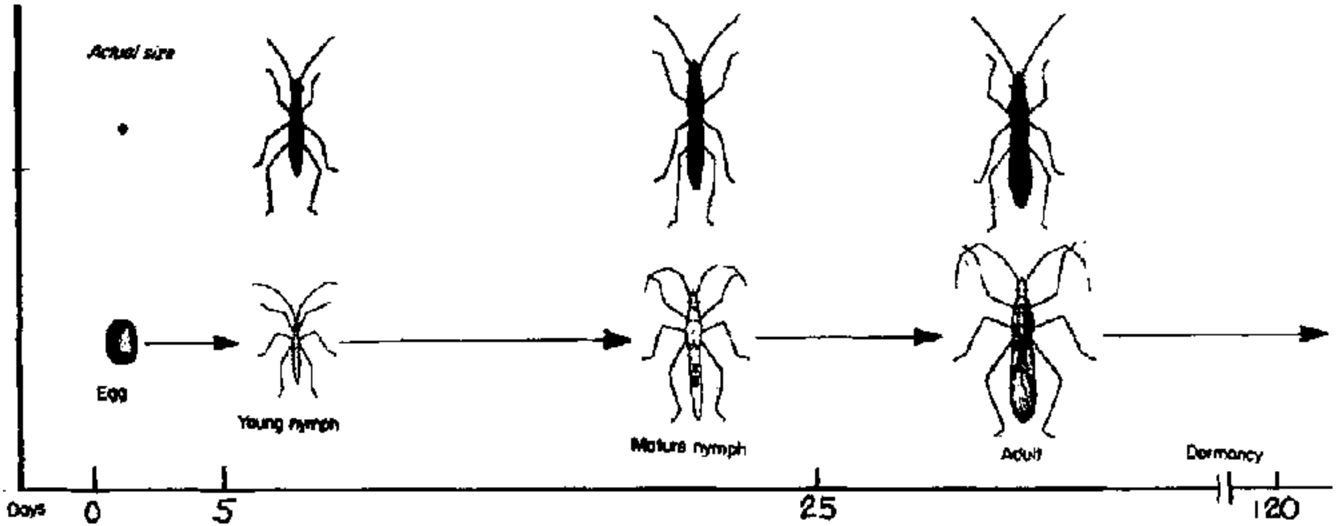
NATURAL ENEMIES



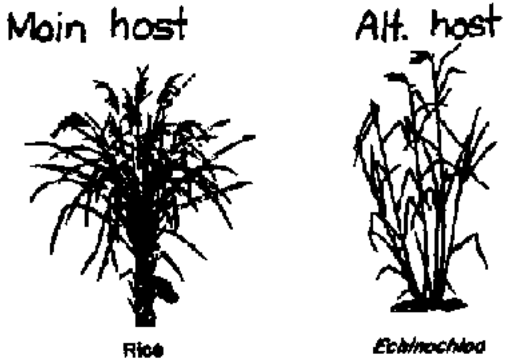
Parasites



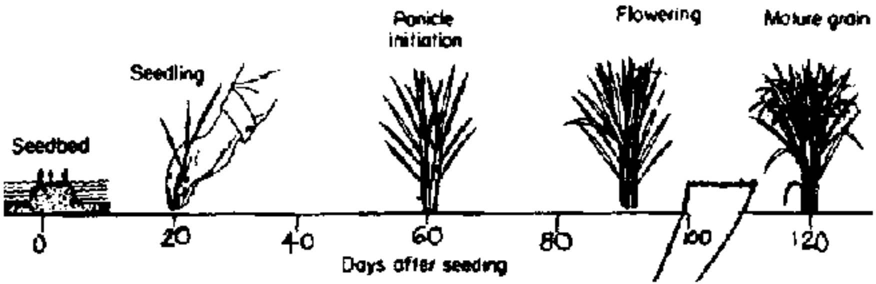
Predators



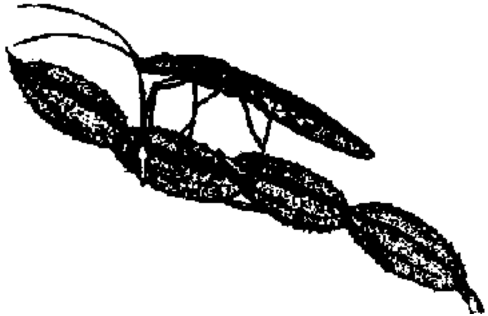
Pest



Host plants



Susceptible stage



Symptoms

WHORL MAGGOT (Hydrellia philippina)

· ECONOMIC THRESHOLD LEVEL (ETL)

a. 2 eggs/hill
b. 5% whorl maggot - damaged leaves + 5% leaves damaged by chewing insects at 5 DAT

· SAMPLING METHOD

20 random hills/ricefield at 5 and 8 days after transplanting

· INSECTICIDE

Monocrotophos EC

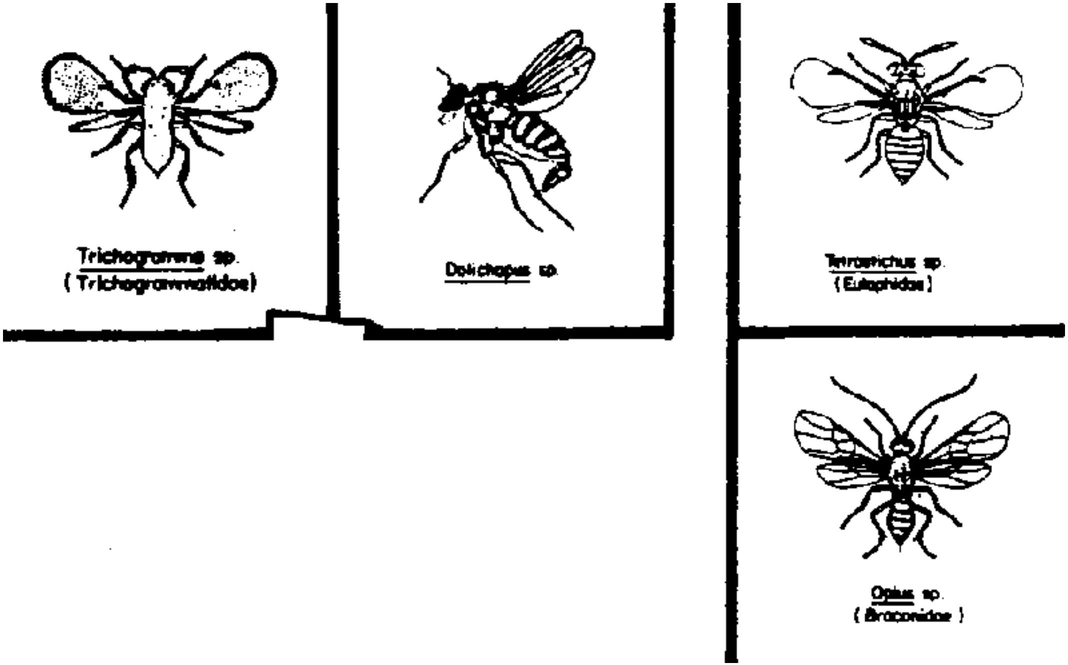
· DOSAGE (kg ai/ha)

0.4

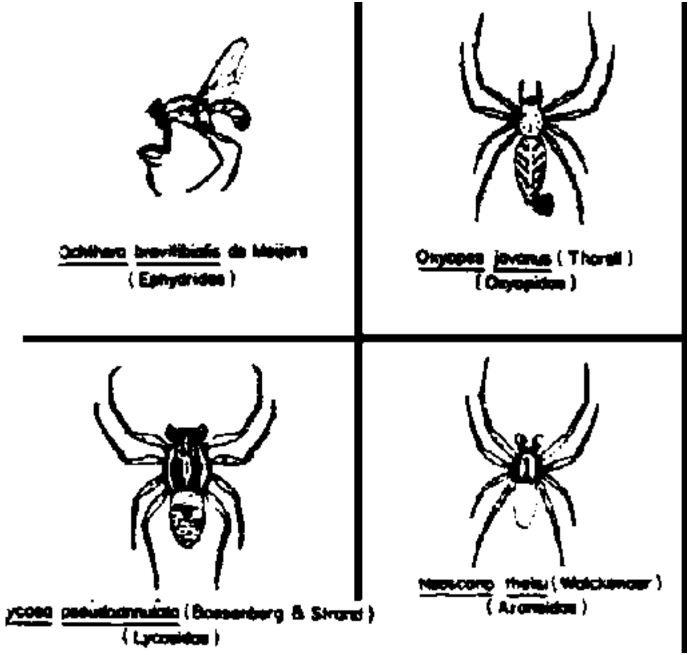
· **METHOD OF APPLICATION**

Spray when threshold is reached

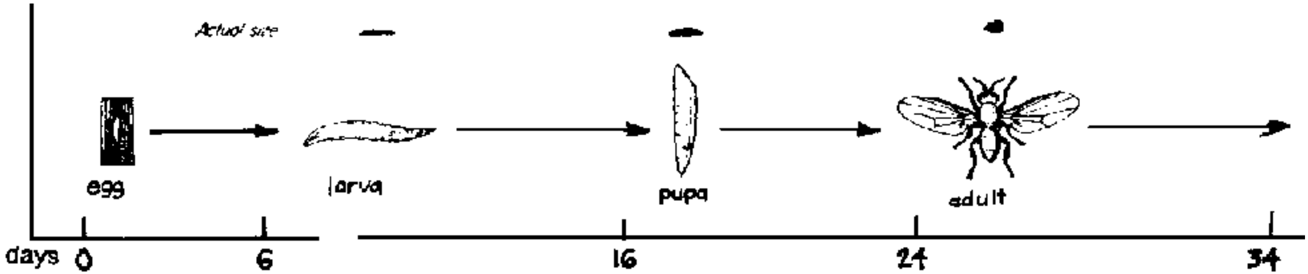
NATURAL ENEMIES



Parasites

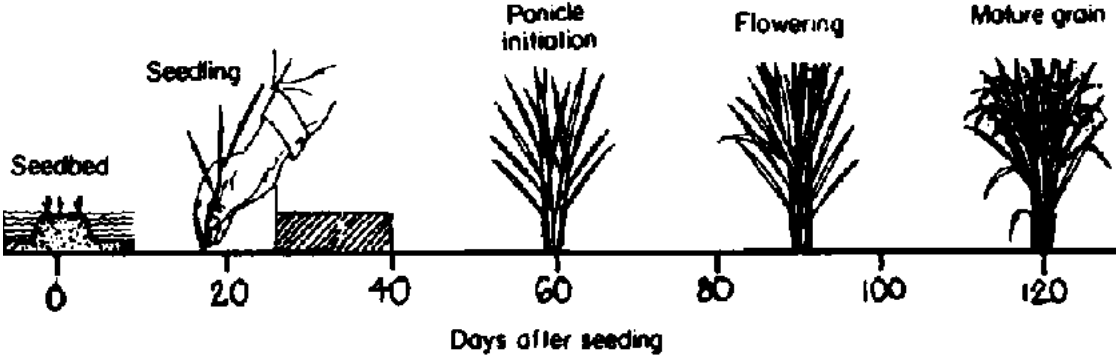

(Ephydridae)
Oxyopes javanus (Thorell)
(Oxyopidae)
ycosa pseudoannulata (Bosenberg & Strand)
(Lycosidae)
(Araneidae)

Predators

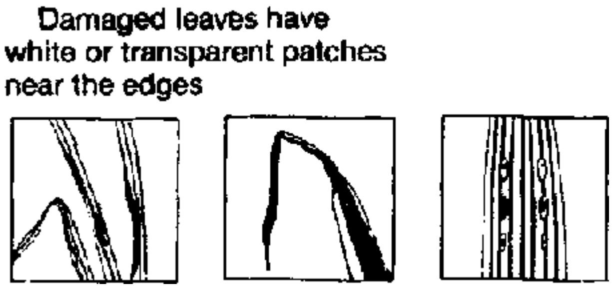


Pest

Host plants



Susceptible stage



Symptoms

STEMBORER (Scirpophaga incertulas)

· ECONOMIC THRESHOLD LEVEL (ETL)

75 deadhearts in 20 hills or 2 adults or 2 egg-masses/m²

· SAMPLING METHOD

20 random hills/ricefield from tillering to panicle initiation stage

· INSECTICIDE

Chlorpyrifos EC

· DOSAGE (kg al/ha)

0.4

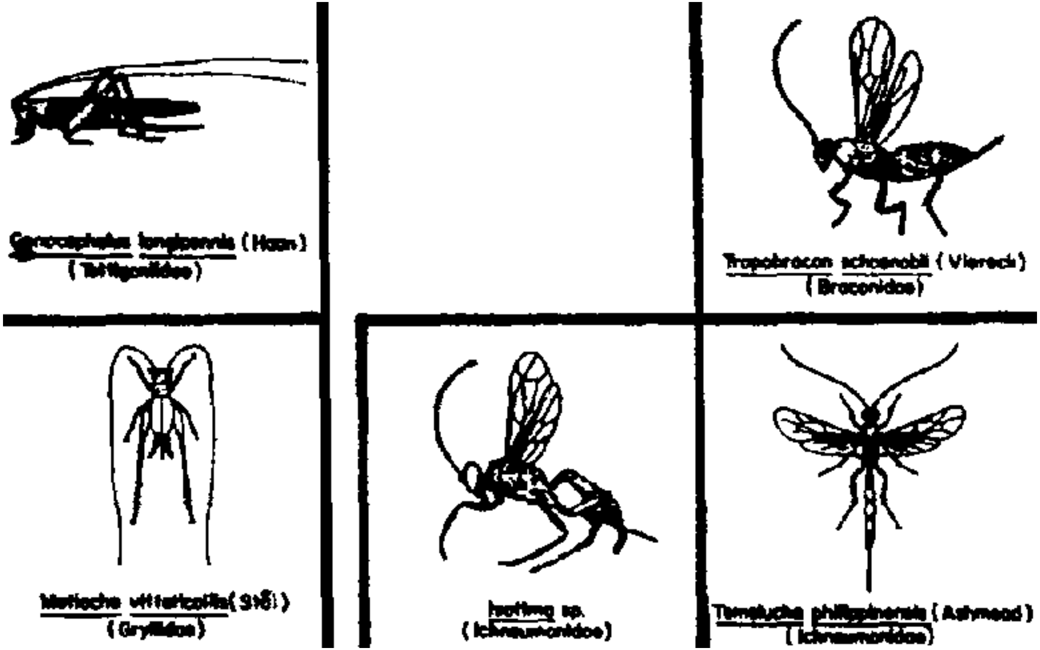
· METHOD OF APPLICATION

Spray when larva hatch

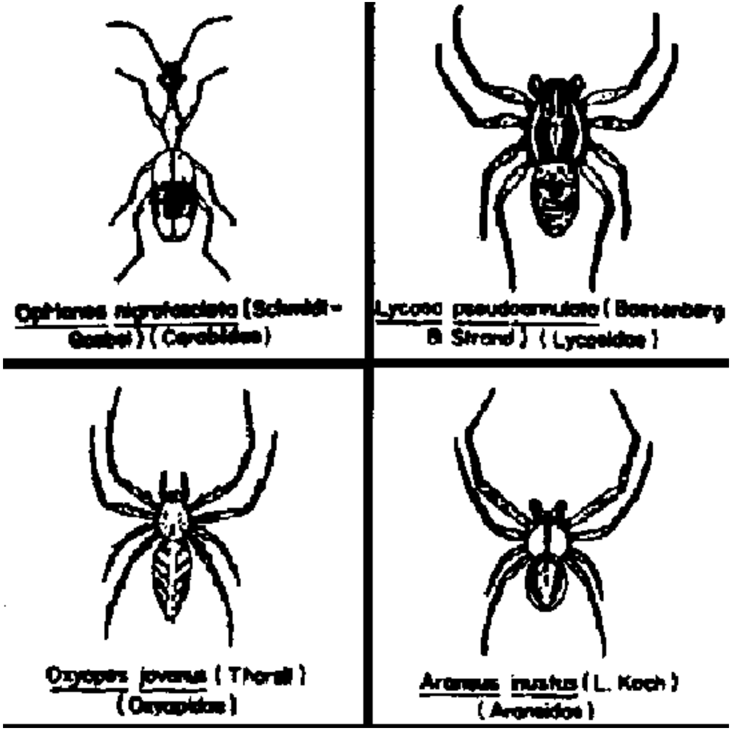
· DAMAGE

Larvae feed on leaves and leaf sheaths

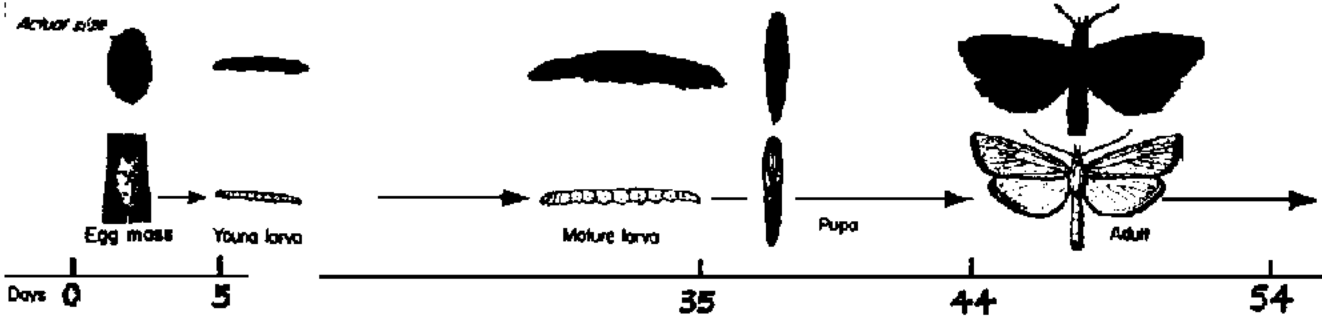
NATURAL ENEMIES


(Haan)
Tropobracon schoenobii (Viereck)
(Braconidae)
(Gryllidae)
(Ichneumonidae)
(Ashmead)

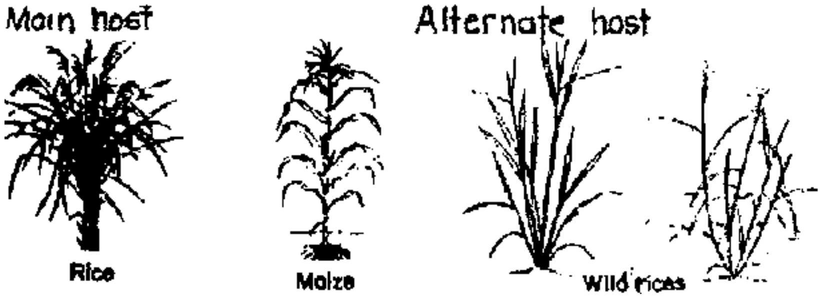
Parasites



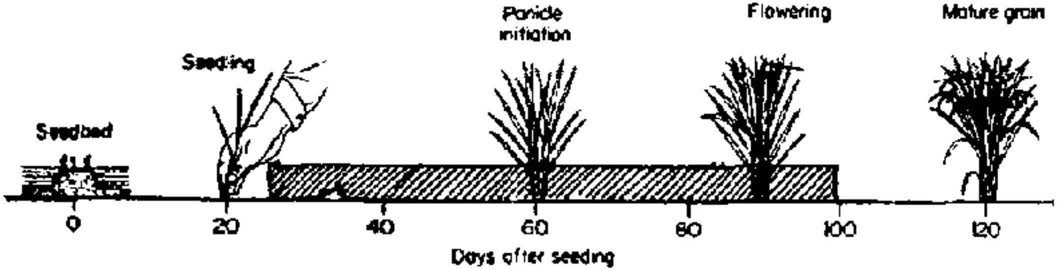
Predators



Pest



Host plants



Susceptible stage

Symptoms

GREEN LEAFHOPPER (N. Virescens)

· ECONOMIC THRESHOLD LEVEL (ETL)

1 hooper/tiller

· SAMPLING METHOD

20 random hills/ricefield 1 to 10 weeks after transplanting

· INSECTICIDE

BPMC WP

· DOSAGE (kg al/ha)

0.4

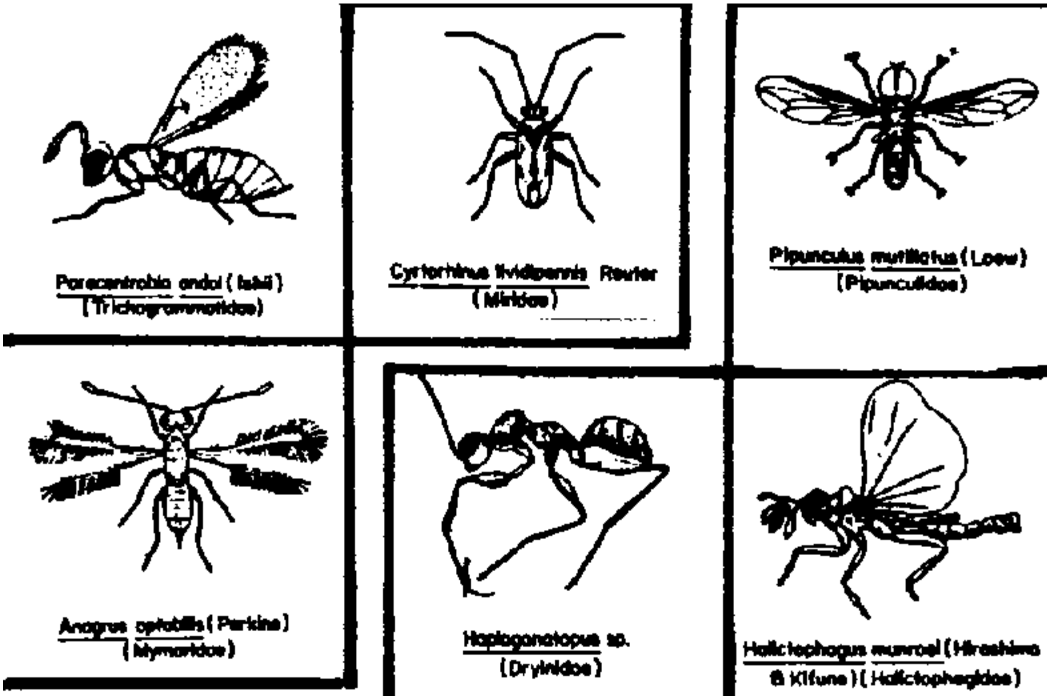
· METHOD OF APPLICATION

Spray when older nymphs are present

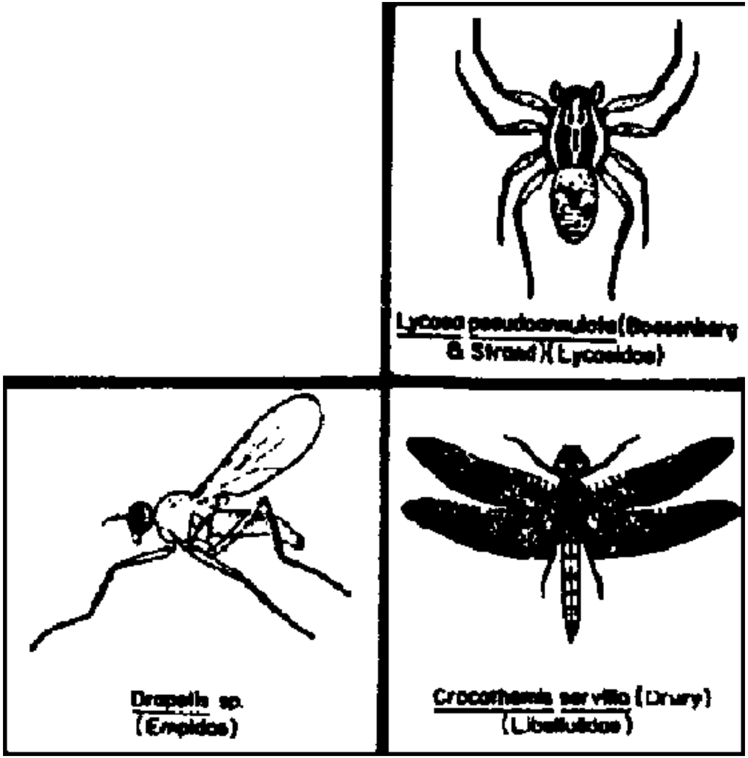
· DAMAGE

Drief leaf tips and leaf margins orange discoloration

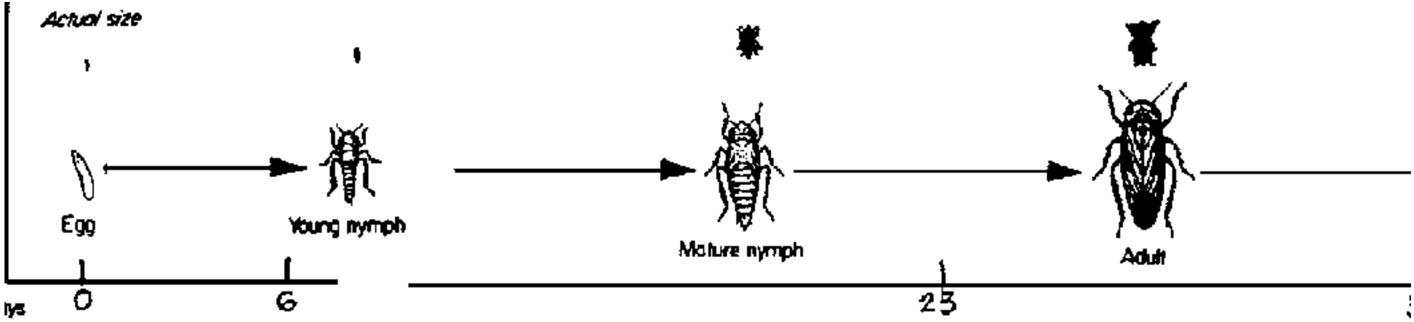
NATURAL ENEMIES


Paracentrobia andoi (Ishii)
(Trichogrammatidae)
Cyrtorhinus lividipennis Reuter
(Miridae)
Pipunculus mutilatus (Loew)
(Pipunculidae)
Anagrus optabilis (Perkins)
(Mymaridae)
Haplogonatopus sp.
(Dryinidae)
Halictophagus munroei (Hirashima
& Kifune) (Halictophagidae)

Parasites

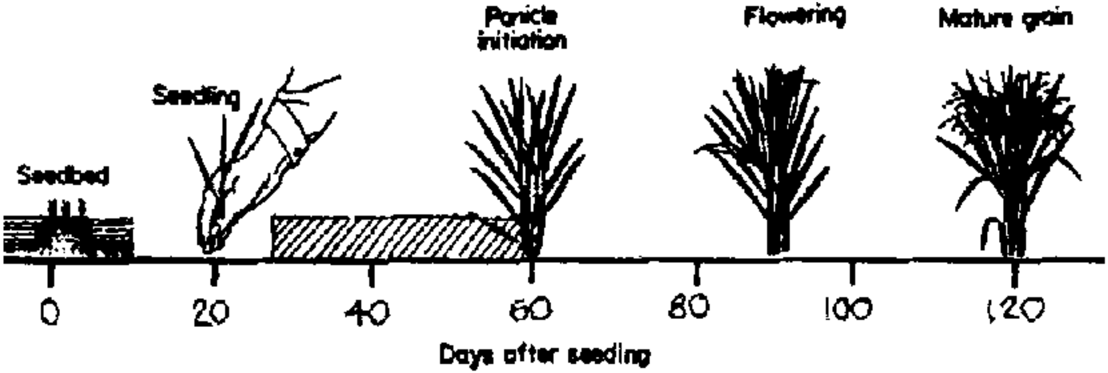

Lycosa pseudoannulata (Boesenberg
& Strand) (Lycosidae)
Drapetis sp.
(Empidae)
Crocothemis servilia (Drury)
(Libellulidae)

Predators

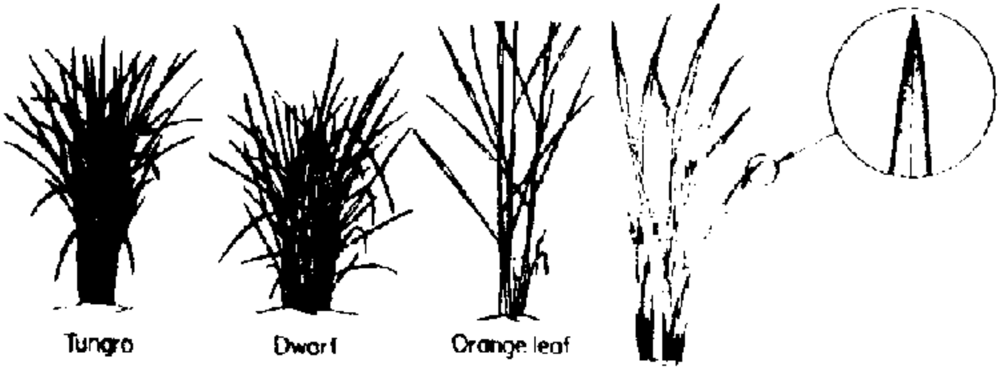


Pest

Host plants



Susceptible stage



Symptoms

CASEWORM (Nymphula depunctalis)

· ECONOMIC THRESHOLD LEVEL (ETL)

50% of the leaves are damaged. Combine the damage caused by other leaffeeding pests with that of caseworm.

· SAMPLING METHOD

20 random hills/ricefield at 2 to 6 weeks after transplanting

· INSECTICIDE

Carbaryl

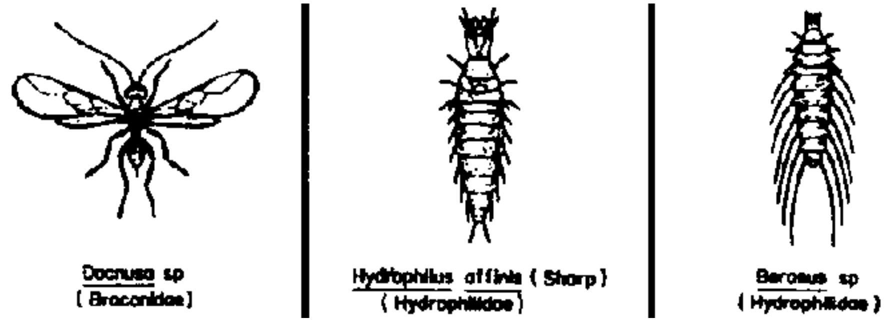
· DOSAGE (kg al/ha)

0.5

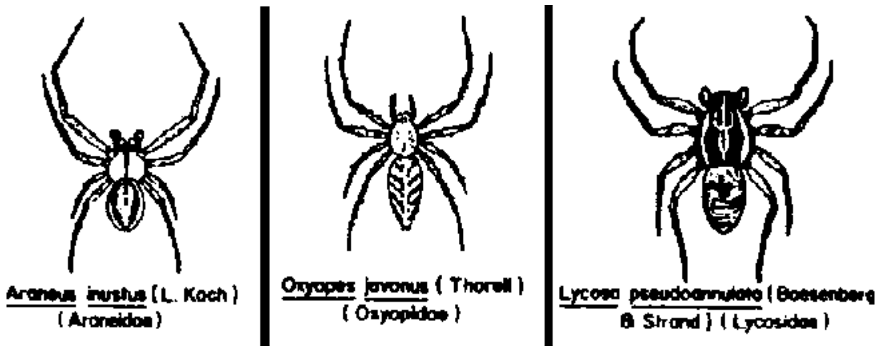
· METHOD OF APPLICATION

Spot treatment

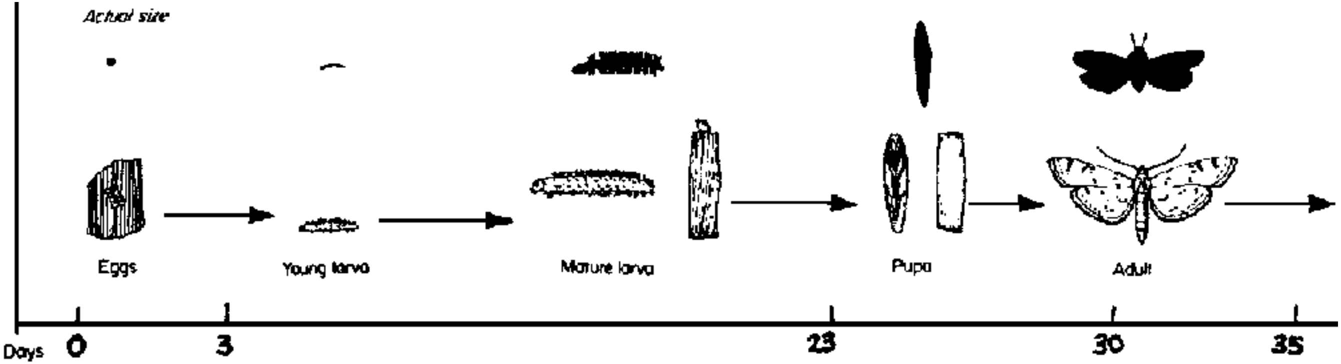
NATURAL ENEMIES



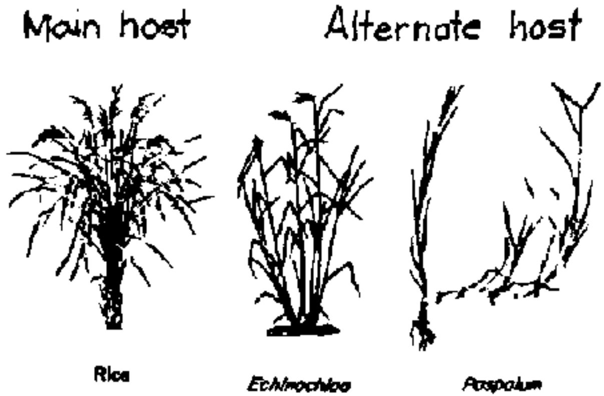
Parasites



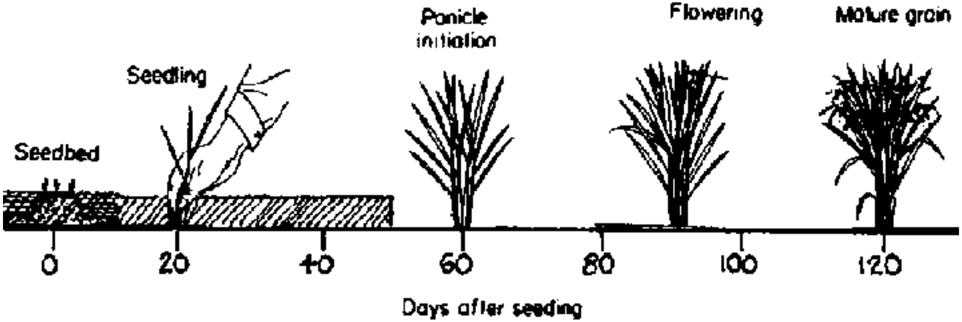
Predators



Pest



Host plants



Susceptible stage

Symptoms

BROWN PLANTHOPPER (N. Lugens)

· ECONOMIC THRESHOLD LEVEL (ETL)

1 hopper/tiller

· SAMPLING METHOD

20 random hills/ricefield 2 to 10 weeks after transplanting

· INSECTICIDE

BPMC WP
Buprofesin WP

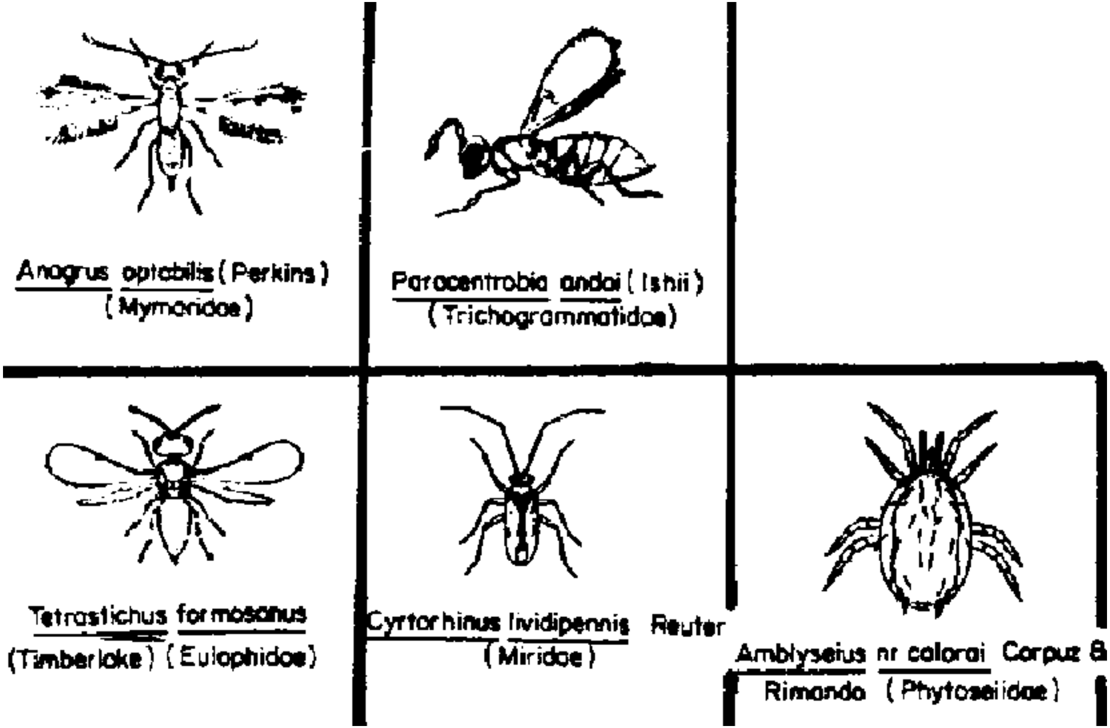
· DOSAGE (kg al/ha)

0.4 each

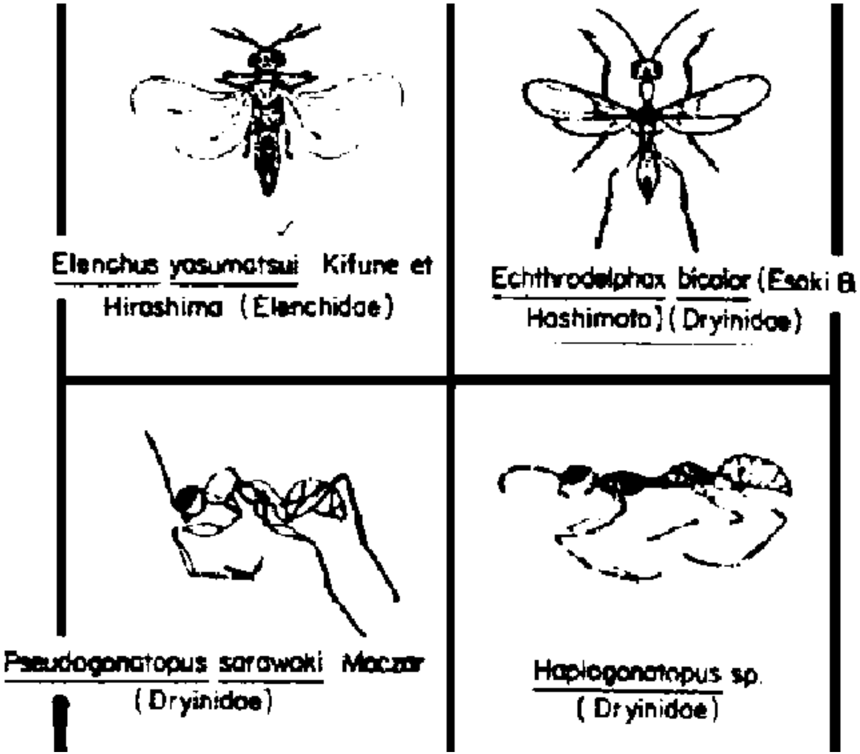
· METHOD OF APPLICATION

Spray when other nymphs are present.

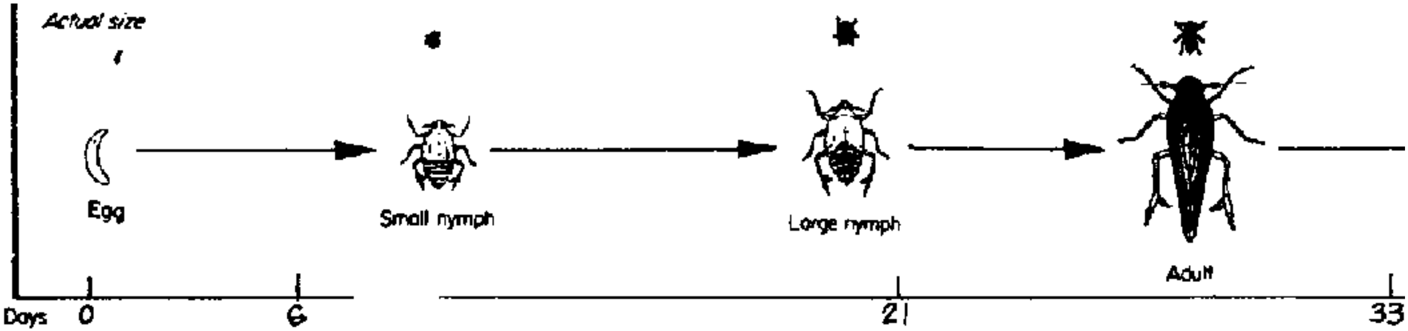
NATURAL ENEMIES


Anagrus optabilis (Perkins)
(Mymaridae)
Paracentrobia andoi (Ishii)
(Trichogrammatidae)
Tetrastichus formosanus
(Timberlake) (Eulophidae)
Cyrtorhinus lividipennis Reuter
(Miridae)
Amblyseius nr calorai Corpuz &
Rimando (Phytoseiidae)

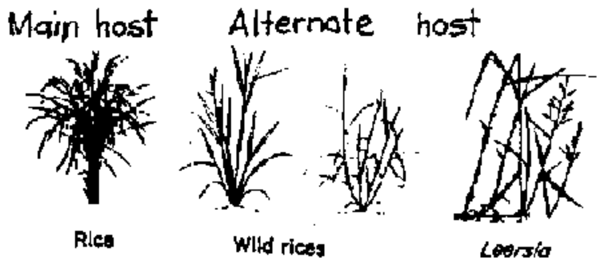
Parasites


Elenchus yasumatsui Kifune et Hirashima (Elenchidae)
Echthrodelphax bicolor (Esaki & Hashimoto) (Dryinidae)
Pseudogonatopus sarawaki Moczar (Dryinidae)
Haplogonatopus sp. (Dryinidae)

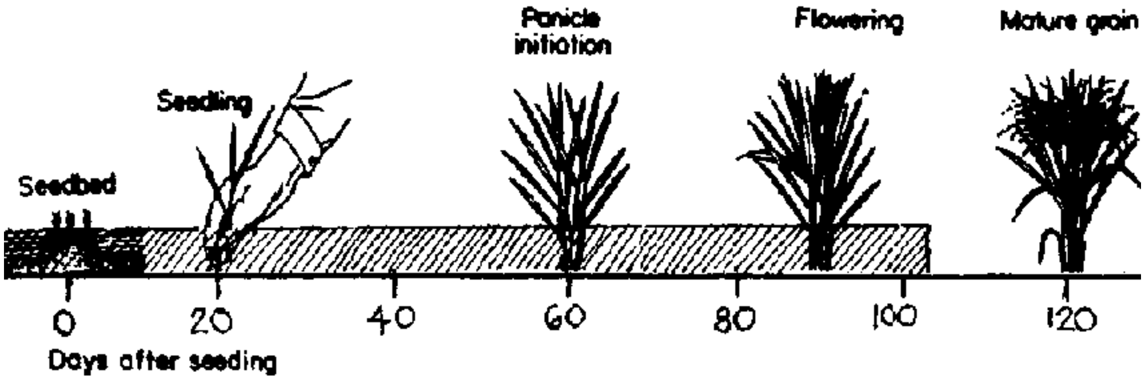
Predators



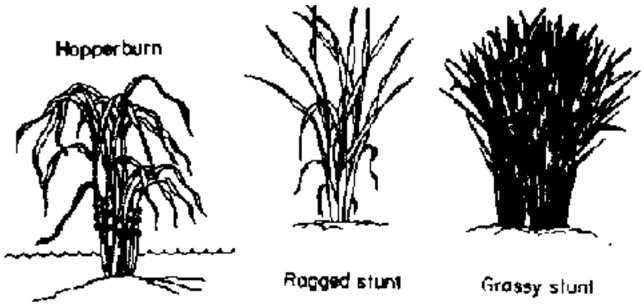
Pest



Host plants



Susceptible stage



Symptoms

LEAFFOLDER (Cnaphalocrosis medinalis)

· **ECONOMIC THRESHOLD**

LEVEL (ETL)

a. 15% of leaves are damaged before Panicle initiation.
b. 5% of leaves are damaged after panicle initiation stage.

· SAMPLING METHOD

20 random hills/ricefield at 2 to 6 weeks after transplanting watch for months

· INSECTICIDE

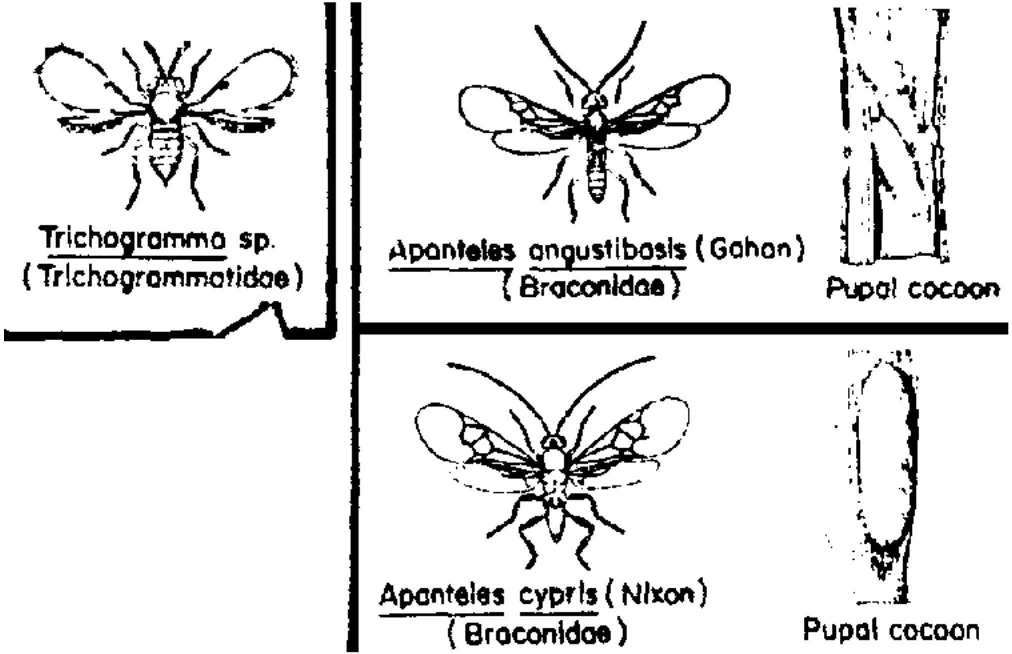
Monocrotophos EC

· DOSAGE (kg al/ha)

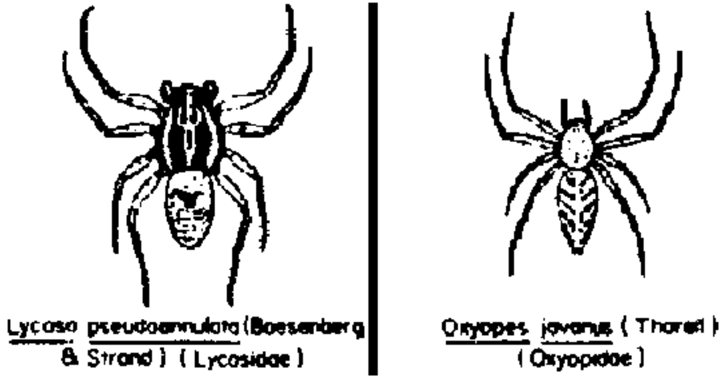
0.4

· METHOD OF APPLICATION

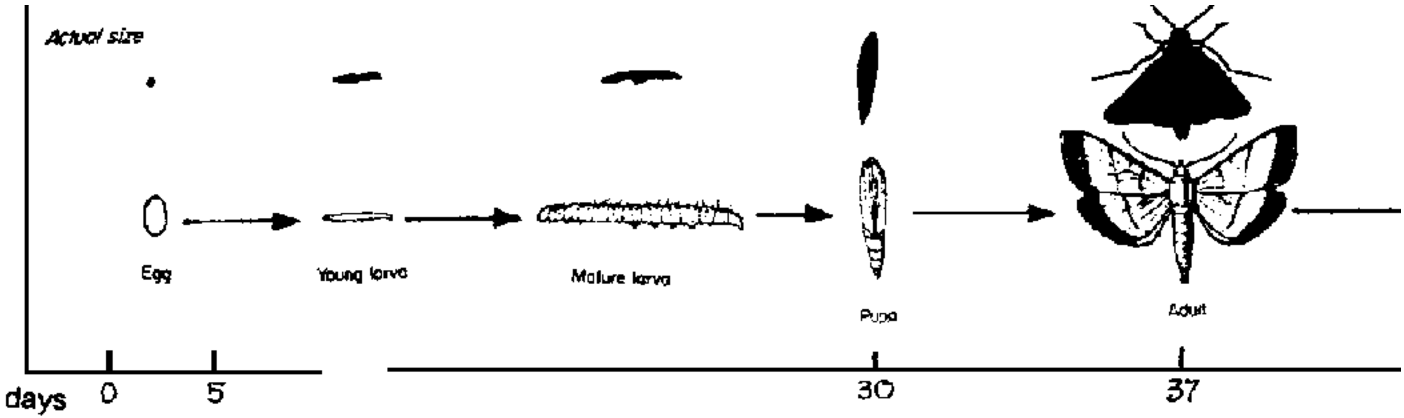
Spot treatment


Trichogramma sp.
(Trichogrammatidae)
Apanteles angustibasis (Gahan)
(Braconidae)
Pupal cocoon
Apanteles cypris (Nixon)
(Braconidae)
Pupal cocoon

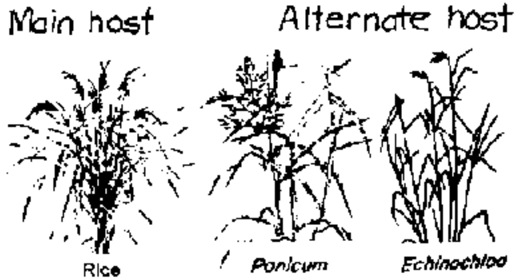
Parasites



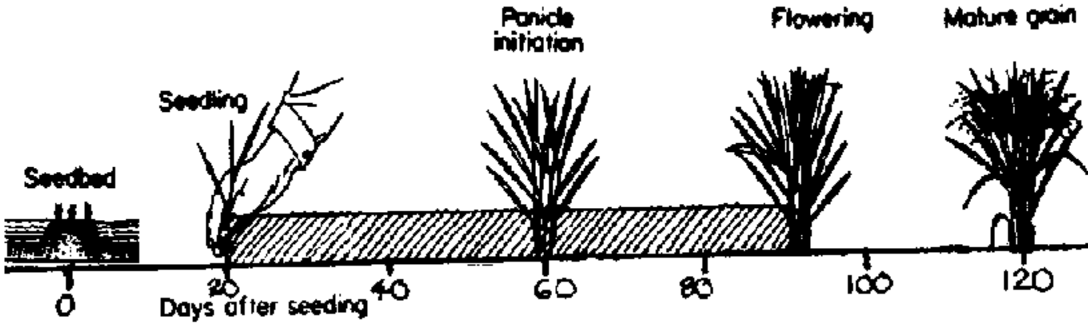
Predators



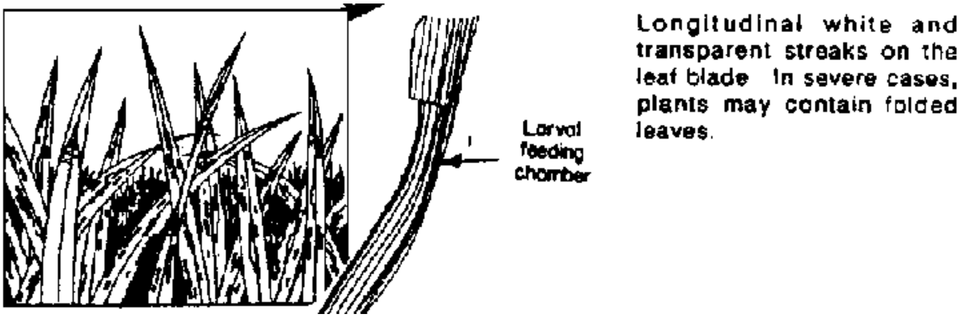
Pest



Host plants



Susceptible stage



Symptoms

CULTURAL MANAGEMENT PRACTICES FOR PEST CONTROL IN RICE

A cultural practice is any farm operation that will make the environment less favorable for pests to develop or multiply but which still favors rice production.

Rice ecosystems are fundamentally very stable systems but can be disrupted by inputs such as pesticides and inorganic fertilizers. There are few key pests in rice. Therefore, cultural practices, when used together with pest-resistant rice varieties, will provide adequate defense against most rice insects and diseases.

Cultural practices for rice pest management include the following:

SYNCHRONIZED PLANTING:

Since the massive introduction of rice intensification programs in the 1960s when shortduration modern rice varieties were introduced, there was room for planting rice three times a year or even five times in two years. Due to socioeconomic factors (labor shortages, market prices), staggered rice planting (i.e., non-synchronized) became

unavoidable. This situation is ideal for continuous development of pests. Staggered planting with short idle intervals stimulates the build-up of BPH populations and may result in serious outbreaks of the rice dwarf virus, BPH, RTV (transmitted by GLH) and WBPH. Rice gall midge and the rice stink bug also became more serious in Indonesia because of staggered planting.

In staggered rice patterns, the generations of the pests are overlapping. There is no clear-cut fallow period (i.e., for soil preparation) between the two rice seasons. In this situation, any rice pest will build up continuously. On the other hand, in the synchronized patterns, there is a fallow period between the two rice seasons for about one month. This is the time for simultaneous soil preparation (irrigating field, deep plowing under the stubbles [ratoons] and sanitation). Most rice pests will then be destroyed.

CROP ROTATION AND INTERCROPPING (DIVERSITY):

Rotating rice with non-rice crops helps to break up the life cycle of both insects and pathogens. Continuous planting with no time for the soil to rest not only depletes its fertility but also enables pests to survive better. Intercropping (planting a second crop between rice, as in upland areas) will also reduce the spread of insects and diseases especially if the crop is very different in architecture from rice. During the growing of short maturity non-rice crops, there is no chance for rice pests to develop and they are gradually brought under control in areas where synchrony and crop rotation are strictly followed.

SANITATION:

Sanitation aims to remove all breeding or hibernating sites and sources of food of the insect or survival sites for the pathogen.

The survival stages of the rice stemborer, BPH and GLH in the ratoons are all destroyed by

plowing under or burning stubble, ratoons and straw. Grasses on the dikes and surrounding areas may also be removed or cut short to disrupt the life cycles of stink bugs and the green leafhopper. In rice, intensive cultivation and wet weather do not permit drying and burning of the straw.

Straw burning is not always advisable because it destroys most of the arthropod populations that play an important role in decomposing plant remains. It also eliminates the available nitrogen in the plant remains. Nutrient loss by leaching is also much higher after burning.

When the rice plant is somewhat older, weed sanitation in the field is, of course, needed. Weedy fields may make the microclimate more favorable for insect pests than clean fields. Clean weeding may not be always advantageous for certain species of natural enemies because there may not be any shelter left for them. For example, spiders require some shelter to survive during the period between two rice crops and this may be provided by having weeds on the bunds. With respect to BPH, the sanitation program may be limited to only destroying the rice stubbles and ratoons because other grasses are not real host plants for the insect.

Fish and ducks have been successfully used in several countries to control sheath blight and insects/weeds, respectively.

FERTILIZER MANAGEMENT:

The population of many pests, such as certain aphid species, BPH, spider mites, blast, bacterial blight and sheath blight are significantly more abundant with increased nitrogen levels. The rice stemborer Chilo suppressalis and the gall midge have also been found to be significantly more abundant in fields treated with high rates of nitrogen. High nitrogen causes the rice plant canopy to become very thick. Although high nitrogen generally favors pests, it is not advisable to use fertilizers at lower than the recommended dosage, i.e., to

sacrifice high yield for expected pest control. BPHresistant varieties have commonly been selected in high fertilizer environments and integrating such varieties with synchrony, rotation and other control tactics should achieve both high yield and BPH control. Unbalanced nutrients favor some diseases, e.g., low phosphate levels result in higher levels of brown spot disease.

WATER MANAGEMENT:

Water may influence the abundance of some pest species. BPH problems are known to increase when irrigated rice cultivation replaced dry rice cultivation. In Japan, insects are abundant in the humid lowlands and rice fields with standing water have been found to encourage the multiplication of BPH. In Indonesia, BPH prefers irrigated rice to upland rice. The problems are more serious in plots continuously flooded or with standing water. The green leafhopper Nephotettix virescens also seems to favor fields with stagnant water and specially those with intermittent rain as well.

Good water management should therefore help control certain rice pests. Draining the fields for about two days suppressed BPH outbreaks in Malaysia. In the Philippines, farmers withhold irrigation and plants are spread apart every few rows to help dry out the fields for BPH control. To effectively control the rice water weevil, fields are drained at the proper time and irrigation is stopped for a predetermined period. Draining the water level in rice fields destroys the eggs of BPH laid in the leaf sheaths. Deep irrigation in the morning followed by the addition of a certain amount of kerosene to water gives good control of BPH. In Indonesia, it is a common practice to raise the irrigation water level to control BPH; sand or sawdust containing 0.25 l kerosene for every 100 m is then broadcast on the raised water level and the plants are shaken.

PLANT SPACING:

The spacing of rice plants in a field is believed to influence the abundance of certain rice

pests. Close spacing may rapidly increase the BPH population. Close spacing results in a more shaded, cooler and more humid microenvironment, which makes it less favorable for the development of the natural enemies of BPH. Both GLH and WBPH may also increase in closely spaced rice plants. In direct-seeded rice where spacing is much closer than transplanted rice, these pests may become more severe. Close spacing also intensifies the severity of rice diseases such as sheath blight.

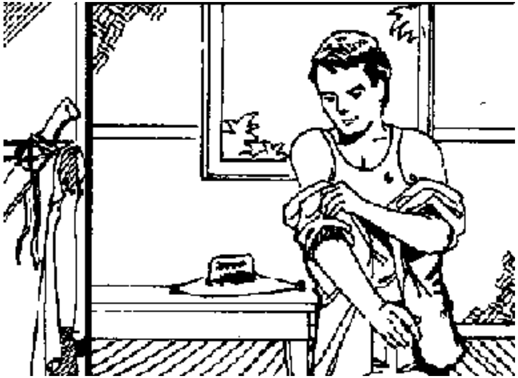
Spacing should be such that it allows some sunshine to penetrate into the basal portions of the rice plants. Solar and ultraviolet radiation restrain BPH increase. More air flow also makes the microenvironment less humid and may also help the natural enemies develop. The distance between rice plants depends on the variety. Modern rice varieties with high tillering capacity may be planted further apart than those with less or moderate tillering capacity. Common spacing between rice plants is 20 x 20 cm or 25 x 20 cm.

KEY:

BPH -- Brown Planthopper
GLH -- Green Leafhopper
WBPH -- White-backed Planthopper
SB -- Stemborer
ShB -- Sheath Blight

Pesticide poisoning

The most common routes of pesticide poisoning are:



Breathing into the lungs

Skin contact

1. Skin contact -- by spilling or splashing pesticides on clothes or directly on skin. Dry materials can also be absorbed.

Wrists, armpits, neck, groin and feet are areas of the body that absorb pesticides more quickly than others. Cuts and scrapes also allow more pesticide to enter more easily.

2. Breathing into the lungs -- Dusts, sprays or fumes can enter the system by being breathed into the lungs. Poor ventilation indoor allows greater exposure.

3. Oral/Swallowing -- Pesticides are absorbed well through the mouth, stomach and intestine. Pesticides can be accidentally taken in by people who eat or smoke while applying pesticides or when improperly stored in food containers.

4. Eye contact -- Pesticides absorption and local damage can occur with eye contamination.

FIRST AID:

In Case of Skin Contact with Pesticide

1. Take off any contaminated clothing.
2. Wash skin with lots of soap and water.

Do Not Touch the Pesticide Again or Handle Contaminated Clothing.

In Case of Eye Contact with Pesticide

1. Hold eyelids open and wash with gentle stream of cool, clean, free-flowing water.
2. If with contact lenses, remove them,
3. Continue rinsing eyes for at least 15 minutes.
4. See physician.

In Case of Breathing in (Inhalation of) a Pesticide

1. Remove person from exposure to pesticide.
2. If conscious, place person in a sitting position with head and shoulders elevated.
3. If unconscious, give artificial respiration and call for medical assistance.

In Case of Oral Contact or Swallowing a Pesticide

A. Induction of vomiting only if

1. patient is conscious
2. pesticide is moderately to extremely toxic.

Induce vomiting using the following procedure

1. Sit or stand-up patient.
2. Give 1 to 2 glasses of water.
3. Tickle back of the patient's throat using a bland instrument (spoon handle). Use 2 fingers of the other hand to force the patient's cheek between his teeth.
4. Return patient to lying position-turned towards the left, neck extended.

General Management

1. Keep patient calm and at rest.
2. Keep close observation of breathing and state of consciousness.
3. Place patient in proper position.

3.1 Place patient on his left side with head lower than the rest of the body by 15 to 30 degrees.
3.2 Keep patient comfortable but not hot and sweating or cold and chilly. Maintain a normal temperature.

BREATHING:

If Breathing Stops

1. Pull chin forward to avoid tongue dropping to back of throat.
2. Roll patient on his back, keeping chin pulled forward and head back. Remove any vomitus or secretions from the mouth using a clean cloth.
3. Pinch patient's nose and blow into his mouth through a piece of cloth or handkerchief following your normal breathing rate. Alternatively, close his mouth and blow into his nose.

Make sure patient's chest is expanding with each flow. Continue until normal breathing takes place.

If Convulsion Occurs

· Insert padded gag between the teeth to prevent the patient from biting his tongue.
· Prevent further injury by placing a cushion or pad under his head and prevent him from falling.

Tips to Induce Vomiting

4 egg whites for children
8 egg whites for adults.

Efficient and safe use of pesticides

Pesticides are still widely used pest control agents against a variety of pests in rice. There are specific pesticide groups which control specific pest problems. There are insecticides to control insects, herbicides for weeds, fungicides for fungi, rodenticides for rodents, etc.

Despite their popularity, improper and careless usage of pesticides has resulted to undesirable effects on people, livestock, non-target organisms and the environment in the rice field. Accidents have also resulted during their use, transport and storage.

To avoid these adverse effects, the following tips should be followed in using pesticides:

THINGS TO REMEMBER BEFORE MIXING:

1. Read the label carefully. The label contains necessary information relevant on how the product must be used and what to do in case of poisoning.

Read the label carefully

THINGS TO REMEMBER DURING MIXING:

1. Wear gloves, safety glasses and/or masks/respirators and mix pesticides outside the house.

2. When mixing liquid concentrates with water, it is always advisable to place pesticide into the sprayer tank first before mixing with water.

Caution: If acid is used, it must be poured into the water during the preparation of the solution. Do not pour water into the acid because an explosion could result.

3. Immediately after mixing, close pesticide container tightly and keep it in a safe area not easily reached by small children.

THINGS TO REMEMBER DURING APPLICATION:

1. Never smoke or eat during the spraying operation.

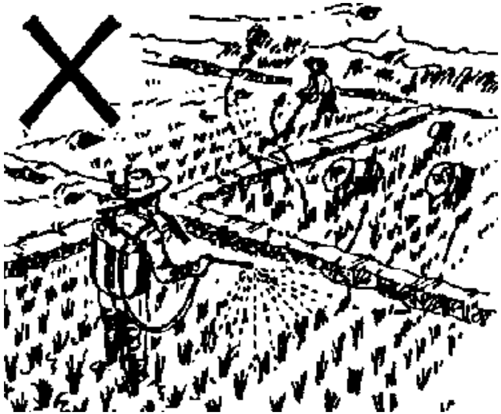
2. Wear protective clothing, such as long-sleeved shirts, pants and respirators when spraying.

Never smoke or eat during the spraying operation

3. Spray pesticide diagonal to the direction of the wind not against it.

4. Do not spray during windy days.

5. Limit spray application to 3 to 4 hours only.



Do not spray during windy days

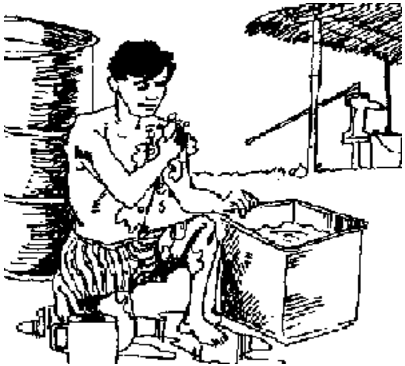
THINGS TO REMEMBER AFTER APPLICATION:

1. Wash all exposed body parts twice with soap and water; a bath would be more advisable. An alkaline soap (Perla) should be used in taking a bath, stay away from sources of drinking water.

2. Wash all contaminated clothings thoroughly with soap and plenty of water. Separate them from ordinary family laundry.

3. Do not dispose excess pesticides nor wash the sprayers in waterways (irrigation, canals, streams, rivers). Do not burn containers.

4. Dispose empty pesticide containers by burying them in suitable pits that prevent pesticide leakage into the groundwater or other bodies of water. Never burn paper packages and plastics.



Wash all exposed body parts

Low-cost control methods for golden snails (kuhol)

INTRODUCTION:

The golden snail, commonly known as kuhol (Pomacea caniculata), was originally introduced in the Philippines as a source of protein for the family. However, it has become one of the most destructive pests of lowland rice. Kuhol usually feeds on the succulent parts of the rice plant, causing stunted growth and eventual destruction of the rice plant.

Kuhol belongs to the snail family (Pelidae) that lives only in or close to fresh water in

swamps and rivers in South America. When kuhol was commercially introduced into the Philippines, its possible escape was not anticipated. The natural predators of the kuhol in South America do not exist in the Philippines. Therefore, there has been no natural check against growth and reproduction.

Between 25-500 eggs, depending on breeder size, are laid in oval-shaped clusters. Eggs are laid early in the morning and evening on standing crops, along dikes and on any object sticking up above the water surface. One kuhol can produce up to 200-300 eggs/week or 1,000-1,200 eggs/month, with 80% hatchability.

Kuhol can breathe underwater like fish or in the open air. When ricefields are drained, kuhol burrows into the moist mud, digging deeper as the dry season progresses. It can sleep hidden in dry soil for over 6 months then awaken overnight when the soil is flooded.

The kuhol is a voracious plant eater. It feeds on a wide range of plants such as Azolla, duck weed, water hyacinth, rice seedlings and other succulent leafy plants and vegetables. In irrigated ricefields, the rice is most vulnerable to the kuhol during the first 2 weeks of establishment for transplanted rice and during the first 4 weeks for direct-seeded rice.

To save the rice plant from this pest, farmers tend to use commercial/chemical snail killers which are not only hazardous to human, fish and animal health, but also alter the environment and add to the farmers' expenses. Some of the chemicals used to control snails have recently been banned. (Integrated Kuhol Management, DA/FAD, 1989).

DIFFERENT CONTROL STRATEGIES FOR KUHOL:

A. BEFORE TRANSPLANTING RICE

1. Several weeks before transplanting, allow ducks to roam around the paddy field. Ducks will feed on the eggs and smaller snails.

Allow ducks to roam around the paddy field

2. Hand-pick all the larger snails not eaten by the ducks. Crush them with a mortar end pestle and feed them to the ducks. The snail meet end shells are excellent sources of protein and calcium for laying ducks.

Hand-pick all the larger snails

B. AFTER TRANSPLANTING RICE

1. Install a wire mesh screen in the water runways to prevent the eggs and adult snails from entering the paddy field during irrigation.*

Install a wire mesh screen

2. Maintain shallow water (2-3 cm) during the first 15 days after transplanting to minimize damage. One month after transplanting, allow ducks to roam the paddy field and consume the remaining eggs and snails.

Maintain shallow water

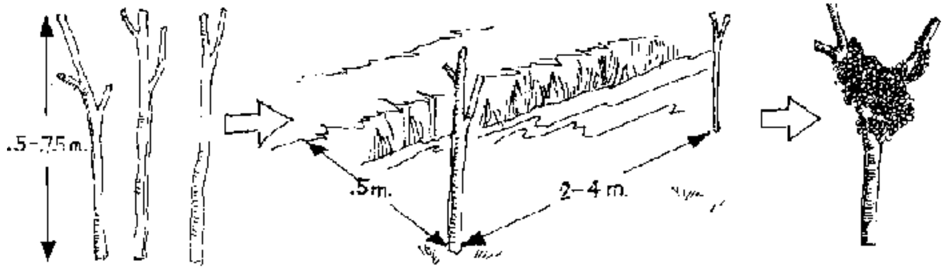
3. Construct depressed strips in the paddy where wafer will be retained when the field is drained. The snails will migrate and collect in these lateral depressions and can then be collected.

Construct depressed strips

C. PLACEMENT OF STAKES

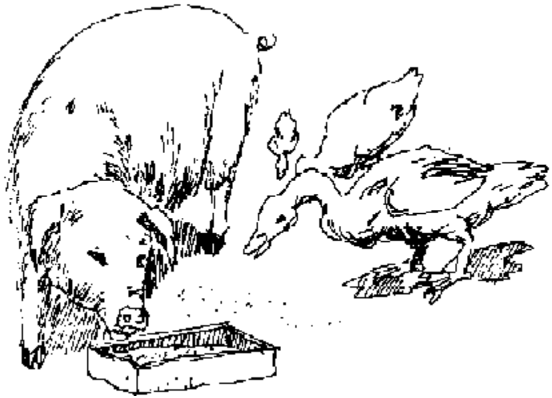
1. Snails prefer to climb above the water level to lay their eggs.

2. Collect stakes 0.5-0.75 m long and 2 cm in diameter. Arrange them 0.5 m from the rice paddy dikes, 2-4 m apart The kuhol will lay their eggs on these stakes.



Collect stakes 0.5-0.75 m long

3. Gather the eggs, crush them and feed them to ducks, chickens and pigs.



Gather the eggs and feed them to ducks, chickens and pigs

D. RICE HULL

1. Separate coarse hulls from the fine ones with a sieve.

2. After a rain, evenly spread a 1-2 cm layer of rice hulls in the ricefield. The hulls will affect the digestive system of the snails, causing them to starve and die. Three or four days after spreading the hulls, collect the dead snails.

Separate hulls

Spread hulls

E. EAT KUHOL

The kuhol first introduced as a high protein food for human consumption, has a high nutritive value. A bite-size snail contains the following:

Food energy	83.0 calories
Protein	12.2 gm
Fat	0.4 gm
Carbohydrates	5.5 gm
Ash	3.2
Phosphorous	61.0 mg
Sodium	0.4 mg

Potassium	17.0 mg
Riboflavin	12.0 mg
Niacin	1.8 mg

The kuhol also contains vitamin C, zinc, copper, manganese, magnesium and iodine. (Integrated Kuhol Management, DA/FAD, 1989).

RECIPES:

TORTANG KUHOL

1 saucer cooked ground kuhol
1 tbsp. chopped onion leaves
1 tbsp. chopped tomatoes
1 tbsp. chopped onions
1 tbsp. crushed garlic
2 tbsp. cooking oil
1/2 tsp. salt
1 whole egg beaten
1 tbsp. all-purpose flour

Put salt on kuhol then saute with garlic, onions and tomatoes. Remove from pan and mix sauted ingredients with beaten egg. Coat the mixture with flour and fry. Serve hot.

GINATAANG KUHOL

2 saucers cooked kuhol shelled
2 cups coconut milk
1 tbsp. crushed garlic

1 tbsp. chopped onions
1 tbsp. chopped tomatoes
1 pc. ginger
2 tbsp. achuete
2 tbsp. cooking oil

Saute garlic, ginger, onions and tomatoes in hot cooking oil. Add cooked kuhol to sauted mixture. Stir in coconut milk and achuete. Boil until oil comes out. Serve hot.

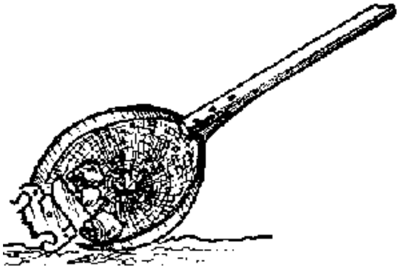
Note: Snails should not be eaten by humans or livestock including ducks if collected from rice paddies which have been sprayed with chemicals.

Easy ''do-it-yourself'' snail collector

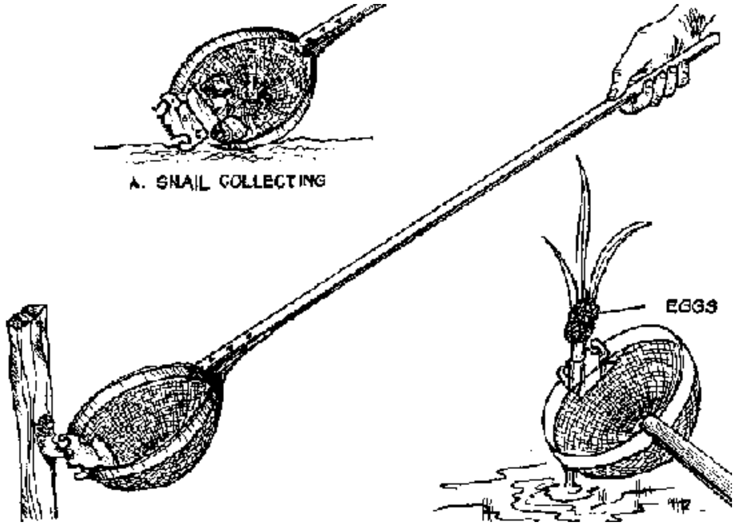
Golden snail (Pomacea caniculata), a serious rice pest, can now be locally controlled at a bargain by using a do-it-yourself method of scoop and scrape snail collecting device called salaan collector.

Instead of bending or- stooping hundred of times to collect snails, the multipurpose snail picker, with its long handle, can now reach distant crawling snails and clusters of eggs, without tiresome bending.

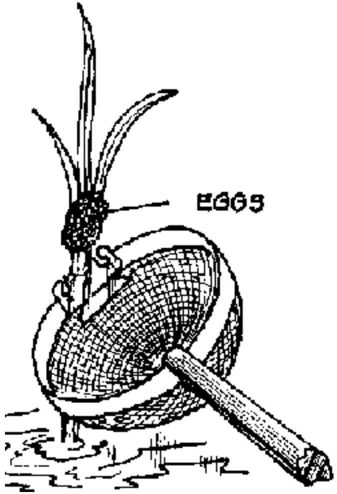
With this simple and inexpensive picker, one can collect and dispatch snails by the thousands while they are still in egg clusters. This device, with its scorpion-shaped plate attachment, enables one to scrape eggs from walls and host plants without damaging them.



A. Snail collecting



B. Scraping eggs on walls



C. Scraping eggs on plants

HOW TO MAKE A "SALAAN" SNAIL COLLECTOR

Materials Needed:

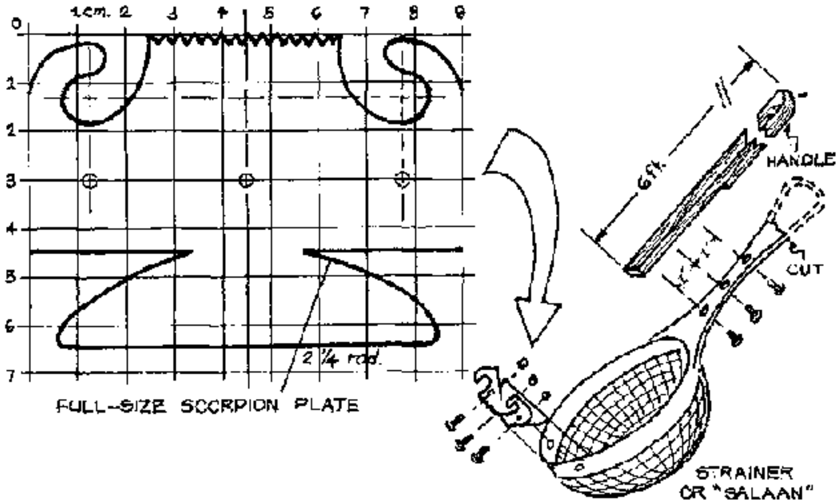
1 pc 1 in x 1 in x 6 ft wood or bamboo pole
1 pc 2 1/2 in x 3 1/2 in gauge 20 or 22 galvanized sheet (This is roof gutter sheet gauge)
1 pc 1-2 mm mesh coconut strainer (salaan)
3 pcs 1/8 in x 3/4 in length self tapping screw
3 pcs 1/8 in x 1/2 in cap screw

Procedure:

1. Paste the pattern below onto gauge 22 sheet metal.

2. **Cut sheet metal with snip.**
3. **Drill hole with 1/8 in diameter puncher.**
4. **Bend metal to shape.**
5. **Plane sharp edges of 1 in x 1 in x 6 ft wood to make round for greater comfort.**
6. **Screw salaan with wood handle.**
7. **Assemble finished scorpion-shaped plate into salaan.**

Note: For the scorpion plate, tin can materials may be used although life span of the plate will be shorter.



How to make a "salaan" snail collector

Makabuhay, a natural pesticide for lowland rice

RESEARCH FINDINGS SHOW THAT:

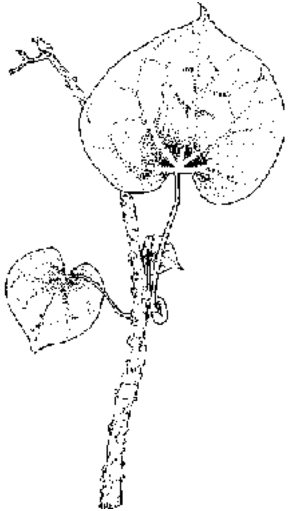
· The application of chopped Makabahay is as effective as the use of chemical pesticides in reducing deadhearts and white heads due to striped stemborer attack and in reducing the green and brown leafhopper populations.

· The aqueous extract of Makabuhay (50 9/125 ml water) is toxic to green leafhopper when applied to rice seedlings by root-soaking 24 hrs before transplanting or by spraying it to the seedlings. These treatments are comparable to root-soaking in chemical pesticides.

· The submerged chopped Makabuhay stem is toxic to the rice green leafhopper.

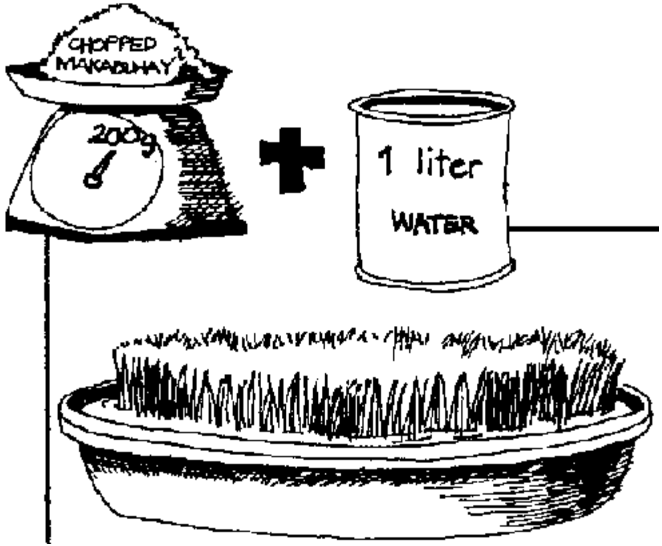
· The combination of aqueous Makabuhay extract root soaking and broadcasting of chopped vine is as effective as the recommended chemical pesticide seedling treatment followed by spraying with chemical pesticides 25 days after transplanting.

· Broadcasting of ground Makabuhay vine (0.25 kg/sq.m) on rice seedbed 10 days after sowing is as effective as broadcasting with chemical pesticides.



Sc. Name: Tinospora rumphii Local Names: Makabuhay (Tag., Bik., Ilk.); Manunggal (Ilonggo); Abukay (Ilk.). Palayawan (Waray)

PREPARATION AND USAGE:



Root soaking

1. Chop the vine into small pieces and pound it with the use of a mortar and pestle.
2. Add 1 liter water for every 200 9 crushed Makabuhay vine. Thoroughly stir the mixture, then soak the rice seedlings overnight before transplanting.

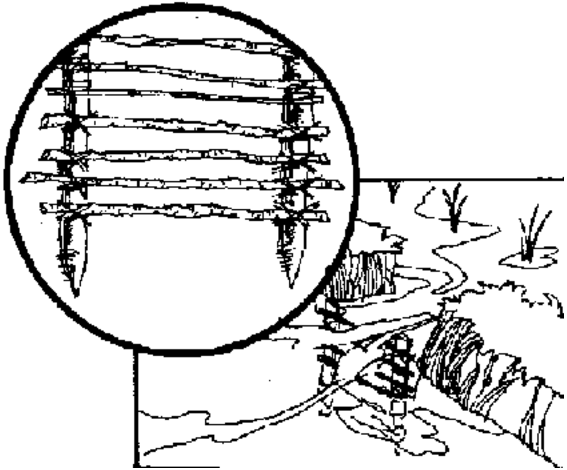
Ten to 15 kg of chopped vine are sufficient to treat seedlings needed to plant 1 hectare.

IMMERSION

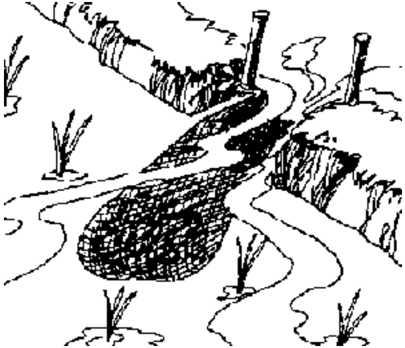
1. Cut the Makabuhay vines to approximately 1 ft lengths.
2. Tie both ends of the cut vines onto bamboo stakes as shown in the diagram.

3. Drive the stakes into the ground along water inlets.

4. You can also put 1 liter chopped Makabuhay vines inside a fish net bag and place the bag along the wafer inlets. Replace the Makabuhay every 2 weeks. Check the bag regularly for accumulation of mud or other debris.



Tie both ends of the cut vines



Put 1 liter chopped Makabuhay vines inside a fish net bag

Low-cost insect trap

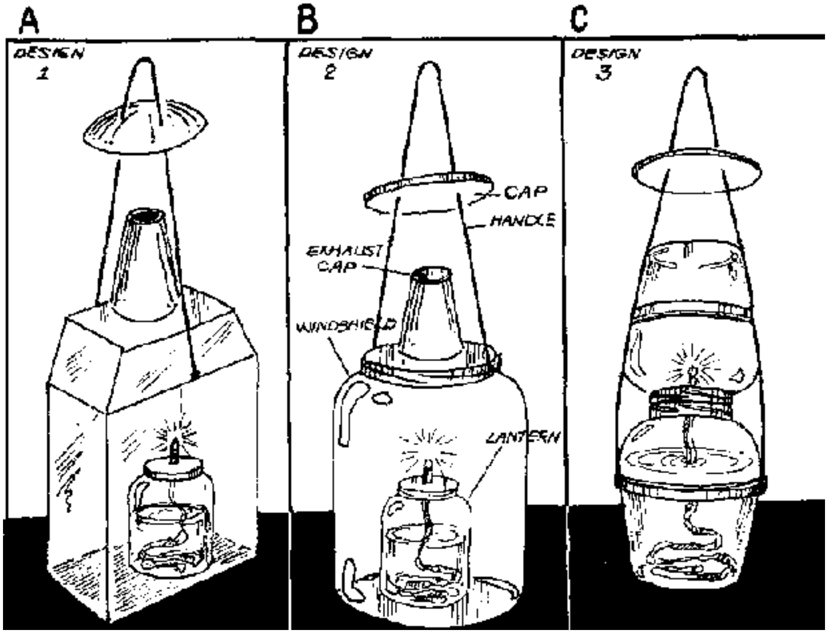
The light trap is an inexpensive tool used in monitoring insect pest populations and helping reduce their numbers. Light traps were used by many farmers before the introduction of modern rice varieties when chemical pesticides were still not generally available. The light trap can also be used in fishponds or rice- fish paddies to attract insects upon which the fish can feed. As pesticides became more common and were used to prevent damage to crop, light traps became less important.

Today, however, chemical pesticides are recommended only as a last resort because of their high environmental, health and economic costs. Therefore, pest management practices today require a greater knowledge in pest identification and a system of monitoring insect populations.

LANTERN DESIGNS:

Lanterns can easily be made from locally available materials like empty glass jars

(mayonnaise jars) as illustrated below. The lantern costs from P50 (design A) to P15 (design C). It uses about P1 to P2 worth of kerosene per night and produces a bright white light.



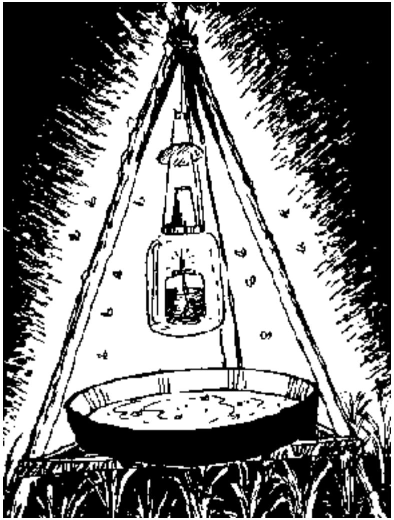
Lantern designs

LOCATING THE INSECT TRAP:

The lantern is attached to a frame (tripod) of either bamboo or wood and is hanged above the rice crop. The frame has a platform that supports a basin of water just below the

lantern. Adding some cooking oil to the water can make the insects immobile upon falling into the water.

In rice-fish fields, hang the lantern over the water in the trench at a height which is just above the dike. At that height, the light is easily seen by insects flying just above the crop canopy.



Locating the insect trap

USING THE LANTERN:

The lantern should be lit as soon as it gets dark (when insects are most attracted to light) for 24 hours. In cases where the field is far from the house, the lantern should be filled with just enough kerosene to burn for 2 hours. The lantern should be visited daily and the

insects identified and counted.

NOTE:

· If the light trap is primarily intended to reduce the insect population, more than one trap is advisable.
· If the light trap is intended to monitor insect population for forecasting, 1-2 traps/ha. is enough. Check with the local technician.

Pests	**Local Name**	**Time When Most Attracted**
Scarab beetle	Uwang, salagubang, salaginto	New moon
Cricket (Gryllotalpa orientalis)	Subong	Full moon
Caseworm (Nymphula depunctalis)	Paruparong gabi	New moon
Green semliooper (Naranga aenescens)	Paruparong gabi (berdeng uod)	New moon
(Rivula atimeta)	Mabalahibong berdeng uod	New moon
Gallmidge (Orseolia oryzae)		Full moon
Armyworm (Mythimma separate)		New moon
Cutworm (Spodoptera litura)		
(Spodoptera mauritia)		
Stemborers:		
Striped (Chilo suppressalis)		
Yellow (Scirpophaga incertulas)	Aksip	New moon
Pink (Sesamia inferers)		

Pink (Sesamia inferens)		
White (Scirpophaga innotata)		
Brown planthopper (Nilaparvata lugers)	Ngusong kabayo	Full moon
Whitebacked planthopper (Sogatella furcifera)		
Green leafhopper (Nephotettix virescens)		
(Nephotettix nigropictus)	Berdeng ngusong kabayo	Full moon
(Nephotettix malayanus)		

The above is compiled from researches conducted by the Entomology Department of IRRI, Los Baos, Laguna, Philippines.

Weed management

Weed management

REASONS FOR WEED MANAGEMENT:

1. Weeds reduce yield by competing with the crop for sunlight, moisture and soil nutrients.
2. Fertilizer application in weedy fields may prove wasteful because weeds absorb the fertilizer (especially N) more effectively than the crop.
3. Weeds may serve as alternate hosts for crop pests.

LOW-COST WEED MANAGEMENT PRACTICES:

There are many ways to manage weeds in ricelands at little cost without having to resort to the use of herbicides. The key to low-cost weed management and high yield is prevention. Preventing weeds from growing is cheaper and easier than removing them. Some simple methods of prevention include: (1) thorough land preparation; (2) using weed-free seed or seedlings; (3) employing shade and mulch to slow down weed growth; (4) crop rotation; and (5) good water management (for lowland rice).

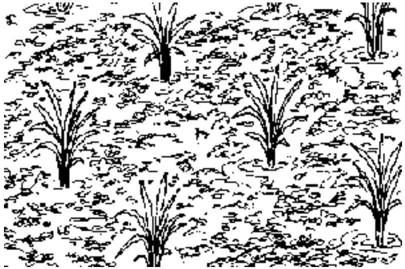
1. Land preparation. Good land preparation gives the crop a chance to grow ahead of the weeds. This reduces competition during the very sensitive seedling stage. Moreover, by the time the weeds start to emerge, the plants have grown tall enough to shade them out, further preventing their growth.

2. Weed-free seed and seedlings. If planting material is not kept free of weeds (or weed seeds) then the crop will have a competitor from the start of growth. In the Philippines, transplanting weeds with rice seedlings is causing losses of 16-23%. (See technology sheets on Rice Seed Production.)

3. Shading/mulching. "Let plants do the work for you." Keep a cover of economic plants on the field to shade out weeds.

· Select taller varieties of the crop to be grown.
· Increase the planting density to reduce weed competition.

· Use Azolla to effectively shade out grasses, sedges and small broadleaf weeds in (lowland rice). Use of Azolla alone can reduce weed dry matter production by 50-60%.
· Residues from the previous crop can be applied as mulch to deter weed growth (aside from conserving water and improving soil fertility).
· In fallow periods, a good stand of green manure will shade out most weeds, preventing them from setting seed.



Select taller varieties of the crop

Increase the planting density

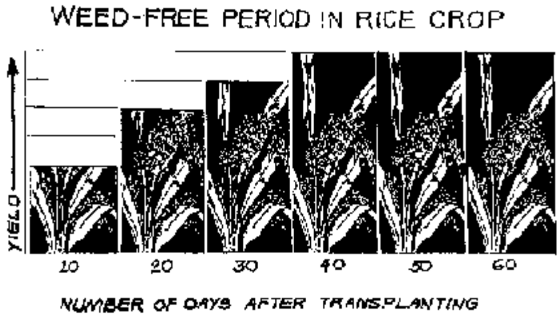
4. Crop rotation can considerably reduce weeds. Weed population is lower when planting rice after an upland crop like mung bean or cowpea rather than when it is preceded by another rice crop. The radical differences in cultural practices between upland and lowland crops result in different species of weeds with each system. By rotating crops, weeds have less chance to establish, keeping their population down.

With continuous monocropping, weeds associated with the crop have a chance to establish themselves and increase their populations.

In areas where crop rotation cannot be practiced, levels of weed control have in the first crop affect weed population in the second. Good weed control in the first crop means fewer weeds in the second.

Another way to inexpensively control weeds is to have livestock do it for you. Both ducks and fish consume large numbers of weeds.

Most crops do not have to be kept weed-free for the duration of their growth, especially so when labor is scarce or expensive. The number of weedings can be reduced by comparing the recommended weed-free period and the time that critical competition begins between the crop and the weeds. This varies with crops and different cultural methods. For example, transplanted rice is supposed to be kept weed-free for the first 30-days after planting. However, the period when weed competition will actually reduce yields does not begin until 25-30 days after transplanting, so weeding can be reduced to one time only, that time between 20-30 days after transplanting.



Weed free period in rice crop

WEEDS ARE NOT ALWAYS BAD FOR FARMERS:

· Some weeds can be used as additional forage for livestock.
· Other weeds can be returned to the soil to increase OM.
· Allowing weeds to grow in some paddy dikes provides shelter to many beneficial insects where they stay throughout the dry season and help keep pest populations down once rice planting begins.

ccccccc

Weed control in lowland rice

With no weed control measures, an average of 34% yield loss is expected in transplanted lowland rice and 45% in direct-seeded rainfed lowland rice.

COMMON WEED CONTROL METHODS:

· Land preparation

- **Hand weeding**
- **Mechanical weeding (use of push-type rotary weeders)**
- **Flooding (keeping the field flooded for a period of time to control most weeds)**
- **Use of herbicides**
- **Use of azolla**

Method	Labor Requirement	Reduction in Weed Weight	Remarks
Hand weeding 	120 man-hours/ha	94.4%	high labor input required to finish weeding within the critical weeding period (2-4 weeks after transplanting)
Use of mechanical weeder 	40-60 manhours/ha	50.3%	requires row planting; cannot remove weeds at the base of rice plants and in the planting row; provides better aeration to crops; can be used for azolla incorporation to reduce fertilizer costs
Use of herbicides/ weedicides 	4 manhours/ha	18.5%	requires proper handling of chemicals, otherwise, would pose extreme health hazards; continued use may lead to development of herbicide resistance by weeds; azolla cannot be used.

General comparison of selected weed control measures

MECHANICAL WEEDER VS. PRE-EMERGENCE WEEDICIDES

If on-farm labor is unavailable and must be hired, the use of mechanical weeders will involved higher costs compared to the use of weedicides. However, the net returns will be higher if farm family labor is used to utilize mechanical weeders.

The following case study (based on farm records) compares the two methods:

	Weeder	**Pre-Emergence Herbicide**
1. Area planted	1/2 ha.	1/2 ha.
2. Variety	IR 42	IR 42
3. Crop period/duration	Aug. 4	Nov. 18,1987
4. # Cavans harvested @50 kg/cay.	42	38
5. Gross Value of harvest @P3.5/kg	P7,350	P6,650
6. Cost		
a. Labor for marking rows for transplanting @P40/ha.	20	20
b. Depreciation cost of weeder*	50	-
c. Cost of 1/41iterweedicide (Machete)	-	50
d. Labor for mechanical weeding (5 man days @P35)	175	-
e. Labor for spraying	-	8.75
(1/4 man days @P35)		
f. Additional handweeding	70	70

(2 man days @P35)		
g. Total cost of weed control	P315.00	P148.75
7.Gross returns less cost of weed control	P7,035.00	P6,501.25

Above case also illustrates that a more effective weed control scheme is one that involves a combination of two or more weed control methods.

*** Assuming a weeder costs P300 and can last for six cropping seasons.**

Water management for weed control in rice

Flooding rice paddies was one of the first tools developed by farmers to control weeds in rice. On farms with reliable irrigation, water. management is also one of the most effective and lowest cost methods of controlling weeds. Even for farms in rainfed or semi-irrigated areas where the need to conserve water limits the ability to manipulate water levels, water management is still an important tool in weed control.

Water management for weed control in rice

1. At land preparation

Keep the paddy field flooded after harrowing to kill weeds and to hasten decomposition. Water level should be high enough to submerge all weeds.

2. At final levelling

Final levelling eliminates any high spots in the field. Weed seeds in these high spots would be able to germinate because they would be above the water level.

In areas with good irrigation, final levelling should be done in saturated soil but with no standing water.

In rainfed or semi-irrigated areas, conserve water by maintaining water levels at 3 cm.

Final levelling should be done 1 day before transplanting.

3. At transplanting

Irrigated: The puddled, levelled field should not have standing water. This facilitates straight-line transplanting because the lines can easily be seen and assures that the seedlings will establish good root-soil contact and quickly begin to grow.

Rainfed: Paddies should be drained to facilitate transplanting unless no rain is expected -- in which case some water should be maintained in the paddies.

4. Transplanting to tillering

Paddies should be flooded 1-3 days after transplanting to prevent weed seeds from germinating. The time to flood is determined by presence or absence of Azolla (Flood 1 day after transplanting if Azolla is being used.) and establishment of the seedlings.

Water level should be 2 cm initially and increased gradually to 10 cm as the rice plants grow.

5. After maximum tillering to post-flowering

Once maximum tillering stage is over, weeds have no effect on rice yield. Continuous flooding or submergence of the field is desirable but not necessary. Water depth may vary from 3-10 cm if there is sufficient irrigation water. Where irrigation water is scarce, the objective should be to maintain at least a saturated soil once crop canopy is full enough to shade out weeds.

Using ducks for low-cost weed management

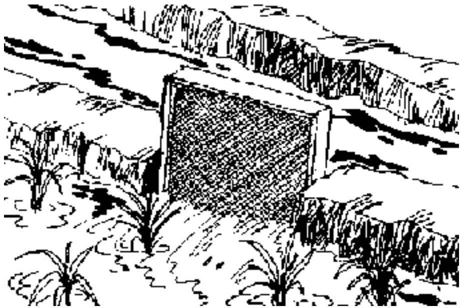
The use of ducks can complement other weed management practices in rice paddies where straight row planting is used. When the crop reaches 20 cm in height (approximately 25 days after transplanting) until the booting stage, the ducks can be allowed into the rice paddy without damaging the crop. Forty to fifty (40-50) adult ducks feeding for 3 hours a day for 3 consecutive days can weed a 1,000 sq.m area. Any species can be used but Mallard ducks (Anas platyrhynchos) are most recommended because they are more active and have light and narrow bodies.

PROCEDURE

1. Irrigate the field to a depth of 3 cm (ducks will not enter the rice paddy field without water). To encourage them to enter, broadcast a handful of rough rice into the paddy.

Irrigate the field

2. The constant dabbling or feeding and trampling by the web-footed ducks make the soil soft and muddy and inhibit the growth of weeds and at the same time incorporate weeds growing in between the rows of rice.



Dabbling

3. Broadleaf weeds and sedges are eaten by the ducks. Insects (e.g. moths or stemborers, hoppers, mole crickets, etc.) and golden snails which are found at the base of the rice crop are also eaten, thereby reducing pest populations.

Low-external Input Rice Production (IIRR, 292 p.)

Water management/cropping patterns

Water management for rice in drought-prone locations

A number of strategies exist for farmers to minimize risks and reduce losses in drought-prone and rainfed rice-producing areas. These strategies focus mainly on the following: varietal selection, timing of planting to minimize drought damage, maintenance of water level, cultural practices aimed at conserving water or improving drought resistance and altering the physical farm environment.

1. Varietal selection

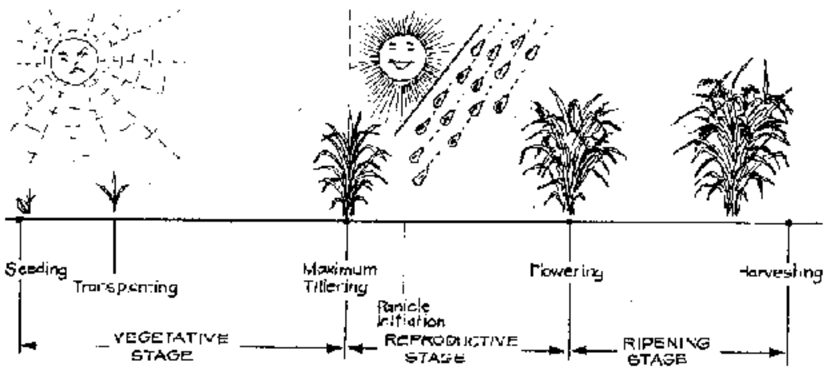
· Select drought-tolerant varieties if drought is likely to occur. In general, IRRI found droughttolerant rice varieties to have long, dense and thick roots. Traditional varieties like BE-3, Peta and Intan tolerate some drought but yields are lower than modern varieties. The IRRI varieties IR6, IR46 and IR64 also withstand mild drought although IR36 and IR64 are prone to tungro disease.

· Plant very short-duration varieties to avoid the drought period entirely.

2. Timing of-planting

· Plant the rice such that the vulnerable reproductive stage does not fall during the drought season. This presupposes a regularly occurring drought in a region which the farmers anticipate and plan around.

· Synchronize planting with neighboring farmers to minimize irrigation water wastage.



Timing of-planting

3. Maintenance of water level

· It is important to provide the crop enough water to induce maximum tillering (formation of stalks) for a good cover (canopy) so that water losses by evaporation would be minimized.

· Water is essential during flowering on from 55-70 days after transplanting of the shortduration varieties. If simultaneous planting is done, 800-1,000 mm of water would be minimum requirement.

· Fields need only be kept moist (not flooded) all the time with a 1-2 mm layer as minimum. Using this strategy gives a 30-50% cut requirements without yield losses.

4. Other cultural practices

· Maintain rice paddy dikes to minimize seepage and clean irrigation ditches regularly.

· Establish good weed control. Most weeds are much more efficient than rice in exploiting soil moisture.

· Supply nitrogen (N) and other fertilizers early. If using less than 30 kg N/ha, apply all of it basally. If applying more than 30 kg N/ha, use the best split (2/3 basal and 1/3 topdress 5-7. days after panicle initiation [DAP]). This improves the plant's drought resistance by encouraging faster root growth and, thus, more soil area can be exploited for soil moisture.

· Increase soil organic maker (OM) content. OM improves the soil's water absorption and retention capacity.

· Minimum tillage (one plowing and one harrowing) reduces the water requirement for

land preparation and speeds crop establishment, lowering the risks of an end-of-season drought. Minimum tillage is possible in fields where perennial weeds are few.

· Direct seedling of pregerminated seed can be used where there is not enough water to thoroughly prepare the land for transplanting. Direct seeding also results in a stronger root system. This gives the crop batter capacity to survive during short drought.

· Farmers should use the early rains of May for land preparation since this water largely goes to waste.

5. Altering the physical farm environment

· If feasible, impound water in one-fifth of the land area. A 200 sq.m structure will be enough to supply the water for a half hectare of rice crop and could also be used for fish production.

· Reduce the area planted to rice to increase the amount of irrigation or residual rainfall water available. The Sorjan system developed by farmers in Indonesia is one such method of water management. Tests done in Indonesia show that this system nearly doubled the amount of available water for rice production. Devote low-lying areas of the farm to rice and plant the upper areas with dryland crops. The rice crop can take advantage of the higher water table in the lower areas and can utilize runoff from the upper areas. (See the technology sheet on Sorjan: Towards Rice-based Integrated Cropping System.)

· Plant windbreaks to reduce evapotranspiration of the rice crop.

· At the national level, deforestation is the main cause of irrigated water shortages for rice production. For long-term sustainability, the nation's mountainous area must be reforested.

Legume crop rotation with rice

INTRODUCTION:

In rainfed lowland areas which are traditionally planted to only one crop of rice per year, land use can be optimized by using the pre- and/or post-rice wet period to grow-legume crops. Legumes are suitable rotational crops with rice because they:

· can mature in 55-90 days.
· can be grown as pre-rice crop when rainfall accumulation reaches 100 mm/mo or as postrice crop using the receding rain and residual soil moisture.
· are acceptable crops because they are easy to prepare for consumption or to sell at the market.
· are drought-tolerant.
· are capable of using atmospheric nitrogen and contribute nitrogen to the soil.

IMPORTANCE:

1. Intensifies land use and increases crop production per area per year.
2. Provides an additional source of food and income to farmers. Legumes can also provide biomass for green manure and fodder.
3. Sustains soil productivity through nitrogen cycling with legumes.
4. Weed production is reduced by planting an otherwise fallow area.

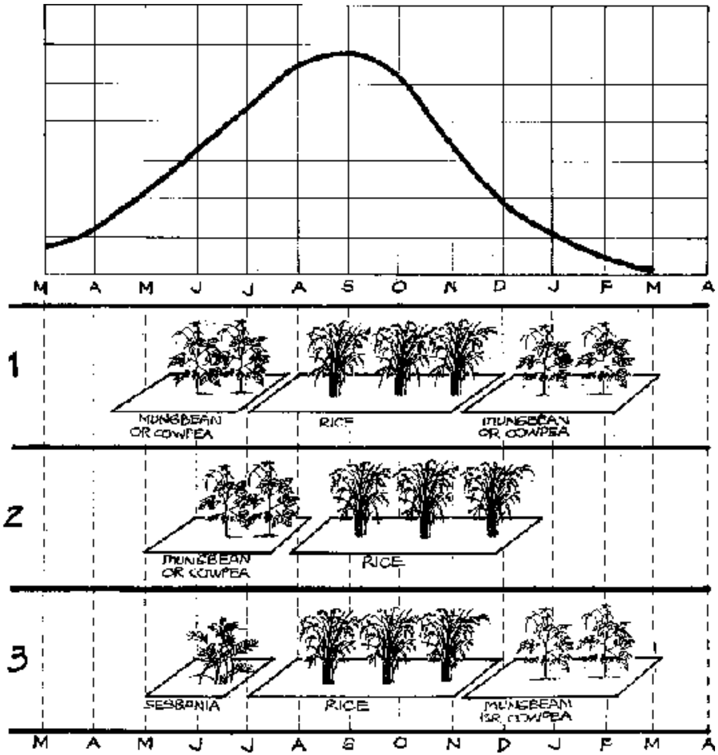
DESIGNING THE CROP ROTATION PATTERN: (Refer to the figure on theoretical rainfall occurrence and proposed legume-rice sequences)

1. Based on knowledge from past years or from rainfall data, determine the onset and the end of the rainy season.
2. Choose short-maturing varieties of both rice and legume crop to accomodate a three-

crop sequence or to avoid water stress.

3. Estimate the planting and harvesting dates of each crop in the cropping sequence.

4. If, based on the rainfall occurrence and drainage system, only a two-crop sequence is possible, there is a flexibility to choose a longer duration crop variety which has other desired characteristics.



Theoretical rainfall occurrence and the proposed legume-rice sequence

ADDITIONAL POINTERS:

1. The field should be well-drained. This minimizes flood damage if heavy rains occur during the legume cropping season and it facilitates post-rice land preparation for legumes.

2. If no legume crop will be grown after the rice crop, the field should still be plowed after rice harvest so that land preparation for the following pre-rice legume could be done quickly and easily using the early rains.

3. For the post-rice legume, a variety high in both grain and biomass yield (usually indeterminate or late-maturing) such as indeterminate cowpea, Indigofera, etc., is desirable so that more residues will be produced for use as fodder during summer or as green manure for the next crop. The crop should be tolerant to drought.

4. Other criteria in choosing crop varieties/species to be used are: adaptability to the site; marketability; tolerance to crop hazards -- like excess moisture (for pre-rice crop), drought (for post-rice crop), wind and short-term floods.

The ideal legume species are mung bean and cowpea. They are planted with 50 cm row spacing at a population of 300-350 and 350-400 thousand plants/ha as pre-rice and post-rice crop, respectively.

5. If the available time for pre-rice legume is less than 60 days, green manures, such as Sesbania, could be planted instead of grain legumes.

Rice ratooning

Ratooning, the ability of rice plants to regenerate new tillers after harvest, may be one practical way to increase rice production per unit area and per unit time. Because ratooned rice has shorter duration than a new crop, it may increase productivity in areas where cropping intensity is limited by inadequate irrigation facilities or by a second crop where the rice season is less than 180 days. Besides short duration, it costs less to grow a ratoon crop than a new crop. The major advantages of rice ratooning are:

· Lower production costs because of savings in land preparation and plant care during early growth;
· Short duration;
· Efficient use of the growing seasons, especially in monsoonal climates;
· Higher yield per unit area in less time;
· Possible maintenance of the genetic purity of a variety or hybrid rice through several seasons;
· Low irrigation water requirements;
· 60% reduction in the amount of water needed to compare to a second crop of transplanted rice; and
· 50-60% reduction in the amount of labor needed especially important considering the shortage of labor when the first rice crop is harvested and the second is planted.

Yields are generally lower in a ratoon crop than in a transplanted second crop. However, the capital and labor savings are often enough to make a ratoon crop more profitable. The lower yield potential outputs of 3-4 T/ha have been frequently reported.

HOW TO HAVE RATOON CROP PRODUCTION:

Selecting the right variety is one of the most important and critical steps in obtaining high crop yields from ratoons. An ideal cultivar for rice ratoon cropping should have the following traits:

- **Produces ratoon tillers after and not before harvest;**
- **Tillering from basal, not upper, nodes;**
- **Sixteen ratoon tillers/hill at 20 x 20 cm spacing;**
- **At least 3 leaves/tiller;**
- **Resistance to major disease and insects;**
- **Synchronized flowering and maturity;**
- **More than 60 growth duration from cutting to maturity; and**
- **High grain yield.**

Recommended land preparation practices for the main rice crop are undertaken only once because the ratoon crop does not require another round of land preparation. Deep plowing (25 cm depth) increases yield of the ratoon crop but under Philippine conditions, this is not practical.

Crop establishment in the main crop may either be by transplanting or direct seeding. Planting density is a more important factor in determining yield: the more plant/sq.m. the higher the yield (if no lodging occurs). Direct seeding usually results in a higher plant density than does transplanting at 20 cm x 20 cm distances but if the triple row transplanting method is used, plant density is about the same and less lodging occurs.

Fertilization of the main crop is essential for good yields in the ratoon crop. Deep placement of N fertilizer, if feasible, should be practiced as yields in the ratoon crop are increased by this practice. Green manuring practices and Nitrogen rates recommended for the first crop should be followed. N should be applied immediately at the harvest of the main crop to stimulate tillering of the ratoon crop. Suggested rate is 15-45 kg. N/ha.

Ratooning is a viable option for those farms where a second rice crop is not profitable and upland crops are either not profitable or cannot be grown due to poor drainage or other. factors.

Sorjan: towards rice-based integrated cropping systems

Sorjan, an indigenous technology of Indonesia, is a series of sinks or canals alternating with raised beds. Rice is usually planted in the sinks and a wide variety of upland crops is grown in the raised beds. The use of Sorjan (on 1000 sq.m) as one component of an integrated rice farming system results in higher and more regular income for the farmer due to the following:

1. Increased production per unit of land area
2. Crop Diversification

· Growing of high-value, off-season crops
· Simultaneous growing of a wide variety of lowland and upland crops assures farmers a good harvest from at least one of the crops.
· Increased fodder production for livestock.

3. Earlier rice crops and higher yields in partially irrigated or rainfed areas
4. Other Benefits

· Increase in quantity and variety of food available for home consumption
· Increased fertility of sinks
· More even use of labor throughout the year
· Practical and ideal for farmers whose land area is less than 1 hectare
· Could be adopted in a wide range of agro-ecological conditions.

Note: This technology has a high labor requirement during the initial development of the plots.

1. INCREASED PRODUCTION AND LAND UTILIZATION

Production increases in Sorjan because water is used more efficiently, weed control is easier and both upland and lowland crops are grown in environments more closely tailored to their needs.

Water collects and stays in the sinks -- where it is needed most. The standing water aids rice growth and keeps weed populations to a minimum. The upland crops have a stable water supply (the standing water in the sinks which is available to them through wicking action), combined with good drainage and air circulation.

Along the sink portion (as well as in lateral canals) fish could also be introduced while, at the top portion of the sink, trellises for vegetable production are also recommended.

Under these Ideal conditions, production is very high. In work done by a Masteral student at U.P. Los Baos, yields of grains and fodder from the Sorjan were 21 T/ha/yr of grains and 14 T/ha/yr of fodder for continuous cropping of rice.

2. DIVERSIFIED PRODUCTION

The growing of upland and lowland crops at the same time in the same field practically assures the farmer a good harvest of at least one of the crops. High-value crops, such as tomatoes and onions, fetch very high price when grown in the rainy season -- which is possible in Sorjan. The most profitable cropping pattern tested by IRRI was tomatoes -- onions -- bush sitao with a net income of more then P40,000/ha.

The quantity and quality of fodder production are also greatly increased. The addition of grain legumes, such as mung bean, provides high protein fodder for livestock. Intensive production of fodder grasses and trees to supplement livestock feeds is possible in this system. Napier planted in the side of the beds prevents the erosion of the beds (reducing maintenance) and produces more than 2 kg of high quality fodder grass/linear meter every month. In the UPLB study, fodder produced was enough to meet the feed needs of

11 carabao heifers or 29. cattle fatteners.

In the study conducted by IIRR in 1988 (dry season), data showed that the net income of rice planted on the sink portion yielded P9,471 on a hectarage basis, while on the elevated plot, cowpea had P10,773 and napier grass with P2,706.

Rice-fish also has very good potential in Sorjan due to the greater degree of water control. IRRI has recorded yields of nearly 200 kg of fish/ha/crop in addition to rice and upland crop yields. Yields could be tripled according to data from India.

3. EARLIER RICE CROPS WITH HIGHER YIELDS

In rainfed or partially irrigated areas, farmers must wait for enough water to accumulate before plowing and puddling the soil (land preparation). In Sorjan sinks where the rice is grown, water accumulation is faster because of runoff from the beds. Tests in India indicate that 46% of the rain falling on the beds is collected in the sinks. Fields can be puddled up to three weeks sooner. The same trials in India compared rice yields from Sorjan and normal rainfed rice over three years. Yields were 70% higher per unit area in Sorjan. This means that even by taking half the land out of rice production (i.e., the raised beds), yields were almost the same (1.5 T/ha for rainfed rice production and 1.3 T/ha in Sorjan).

BED CONSTRUCTION:

The construction of the beds can be done in several ways: plowing with an upland plow and shovelling the soil to form the beds; or plowing a flooded field, harrowing to move the soil into a rough bed and then shovelling to straighten the edges.

The method chosen will depend greatly on labor availability. An area of about 1,000 sq.m. requires anywhere from 300-600 man hours -- which can vary upon the number of beds to

be constructed, their width and height.

DETERMINING BED HEIGHT AND WIDTH:

A number of factors need to be taken into consideration when deciding on bed height and width:

Height:

- Terrain. If field is sloping, a lower height is needed because there is less problem with drainage (for the upland crop planted on the beds).
- Chance of flooding/height of floodwater. If flooding occurs, the bed must be high enough so that the upland crops will not be flooded.
- Rate of soil erosion from bed to sinks. Original heights of bed should be higher under high erosity conditions.
- Soil fertility/depth of topsoil. Sinks should not be dug so deep that subsoil is exposed.

Width (and/or number of beds):

- Water needs. If the land is rainfed, the width will be determined by how much runoff from the beds is needed for the rice in the sinks.
- Convenience of the farmer. If the farmer plans to plow the beds, these need to be wide enough to facilitate the plowing operation. On the other hand, making many narrower beds is faster than making fewer but wider beds.

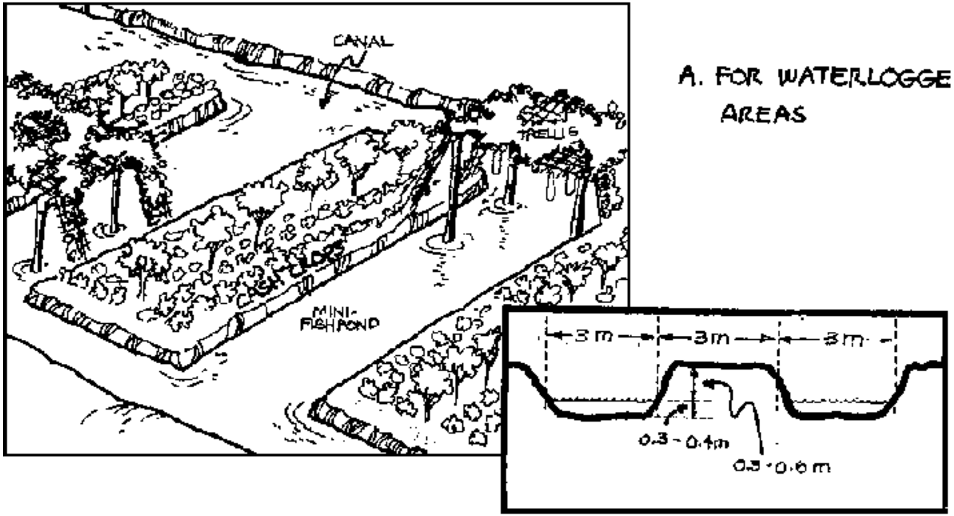
INCREASING FERTILITY OF SINKS:

Removing topsoil from the sink area reduces soil fertility which will affect lowland crop yields. The farmer should therefore focus efforts on increasing soil fertility with large amounts of organic matter. Some possibilities include:

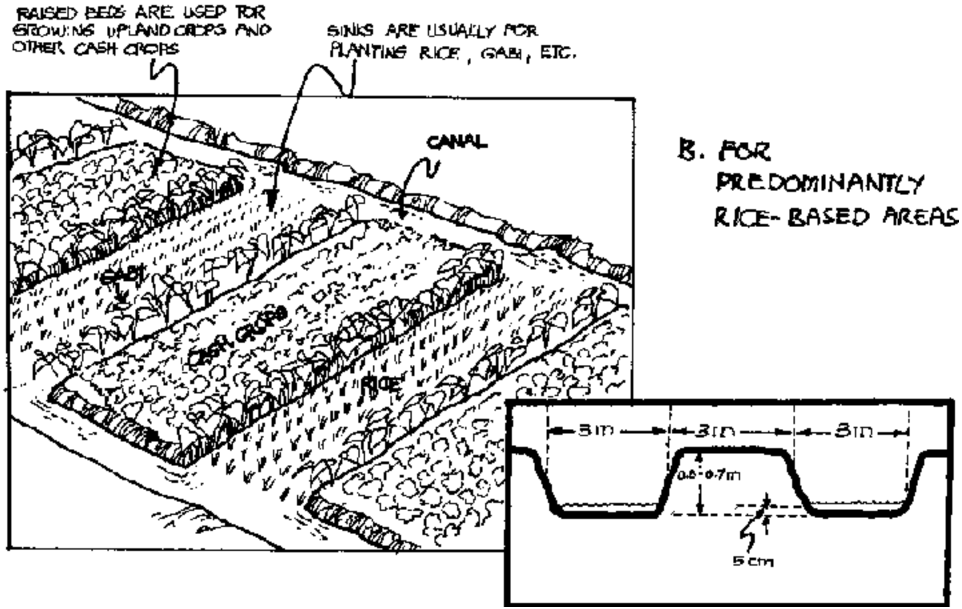
· planting green manure or grain legume in the sinks as soon as possible after formation
· mulching the crops with straw during the dry season
· moving livestock housing to sink areas during the dry season fallow period
· using Azolla if feasible (might be possible even in rainfed areas due to increased moisture availability and better water control).

If moisture is present in the raised beds plant soybean, cowpea, or mung bean. Mung bean, in particular, does very well in newly constructed beds. Mulch the crop as well. Some upland crops are better suited than others to new Sorjan beds including sweet pepper, cucurbits (cucumber, squash and ampalaya) and grain and vegetable legumes.

SOURCE: PCARRD Monitor



A. for waterlogged areas



B. for predominantly rice-based areas

Maximizing the dry season for post-rice alternatives

RATIONALE:

There is a need to maximize the use of residual moisture an/or land area in rice-based farming systems, through crop-intensification by raising alternative crops after rice. This also contributes to the diversification of the farm.

Diversification of crops in a rice-based system, particularly with the use of vegetable

crops, improves overall farm income, reduces the degree of deterioration of fertility, increases the uses of residual moisture and cropping intensity and improves daily cash flows. Such multiple cropping systems also help reduce insect populations.

CONSIDERATIONS:

- **Is land efficiently used?**
- **Are all land areas utilized?**
- **Does the present use conserve the land?**
- **Is available water efficiently used?**
- **Are the crops grown when they are best suited?**
- **Is farm work designed to employ/utilize the labor of other family members?**
- **What capital resources are available?**

Figure

IN THE SELECTION OF CROPS, CONSIDER THE FOLLOWING:

- **market potential/demand**
- **price**
- **family benefit**
- **knowledge/skill in growing**
- **maturity of varieties**
- **time of planting**
- **method of planting**

TRADITIONAL SYSTEMS:

1. Immediately before harvesting, mung bean seeds are broadcasted into the rice paddies. During harvesting, the mung beans are trampled thus establishing a mung bean crop stand.

Mung bean seeds are broadcasted

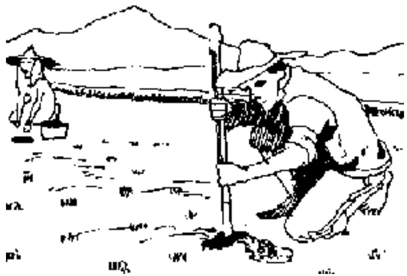
2. The rice stubble is cut to the ground and used as a mulch (in addition-to the rice straw from threshing). After mulching the field, the area is flooded for about 1/2 day or until it is saturated. The area is then planted with onion or garlic. (Nueva Ecija)

The rice stubble is cut to the ground

3. The field is plowed and harrowed and planted with various vegetables. (Nueva Ecija)

The field is plowed and harrowed

4. The paddies are cleaned of rice stubble, flooded until saturated and holes are dug at a 2 m x 2 m distance. Watermelon and musk melon are then planted. (Nueva Ecija and Cavite)



The paddies are cleaned of rice stubble

CROPPING PATTERN FOR A RAINFED LOWLAND RICE-BASED AREA:

Rice is grown from July to October when water is available and the supply is adequate. Then, using residual soil moisture and available rain water, vegetable production can be feasible during the dry season.

CROPPING PATTERN FOR AN IRRIGATED LOWLAND RICE-BASED AREA:

Two crops of rice can be grown between May and January. The first with rain and the second with supplemental irrigation. Vegetable crops can then be grown during the dry months using available residual soil moisture.

Watermelons in rice paddies

RATIONALE:

Scarce land resources can be optimized and farm income can be increased by planting high value crops in rice paddies during the months following the rice harvest. Farmers in Cavite, Philippines, have demonstrated that planting watermelons can be a profitable

venture if the activity is properly timed. Demand for watermelon is high, especially during the hot, summer months when it is a popular fruit used as dessert. The practice can also help farmers to recover any losses they might have suffered in their rice crop resulting from unforeseen circumstances like typhoons, pests and diseases, fluctuations in price and other causes. Labor inputs for crop establishment are low because minimum tillage is used, thus requiring little land preparation.

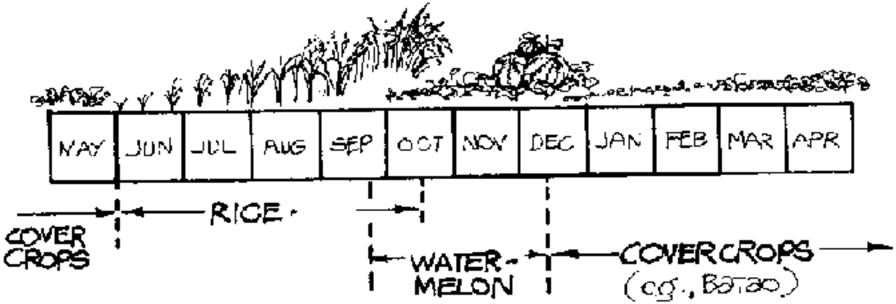
CONSIDERATIONS:

· Recommended Varieties

Cultivar	Maturity	Seed Rate/ha.
Sugar Baby	65 days	3-4 kgs.
La Mallorca	80 days	-do-

· Cropping Pattern

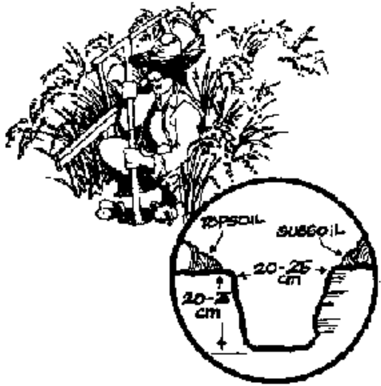
In order to receive the best price, watermelons should be planted from September to late October. Therefore, they should be planted 14-25 days before the rice crop is harvested. Planting during this period enables the farmer to harvest the crop earlier than most farmers, thus he can command a higher price for his produce. Also, raising watermelons during the cooler climate helps avoid possible thrips infestation which usually occurs during the hot, drier months of the year. Once the watermelons are harvested, batao (Dolichos lablab) can be sown as a cover crop and green manure for the remainder of the dry season.



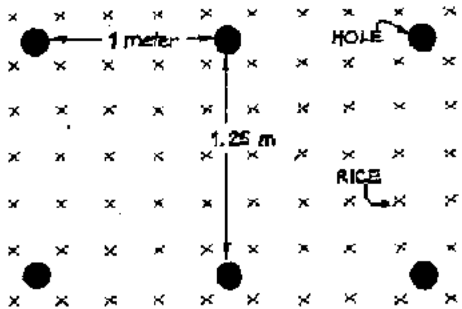
Cropping Pattern

· **Land Preparation -- Direct seeding is a common practice in planting watermelons.**

a. Identify the rows where the watermelons will be planted.
b. Using a stick or planting board, push the rice plants to one side -- creating a space in which the planting can be done.
c. Dig the hole 20-25 cm deep and 20-25 cm wide. Place the topsoil one side of the hole and the subsoil on the other side. The holes are spaced 1.25 m between rows and 1 m between hills.



Push the rice plants to one side

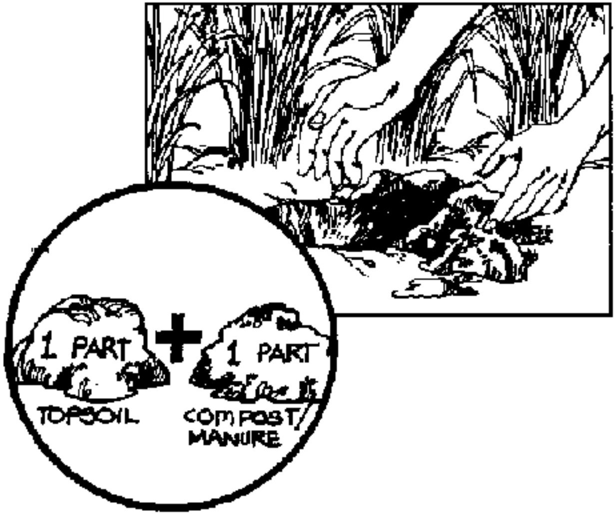


The holes are spaced

· **Planting**

Mix equal amounts of compost or decomposed manure with the topsoil set aside earlier. Return the mixture to the hole. Sow 4-5 seeds. After the rice is harvested, thin out the

unhealthy plants, leaving only three to mature. Place mulch around the base of the plant.



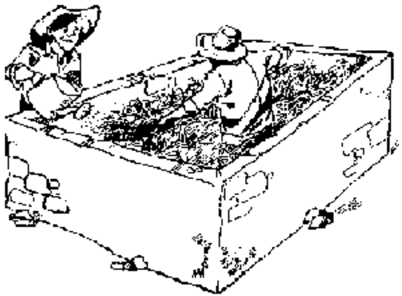
Place mulch around the base of the plant

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Low-external Input Rice Production (IIRR, 292 p.)

Use of rice plant by-products

Improving the taste and nutrient availability of rice straw



Enriching the rice straw

Livestock raising can be an efficient way of converting edible but relatively undigestible and unmarketable nutrients produced on the farm (like rice straw) into valuable animal products. Even though their feed value is low, the crop residues are plentiful and low cost. By using simple methods, these residues can be improved to become important components of livestock feeds.

Rice straw has a low feed value -- not only because of its small amount of nutrients, but also because the nutrients that exist are not readily available to the livestock. Enriching the rice straw with nitrogen or high-quality fodder (such as leaves from leguminous trees) makes the nutrients in the rice straw more available. The bacteria in the rumen of cattle, goats or carabaos use the nitrogen to multiply quickly and they, in turn, break down rice straw nutrients into forms that can be utilized by the livestock.

Rice straw can be enriched directly by mixing it with the nutrients before feeding or indirectly by feeding the improved fodder/feeds separately and allowing the mixing of the straw and the improved feeds to take place in the rumen of the animal. Some simple methods are described below:

A. Mixing dry rice straw with fresh grasses or legume fodder in equal amounts.

B. Sprinkling salt solution (a handful of salt to 1 gallon of water) or molasses on a portion of rice straw to be given in a single feeding.

C. Treating straw with urea

1. Dissolve 400 9 (roughly 1/2 li) urea in 10 liter water (half a kerosene can). Urea increases the nutrient content of the straw.

2. Sprinkle the solution over 10 kg dry rice straw (about 2 sacks, tightly packed).

3. Mix thoroughly.

4. Tightly pack the mixture in an airtight container (concrete or clay container, barrel or drum, or pit lined with plastic or clay).

5. Seal the top with plastic so the ingredients will ferment in 10-21 days.

6. Once the container is opened, the treated rice straw should be consumed within 14-21 days.

D. Providing urea, molasses and water as a healthful drink to ruminants above 6 months old.

When animals are stall-fed with rice straw, they must be provided with this drink at least twice a day, in addition to tap water. Prepare the drink at least two hours before it is given to the animals.

1. Mix 1 tbsp urea granules into 15 liter clean water.

2. Mix the solution until the urea is dissolved. Allow the solution to stand for 2 hours so the ammonia is released.

3. Add 4 tbsp molasses before giving the drink to the animal. (NOTE: Be careful not to put more urea than is required. Harmful effects of urea toxicity range from drowsiness, excessive salivation or going off feed. The most severe reaction is death.)

E. Salting Hay

Sprinkle 10-20 Ibs (5-10 kg) salt on each ton of damp rice straw. This can help prevent mold and undue heating. Salting makes poor quality hay more palatable. However, it does not ensure against spoilage (Morrison, 1961).

F. Providing low-cost molasses-urea block.

Ingredients	FORMULA		
	Original %	**Current %**	
		I	II
Molasses	50	45	50
Urea	10	10	10
Salt	5	5	5
Agricultural Lime	10	-	5
Cement*	-	-	15
Wheat bran/Rice bran	25	25	25
Water (liters)	5.6	5.6	5.6
	100	100	100

*** Contains calcium carbonate, adds nutrients and serves to bind the formula ingredients.**

1. In one container, mix half of the salt (2.5%) in 5.6 liter water, then incorporate the cement (or lime). Add more water if necessary.

2. In a separate container, mix the wheat bran or rice bran, the remaining half of the salt (2.5%) and the urea thoroughly. Add the molasses until they are evenly mixed.

3. Combine the two mixtures and mix into a fine slop.

4. Line a mould or receptacle with plastic sheets to facilitate removal of the block. (Plastic pails or empty biscuit cans will do.) Another cheap method is to arrange 4 wooden boards

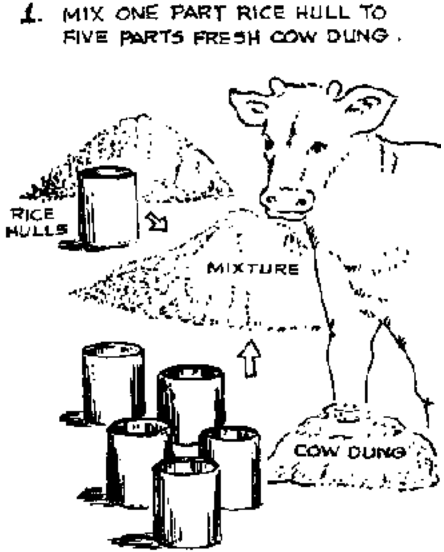
on the ground in a 2 m x 3 m x 20 cm high rectangular mould. Pour the mixture into the mould without compressing and let it set for 24 hours.

5. The following day, cut the mass with a flat spade into 20 cm x 20 cm blocks, each one weighing about 10 kg.

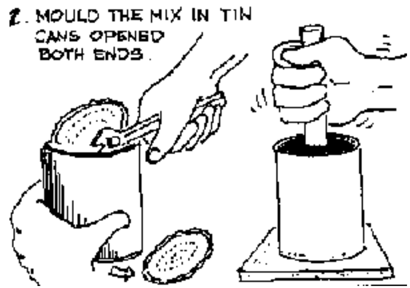
6. The molasses-urea block can be given to the animals on a self-feeding box when they return from pasture or when stall-fed. The average consumption is about 250-700 g/day for an adult animal weighing 250 kg or more.

Briquettes: fuel from farm wastes

1. To make good use of rice hulls and cow dung (if available).
2. Briquettes are convenient to store in homes than loose rice hulls.
3. Saves on wood fuel and other fuel resources.

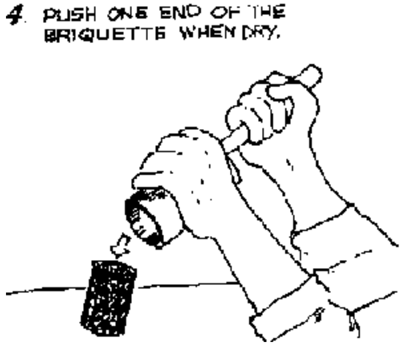


Mix one part rice hull to five parts fresh cow dung.

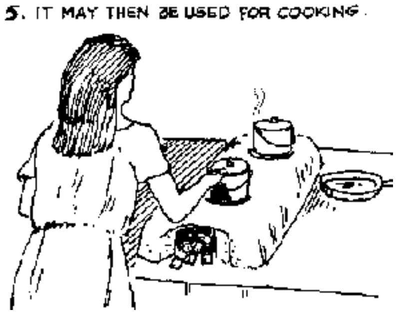


Mould the mix in tin cans opened both ends.

Sundry for three days



Push one end of the briquette when dry



It may then be used for cooking

Making charcoal from rice hulls

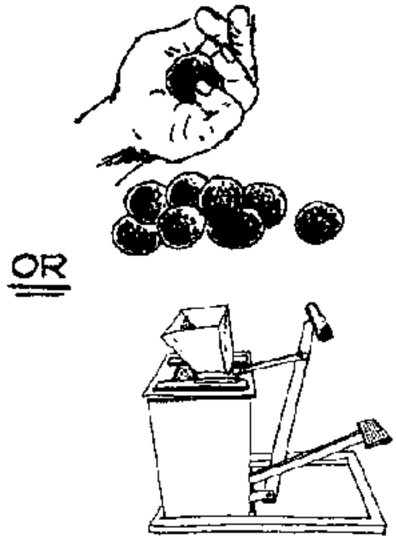
1. Char the rice hulls in a carbonizer (or a rice hull stove, but make sure that the rice hulls are not turned to ashes). Soak in water immediately to prevent char from turning to ashes.

Char the rice hulls in a carbonizer

2. Mix with as little binding material as possible, just enough to hold the charred hulls together when moulded. Paddy soil or fresh cow dung may be used as binder.

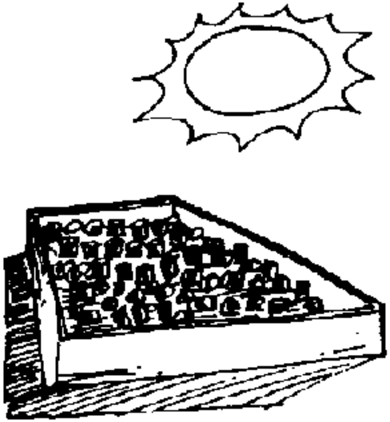
Mix with as little binding material as possible

3. Mould the mixture by hand, or by using a briquettor.



Mould the mixture by hand

4. Dry under the sun for about three days



Dry under the sun

5. When dried, the briquettes are reedy for cooking or drying grain crops.

The briquettes are reedy

(Adapted from IRRI and UPLB brochures)

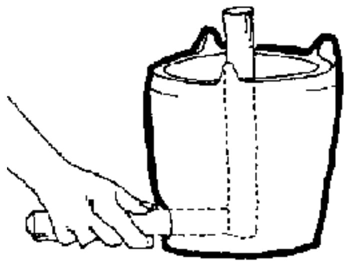
Rice-hull stoves

The unmindful cutting of trees for firewood, poles and other uses has depleted available resources in most villages. Lowland areas are particularly affected as areas are cleared for paddy rice and/or vegetable production.

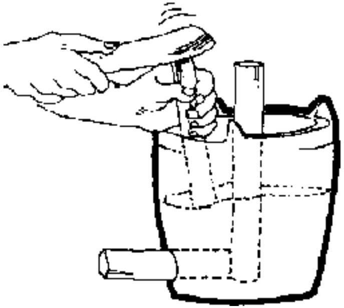
The increasing price of firewood demands the need to search for fuelwood substitutes. Rice hull, often regarded as a waste product of rice processing, can be the answer to such a quest. Rice hulls can be obtained free or at very minimal costs. This sheet discusses stove designs based on rice hulls as the energy source. Promoting their use will conserve valuable tree resources.

RICE HULL STOVE MODELS:

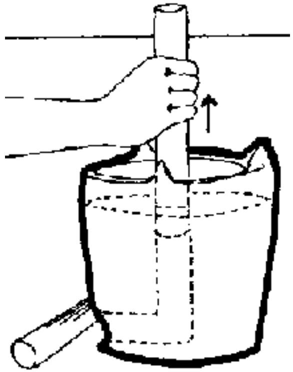
Packed Stoves. The rice hulls are packed tightly into the stove, leaving empty channels through the fuel mass for air, smoke, flames and hot grasses to pass. There are one to three vents at the base of the stove and cook pots are placed on an opening at the top.



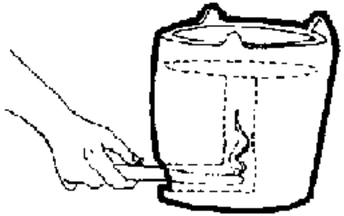
1. Position 2 thick pieces of wood in the stove as shown.



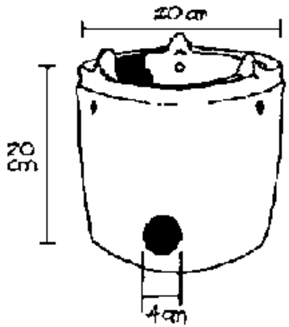
2. Pour rice hulls in and pack them with piece of wood and mallet.



5. When the chamber is filled up to 1-2 inches from the top, carefully remove the pieces of wood, leaving on air vent and a chimney.

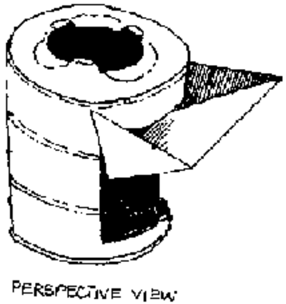


4. Dip a narrow stick in kerosene, light it, and push it into the hole as shown.

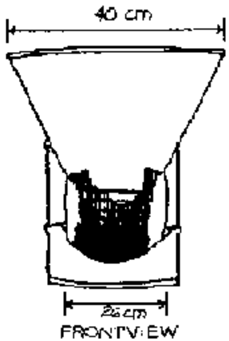


Packed Stoves

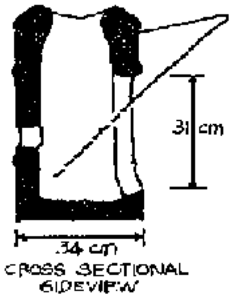
Natural Draft Stove The husks are fed into the stove above the fire and fall down a slanted grate as they burn. The air intake is located under this grate, forcing all air drawn into the stove to pass through the burning fuel. The stove ash is raked out from below the grate. The Thailand and Philippine models below are widely used in the provinces of Bulacan, Laguna and Cavite. The Philippine model comes in different sizes and is widely available in local markets.



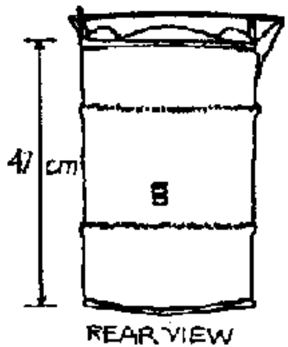
Perspective view



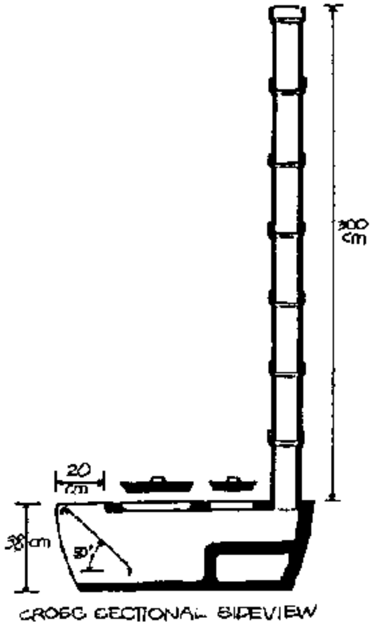
Front view



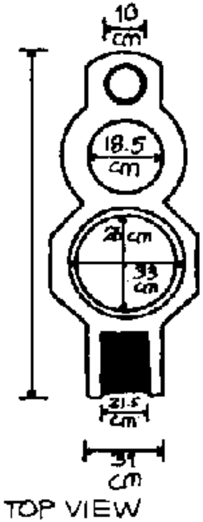
Cross sectional side-view



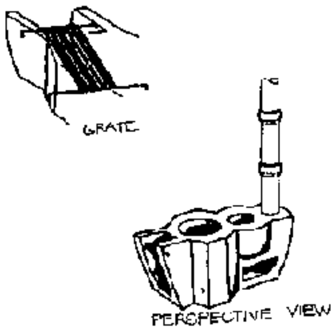
Rear view



Perspective view



Top view



Cross sectional side-view

Adapted from Rice Hulls as Fuel by Craig Thorbum, 1982.

Home"" """"> ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Low-external Input Rice Production (IIRR, 292 p.)

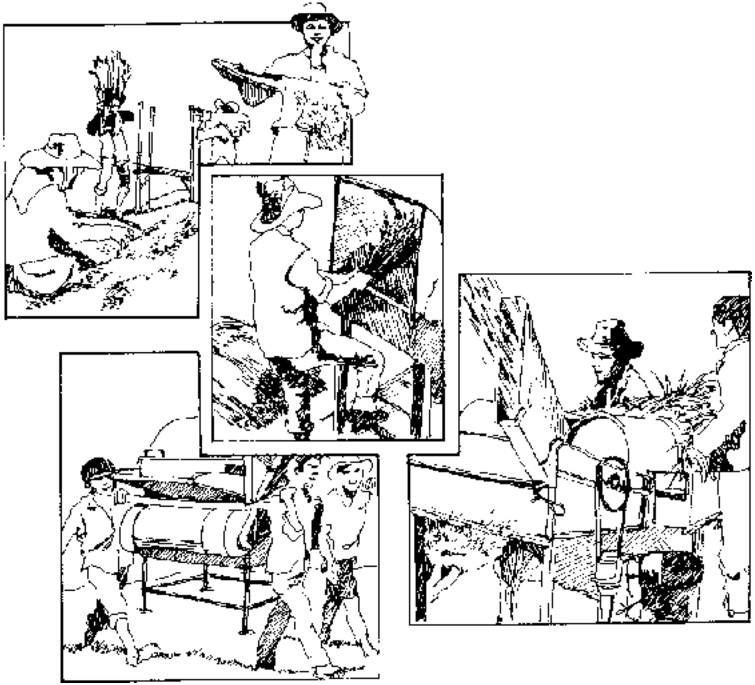
Farm implement

Thresher options for the farmers

With the rise in popularity of the axial flow threshers in the 70's, various sectors of society have since benefitted -- from the small farmer to the big farmer to the non-farmer-worker-turned-thresher-operator to the farm machine manufacturer to the money-lender-businessman. Currently, farmers have a wide range of threshing system options from which to choose depending on the volume of palay to be threshed, available capital and labor resources, availability of threshers for rent and the existing socioeconomic

structures and systems. The threshing can be done by the farmer using the reliable and almost zero-cost hampas method, by paying for the threshing service or by pooling resources of a farmer group to purchase a thresher unit.

Basic data or, existing thresher models are presented on the other side of this sheet. This information may be helpful to farmers or groups of farmers in their initial assessment of existing threshers (as taken from IRRI and UPLB handouts). As of 1989, prices of threshers range from P2,000 to P6,000 depending on size and model.



Thresher options for the farmers

SOME BASIC INFORMATION ON EXISTING PALAY THRESHERS MODELS

THRESHER MODEL	RATED CAPACITY (kg/hr)	POWER REQUIREMENT	LABOR REQUIREMENT	TRANSPORT ABILITY	OTHER FEATURES
Pedal	120	foot-powered	2 persons	carried by 2	hold-on threshing

thresher				men	
Portable thresher	300-600	5 hp engine	2-3 persons	carried by 2 men	throw-in or hold on threshing with air winnowing
Axial flow thresher					
- TH7	500	7 hp engine	3-4 persons	carried by 4 men	throw-in threshing with an air and screen cleaning mechanism
- TH8	1000	10 hp engine	3-4 persons	pulled by power tiller, light truck or animal	throw-in threshing with an air and double-screen cleaning system
Thresher/ Sheller	1000-1500 (palay) 500 (corn)	16 hp engine	3-4 persons	pulled by power tiller, light truck or animal	modification of axial flow threshers to make applicable to both palay threshing and corn shelling

For details contact:

1. Agricultural Engineering Department International Rice Research Institute Los Baos, Laguna
2. Agricultural Mechanization Development Program College of Engineering and Agro-Industrial Technology University of the Philippines Los Baos, Laguna
3. Agricultural Engineering Division Bureau of Plant Industry San Andres, Malate, Manila

Dryers: investment for the rainy days

WHY DRYERS (especially for the rainy season)?

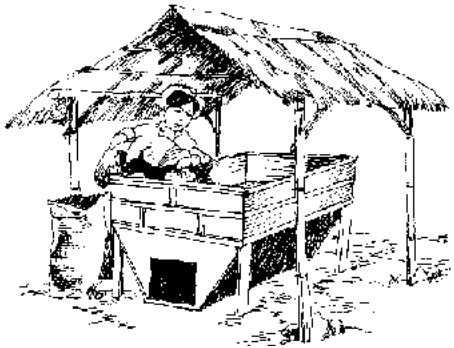
1. Farmers can avoid selling wet palay (unmilled rice) at low prices.

2. Higher milling recoveries are obtained from properly dried grain.

3. Farmers can better save their seeds for the next planting (common practices of using electric fans and frying pans to dry seeds on rainy days are costly and inefficient).

4. Dryers require less space compared to sundrying.

5. Most dryer designs make use of farm wastes for fuel.



Dryers

As far as small farmers are concerned, dryers are for rainy season use. However, if they are paying for the use of the drying pavement and hiring workers to mix and haul the grains, dryers may still prove more economical even in the dry season.

LIMITATIONS TO USING DRYERS AND WHAT MAY BE DONE:

1. Entails higher operational and investment cost compared to sundrying.

Dryers cost from P2000 - P40,0000 per unit. The investment cost per farmer may be decreased if a group or cooperative owns the dryer. The dryer can also be rented out to generate income. A drying cost of about P4.45/cavan (1 cavan = 50 kg) has been calculated for one dryer model (1988 estimates).

2. Limited grain-drying capacity. If there is need for drying large volumes, the multistage drying technique may be used. This involves first drying the grain to 18-20% moisture content (MC) and then drying it a second time to the required13-14%MC. This technique may be used because simply lowering the grain MC to 18-20% greatly delays grain deterioration.

If the task is to dry only 2-40 cavans of grain per day, then the existing dryer models may be used without resorting to the multistage drying technique.

INFORMATION ON SOME EXISTING PALAY DRYER MODELS

MODEL	RATED CAPACITY*	POWER/FUEL REQUIREMENT	FEATURES	DESIGN/ PROMOTED BY
UPLB Multipurpose Dryer	2-12 cavans per batch/day	no motor engine required; uses charcoal rice hulls, wood chips and other farm wastes for the burner	originally designed for copra drying but adapted for grains drying	UPLB
CPV Rotary Flash Dryer	3-4 cavans per hour	1.5 kw motor to drive dryer cylinder; 2 kw motor to drive blower; uses rice hull for the burner	multistage dryer; a smaller, simplified version of MA- IRRI rotary dryer	Central Philippines University College of Agriculture (CPU-CA)

IRRI Batch Dryer	20 cavans in 4 to 6 hours	3 hp gasoline engine or 2 hp electric motor to drive blower; uses kerosene or rice hull for the burner	compact and portable; automatic safety device to shut off burner assembly	IRRI
UPLB Flatbed Dryer	40 cavans in 8 hours	5 hp gasoline engine or 3 hp electric motor to drive blower; uses kerosene or rice hull for the burner	compact and portable; automatic safety device to shut off burner assembly	UPLB

***One cavan = 50 kg.**

For details on technical design, contact:

1. College of Engineering and Agro-Industrial Technology University of the Philippines at Los Baos College, Laguna, Philippines

2. Agricultural Engineering Department International Rice Research Institute (IRRI) Los Baos. Laguna, Philippines

3. Central Philippines University College of Agriculture lloilo, Philippines

Slicer for sesbania and other green manures

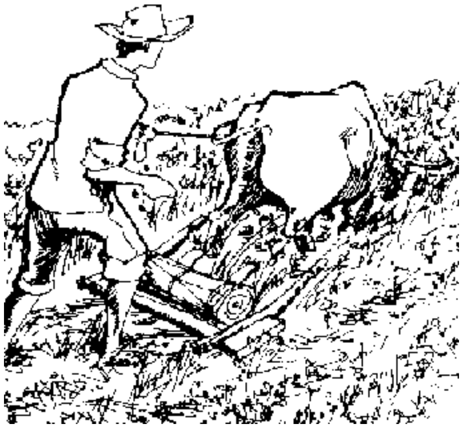
The slicer is an indigenous blade-toothed, animal-drawn weed chopper which has been used by farmers in Northern Luzon for generations. Since rice was cropped only once a year, the slicer was originally used to cut viny and tall weeds that grew during the long fallow period after rice harvest. The slits in the soil made by the slicer also facilitated plowing.

One objection to the use of green manure crops by many farmers is the difficulty of

incorporating the biomass into the soil. The slicer, with its capability of handling large amounts of biomass produced during long fallow periods, should help overcome that difficulty. The slicer could help to make green manuring (the practice of growing and incorporating plant biomass for fertilizer) more attractive to farmers.

USING THE SLICER:

The slicer, with a weight on the board, is pulled by a carabao. As the carabao steps forward, the plants are pressed down. The front board of the slicer further presses the green manure crop to the ground and the blades then cut the biomass into pieces. The slicer is pulled ever the green manure several times depending upon the amount and thickness of the biomass. If the crop growth is dense, a cries-cross passing may be needed to finely chop the biomass.



Using the slicer

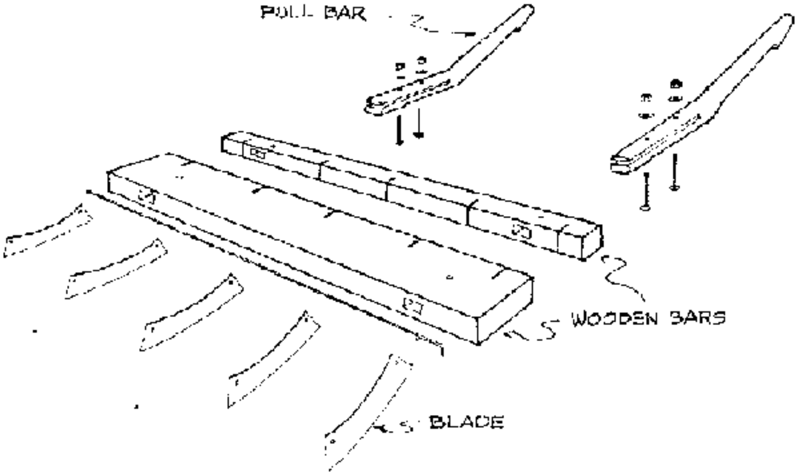
LIMITATIONS:

· **If the green manure is too tall, it may be difficult for the carabao to pass through the field.**
· **If the stalks or stems become woody, the slicer may not be able to cut the stems very well.**

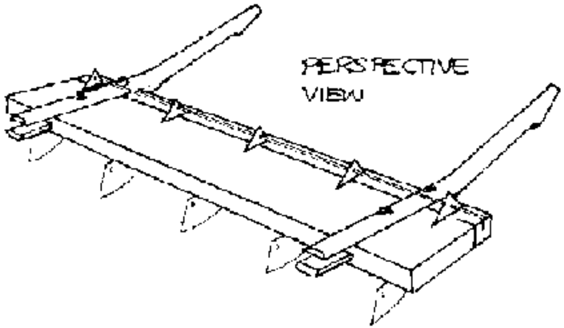
MATERIALS NEEDED FOR SLICER:

Farmers can easily make a slicer with local materials. The blades can be ordered from blacksmiths at P25 (5 blades are needed). The wooden board that holds the blade would cost only P50 to P80. The draw bar can be made from any hard wood like kakawate (Gliricidia septum) or coffee branches.

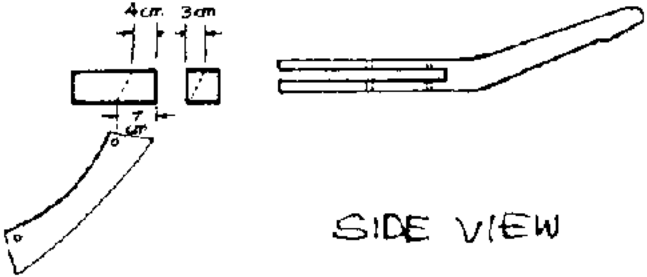
The slicer design illustrated here is the same as that used by farmers in Northern Luzon with the exception of one extension hole in each of the five blades The original design haz only one hole in one end of each blade. IIRR engineers added the other hole to double the life of the blades. Only one end of each blade is attached to the slicer. The other end is worn down by constant contact with the soil. When that end is worn down almost to the hole, the blade is turned around. The end originally attached to the board now serves as the slicing end of the blade.



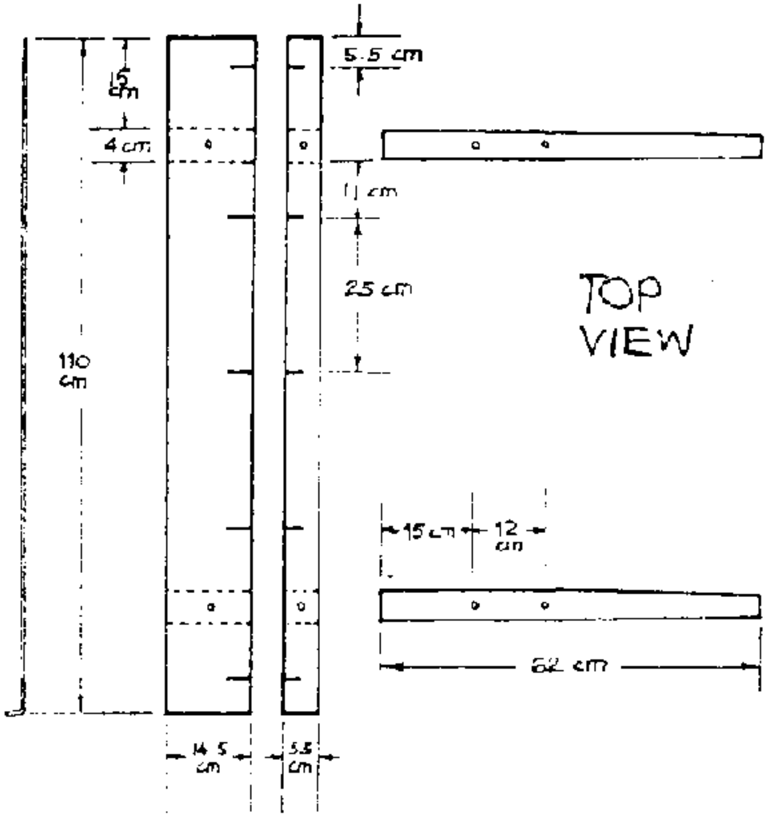
General view



Perspective view



Side view


5.5 cm
15 cm
4 cm
11 cm
25 cm
110 cm
TOP VIEW
15 cm
12 cm
62 cm
14.5 cm
5.5 cm

Top view

Low-external Input Rice Production (IIRR, 292 p.)

Integrated systems (rice-fish-livestock-trees)

Rice-clam culture

Clams grow naturally in many rice paddies and rural people have traditionally harvested them. This was true until chemical use in rice paddies resulted in the elimination of these clams in many areas. Intentional culturing of clams simply adds one extra step to the traditional clam harvesting -the seeding of clams.

From work with farmers in Quirino province, it was found that:

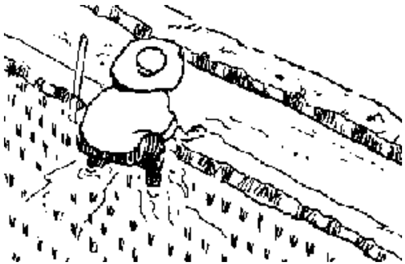
· Clam culture in rice serves as a buffer against unforeseen crop losses due to flooding or diseases like tungro.

· Clam production serves as a source of additional income (in 1 hectare paddy the average yield was 226 kg marketable clams valued at P1,800/ha.)

· In addition to extra income, the clams serve as a source of protein and minerals for the farmer's family.

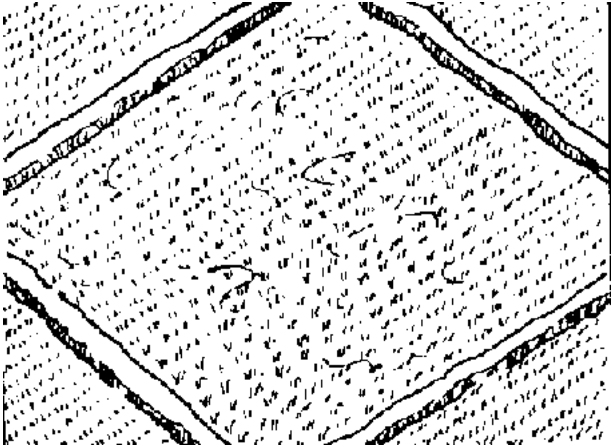
PROCEDURE:

1. 20-25 days after planting, increase the irrigation water in the paddies to the maximum tolerable depth proportionate to the rice plant (approximately 5 cm depth). If the crop needs weeding, the rotary weeder can be used before irrigation.



Increase the irrigation water in the paddies

2. Let the water stand for 2 days to soften the soil and to neutralize sold toxicity or pesticide residues.

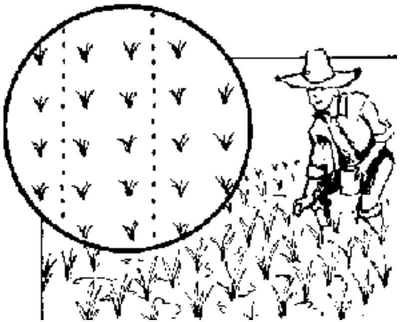


Let the water stand for 2 days

3. On the third day, drain the water and replace it with fresh irrigation water to the depth mentioned above.

Drain the water and replace it with fresh irrigation water

4. Evenly broadcast baby clams along the rice furrows. Seeding should be done in every other furrow.



Evenly broadcast baby

5. Harvest the clams as soon as they reach the desired marketable size (size of the new P50 coin) or just before harvesting the rice.

Harvest the clams

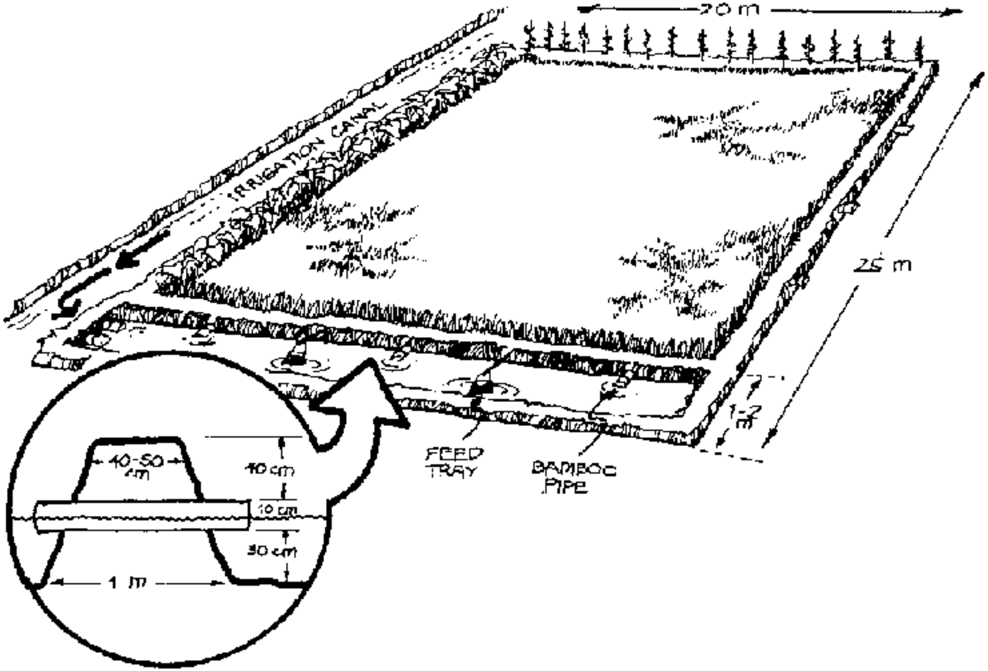
Note:

· Avoid using chemical insecticides; as a substitute, use botanicals.
· Don't introduce carp into the paddies seeded with clams. Carp eat clams.
· Faster growth of clams is attained when fields are fertilized with organic materials.
· Medium- to long-maturing rice varieties should be used in clam-rice culture. This allows the clams to stay longer in the paddy field.
· Rice-clam system is best suited to areas where there is a continuous supply of water.

Rice-fish culture

Before the advent of modern farming practices, freshwater fish, such as catfish (Clarias sp.) and mudfish (Channa striate) grew abundantly in rice field paddies in Asia. These fish occurred naturally without being cultured by farmers. The indiscriminate use of chemicals for protection from pests in rice has largely reduced their populations.

In rice-fish culture, it is possible to produce freshwater fish like nile tilapia (Oreochromis niloticus) and carp (Cyprinus carpio) with catfish and mudfish along with a high rice yield.



Rice-fish culture

1. TRENCH CONSTRUCTION

· Begin construction before the onset of the rainy season.
· For tilapia, mudfish and catfish, the trench is 1 1/2-2 m wide and 1 m deep or 10% of the rice field area.

Notes on Rice-Fish Trenches:

1. Raise peripheral dikes of the rice-fish field.
2. Locate the trench at the lower end of the field.
3. The bamboo outlet and inlet pipes should be at least 3 inches in diameter.

· The water that falls from the inlet pipes provides aeration to the trench.
· The outlet pipes are necessary for drainage to maintain the desired water level in the rice field.

4. Construct a small trench 30 cm wide and 30 cm deep. This will guide the fish to go to the trench.
5. For additional sources of income -- plant gabi, string beans and other suitable vegetables on the dikes. However, to minimize seepage, do not plant gabi where the pipes are installed.

2. FERTILIZATION OF THE TRENCH

· When there is enough water in the trench (from initial rains or from irrigation canal), apply any of the following organic fertilizers:

Chicken/Hog manure	Carabao/Cow manure
0.3 kg/sq.m fresh	0.5 kg/sq.m fresh
0.5 kg/sq.m dried	1.0 kg/sq.m dried

· Fertilize once a month or when the color of the water is no longer greenish. Greenish water is indicative that there is sufficient natural food (plankton) in the trench.

· Method of application

- Broadcast the manure after the construction of the trench (basal application).

- Place the manure in a sack. Submerge it in the trench 15-20 cm below the water level.
- You may also dump the manure in one corner of the trench.

3. STOCKING

· Stock the trench with Tilapia fingerlings (3-5 9) 15 days after the application of manure at the following rate:

- 1 fingerling/sq.m - no supplemental feeding (10,000/ha)
- 2 fingerlings/sq.m - with supplemental feeding (20,000/ha)

· If polyculture is practiced, the stocking rate should be:

- Tilapia - 75%-85%
- Carp - 10%-15%
- Catfish/Mudfish - 5%-10%

4. LAND PREPARATION AND TRANSPLANTING

· During the onset of the rains, plow and harrow the land thoroughly. Transplant seedlings 1 day after the last harrowing.
· Maintain at least 1 inch water depth.

5. FERTILIZATION OF THE RICE FIELD

· Incorporate manure into the soil at the last harrowing.

- Chicken/Hog manure 2-3 kg./10M²
- Carabao/Cow manure 3-4kg./10M²

· At this point, also apply the recommended basal N for the rice crop.

6. OPENING THE DIKE

· One month after transplanting, make 3 openings in the dike to allow the fish from the trench to enter the rice field.
· Maintain the water level at 10-15 cm and increase it to 20-25 cm after the maximum tillering stage.

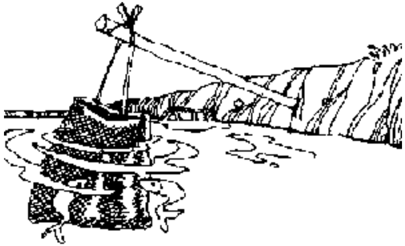
7. HARVESTING

· By the time the rice crop is ready for harvesting, so are some of the fish.
· Harvest only the big fish (50-60 9 or heavier). Extend the culture period of the smaller ones for the next rice cropping.

SUPPLEMENTAL FEEDING (OPTIONAL)

a) Rice bran- 80%
Ipil-ipil- 20%

b) Rice bran - 65%
Ipil-ipil meal - 20%
Molasses/Golden
Snails (ground) - 15%



Supplemental feeding

Feeding Method

1. Add a little water to the feed ingredients and ball it.
2. Place the balled feeds in a feeding tray made of fish net.
3. Tie the feeding tray to a pole and submerge it in water (see illustration).

Rate and Frequency of Feeding

· Determine the consumption of the fish per feeding by actual observation. First month 1-2 handfuls for 100 fish per day. Adjust the amount accordingly.
· Feed twice a day, morning and afternoon if necessary.

Notes:

1. For a single crop of rice, extend the culture of the small fish after the harvest by utilizing the whole field if water is still available.

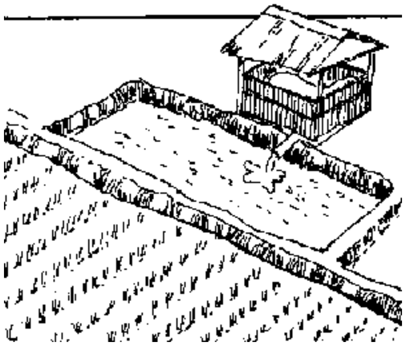
2. Establish a tilapia and carp hatchery pond (3 m x 5 m) in addition to the trench to maintain a breeding stock of quality fingerlings for future use.

3. Catfish and mudfish are migratory. To keep them in the rice paddy/trench, they should

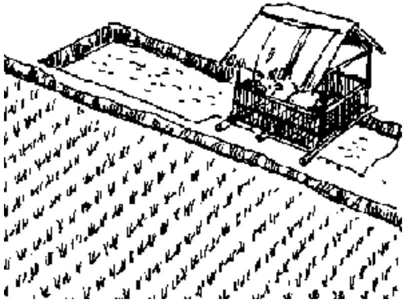
be provided with a continuous supply of feeds. Tilapia fingerlings serve as feeds for catfish and mudfish, as do slaughter house by-products (pieces of skin) and crushed golden snail. Plant kangkong or gabi (taro) around the trench. This may help to discourage the fish from leaving the trench.

Rice-pig-fish culture

The traditional Chinese farming practice of pig and fish raising within the rice field is now spreading throughout the Philippines and Southeast Asia in general. In addition to supplementing income and improving nutrition through pig and fish culture within the rice field, rice-pig-fish culture maximizes land use by integrating three farm enterprises.



Design 1. The pig pen is constructed on top of the dikes near the trench. The floor should be sloping towards the trench and preferably be made of a soil-cement mix or concrete. A pipe is necessary to convey the waste matter into the bench.



Design 2. The entire pig pen is over the trench. The floor is made of bamboo slats spaced just enough to allow manure to fall directly into the trench but not too wide for the feet of the pigs to be injured.

BASIC STEPS IN ESTABLISHING THE SYSTEM:

1. Trench construction

Establish the trench at the lower end of the rice field. The minimum trench area requirement should range from 70-80 sq.m/pig. The water depth is 60-100 cm. The rice field area is 500 sq.m. Inlet and outlet pipes should also be installed.

2. Location of the pig pen

The pig pen should be near or over the trench. Typically, the pig pen is 1 m x 1.5 m for each pig.

3. Stocking

Fish:

Stock the trench with fish when there is enough water from the irrigation canal or from other sources.

Stocking rate:

Monoculture: one (1) fish/m² (average weight 3-5g) or 10,000fingerlings/ha.

Polyculture:
Tilapia nilotica - 75-85% (average weight 3-5 9)
Common carp - 10-15% (average weight 3-59)
Catfish/mudfish - 5-10% (average weight 1-29)

Pig:
Stock weanling -- 8-10 kg. in the pig pen.

4. Dike construction

Construct the dikes after plowing the rice field. The size of the dikes is 1 m wide at the base and 40-50 cm at the top. The height of the dikes should be 75-80 cm. Install the inlet and outlet pipes.

5. Land preparation

Plow the rice growing area at the onset of the rainy season to provide ample time for the construction of dikes.

6. Fertilization of the rice field and transplanting

a. For the first rice crop in a 500 m² rice field apply the following inorganic fertilizer (depending on the fertility and kind of soil)

Urea --5-10 kg
14-14-14 -- 3- 5 kg

Reduce the rate of fertilizer application for the succeeding rice crop.

b. Allow some of the manure to flow to the rice field.
c. Transplant after thorough land preparation and fertilization.

7. Opening the dikes

a. One month after transplanting, make 3-4 openings in the dikes in the trench to allow the fish to move into the rice field and forage for feed.
b. Maintain the water level at 10-15 cm and increase it to 20-25 cm after the maximum tillering stage.

8. Harvesting

a. Fish

Harvest the bigger-sized fish after 120-150days by draining the trench. Extend the culture period of the small fish to the next rice crop.

b. Pig

Sell the pig after 4-5 months.

c. Scrape out the decomposed organic waste and use as fertilizer for the rice crop.

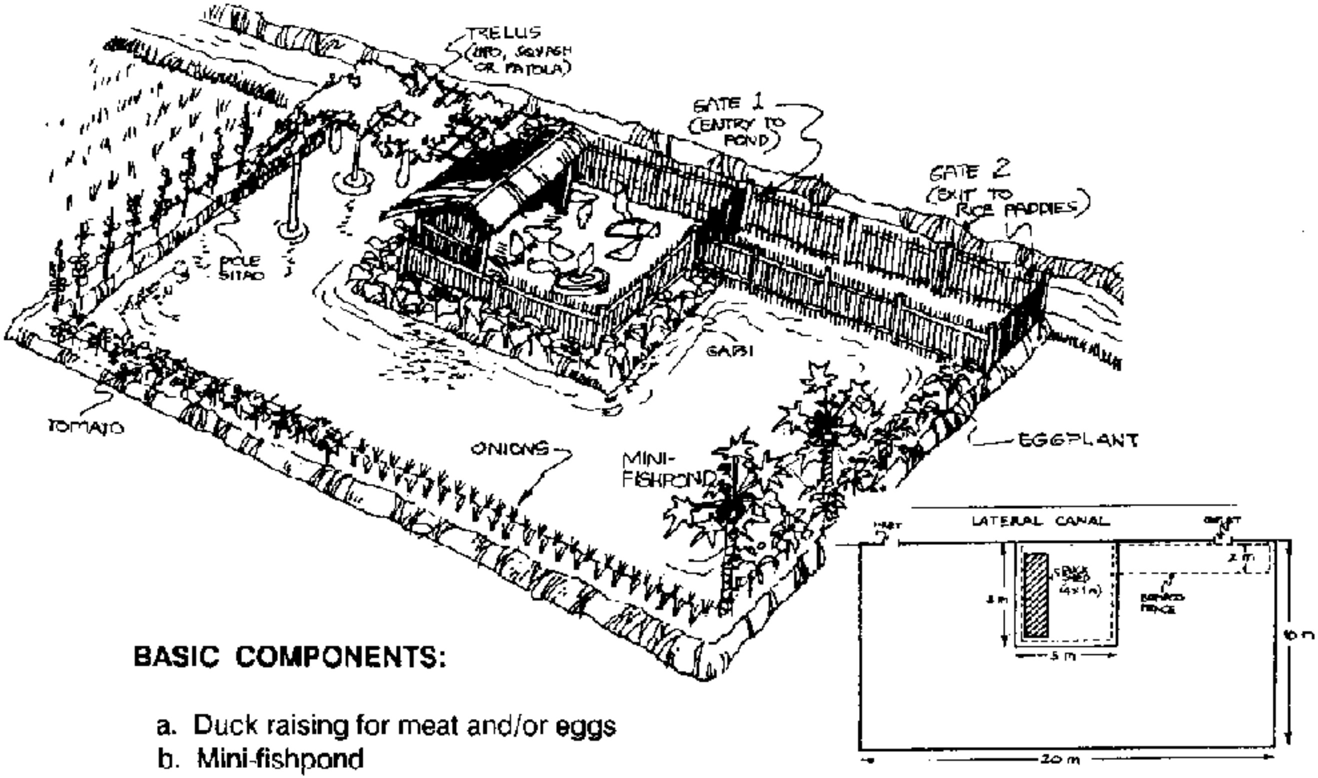
NOTE:

Establish a tilapia and common carp hatchery pond (3m x 5m) to maintain a breeding

stock of quality fingerlings for future use.

Vegetable-duck-fish culture (Tinola garden)

Tinola garden, as the name implies, is a type of garden where major ingredients in the preparation of tinola (a kind of poultry or fish soup with vegetables) are found in a 200 sq.m area.



Vegetable-duck-fish culture

BASIC COMPONENTS:

a. Duck raising for meat and/or eggs

b. Mini-fishpond
c. Vegetable growing

This vegetable-duck-fish culture is actually a modification of the original mini-fishpond operation. This technology, however, optimizes land use by planting vegetables on the dikes, fence and the construction of trellis over the mini-pond. Depending on the preferences of the farmer, dikes could be planted with different vegetables and crops (e.g., leaf, fruit, root or legumes) and areas along the fence and trellis with any climbing vegetables.

ADVANTAGES:

Some of the advantages of this tinola garden are the following:

· increase in quantity and variety of food for home consumption
· ensures fresh supply of poultry meat and eggs, fish and vegetables
· practical for those farmers whose land area is less than 1.0 hectare and adopting the ricefish culture.

NOTES ON INDIVIDUAL COMPONENTS:

A. Vegetables

· On the trellis and fence -- squash, patola and other climbing vegetables.
· After the construction of pond dikes, the trellis could be constructed and planting of varieties of crops could immediately follow.

B. Mini-fishpond

· The dikes should be at least 1 m high, 1/2 m wide on the top and 1 m wide at the base.

· Water inside the pond must not be more than 1/2 m (to minimize fish losses).
· Recommended fish for stocking is Tilapia (Tilapia nilotica) and common carp (Cyprinus carpio) at the rate of 3 fingerlings/sq.m.
· Low-cost feeds may include rice bran, crushed snails and kitchen refuse.

Note: Refer to technology paper on Rice-Fish Culture for feeding and other management techniques.

C. Duck-Raising

Shed house (4 m x 1 m) made of low-cost and locally available materials (e.g., bamboo, ipilipil, madre de cacao, cogon, nipa, etc.) located in a 25 sq.m area in one section of the pond.

· Feeding troughs and waterers using old jeep or truck tires, clay pots or old cooking utensils.
· Stock: 8-12 heads (any species, depending on the farmer).
· Feeds may consist of rice bran, crushed banana trunk, crushed snails, kitchen refuse, kangkong, etc. Feeding is done twice a day.

Note: For more detailed information on duck raising, please see the technology paper on Backyard Duck Raising for Meat and Eggs.

Care and management of mini-ponds

The secret of success in growing fish in mini-ponds is proper care of the fish and management of the pond. Good pond management and care of the fish means faster growth and more fish for the family. The major points to remember are the following:

1. POND CONSTRUCTION

· Establish the mini-pond near a water source such as streams, springs, irrigation canals or manually operated pumps (pitcher pump), etc., which is free from flooding and with good drainage.

· The soil at the bottom and side of the minipond must be well packed to minimize seepage. If the soil is sandy or porous, line it with a mixture of carabao or cow dung, clay soil and cement.

· Plant grasses on the banks to prevent soil erosion. Grasses that grow fast and spread rapidly are ideal for this purpose.

· Put screens on the inlet and overflow pipes to prevent the entrance of predators and at the same- time to keep the fish from escaping.

Care and management of mini-ponds

2. WATER—QUALITY, DEPTH AND TEMPERATURE

· Water is of vital importance in raising fish. Always make sure that it is free from toxic substances, of the right temperature and the proper volume (depth). However, the warmwater fish do not require a constant supply of a large volume of fresh water. Most freshwater fish can be raised with water temperature ranging from 20°C - 40°C.

· The ideal water temperature ranges from 25°C - 30°C. In order to maintain the right temperature, plant leguminous trees like ipil-ipil (Leucaena leucocephala), katuray (Sesbania grandiflora), madre de cacao (Gliricidia septum) and Dapdap (Erythina) on two sides of the mini-pond, about 1.5 m - 2 m from the bank. Orient the planting of trees on the east-west direction to allow enough sunlight into the pond. The leaf litter also serves to improve aquatic life.

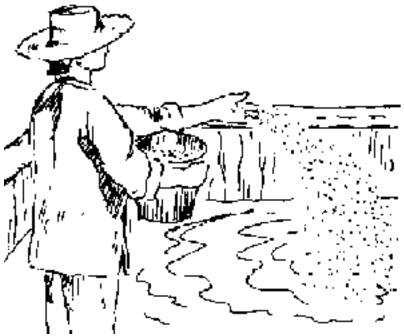
· Occasionally, the water in the pond becomes turbid and muddy. To check the turbidity of water apply lime at the rate of 1 tbsp/sq.m. Dissolve the lime water and sprinkle it over the pond.

· Maintain water depth at 1 m so that the sun's rays can penetrate the water and induce the growth of plankton (natural fish food). Production of plankton decreases as water depth increases. In shallow water (.5 m), the water temperature easily gets high during summer. High temperature retards fish growth.

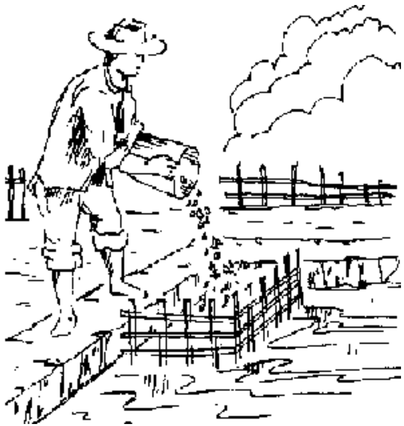
· Avoid letting the water out from the pond to prevent the fertilizers and plankton from flowing out.

· Drain the pond once a year. Keep it dry for a period of 2-3 weeks to aerate the soil.

3. POND FERTILIZATION



Fertilize the pond



Any kind of animal manure can be used

· The production of algae and microorganisms in the mini-pond is the most important task

for the low-cost production of fish. Fertilize the pond at least twice a month for the water to remain greenish. Green color indicates that the water has plenty of small plants and microorganisms which serve as nutritious food for the fish.

· Any kind of animal manure can be used. However, chicken manure makes a better fertilizer. Apply .5-1 kg chicken manure/m. The manure can be placed directly in one corner of the pond or put in a burlap sack and submerged 20 cm below the water surface. Never broadcast the manure on the surface as this, in turn, will reduce sunlight entry into the water, resulting in poor plankton growth.

· Dried leaves of leguminous trees can also be used to fertilize the pond. Put the leaves in porous bags and submerge in water 20 cm below the surface. One to two sacks of dried leaves can help fertilize the mini-pond. Dried rice straw can also be dumped directly in one corner of the pond. Occasional broadcasting of green leaves of leguminous trees (smallleaf varieties such as Calliandra, Leucaena, etc.) is also very helpful and promotes aquatic life.

· If a combination of organic and inorganic fertilizer is desired, 500 9 of organic fertilizer and 10 9 of inorganic fertilizer (preferably urea or 16-20-0)/m water can be applied to produce good results.

· On soils or water that are acidic, lime must be added. It can be broadcast on the bottom of the pond or put in a porous bag. Tie the bag to prevent it from submerging into the bottom of the pond. If lime is not available, it can be substituted by aged wood ash (not fresh ash or ash from paper).

4. FINGERLINGS

Stock only high-quality fingerlings. Secure your fingerlings from reliable hatcheries.

5. FEEDS AND FEEDING

· For faster growth, fish should be given supplemental feeds. A diet consisting of 20-30% ground ipil-ipil leaves or Azolla and 70-80% fine rice bran is recommended.
· When affordable, supplemental feeding of 100% fine rice bran is still the most economical (when natural food plankton in the mini-pond is abundant).
· Feed the fish twice a day, morning and afternoon.
· For a more efficient feeding, mash the feeds and place in a feeding tray made of fish net.
· The fish can also be fed with green leaves of kangkong, sweet potato, Azolla, kitchen leftovers, boiled sweet potato, cassava, gabi, crushed golden snails and white ants (termites).
· Surplus tilapia fingerlings (fresh) can be crushed and mixed with fine rice bran. This diet is very nutritious.
· Other cheap methods of feeding fish are:

- Hanging a lighted lamp over the center of the pond. At night, insects are attracted to the light and hover around it. The insects will fall into the pond where the fish can eat them.
- Feeding the fish with maggots (small worms). To produce maggots, hang pieces of meat or dead animals on a pole 2-3 ft above the water surface. Flies and other insects will lay their eggs on the meat or dead animals. After 2-3 days, maggots will come out and fall into the water.

6. CONTROL OF OVERPOPULATION

Overpopulation of fish is one of the problems in raising fish (tilapia) in mini-ponds. To obtain good yields of harvestable or marketable size of fish, population control is necessary. Any of the following methods may be used:

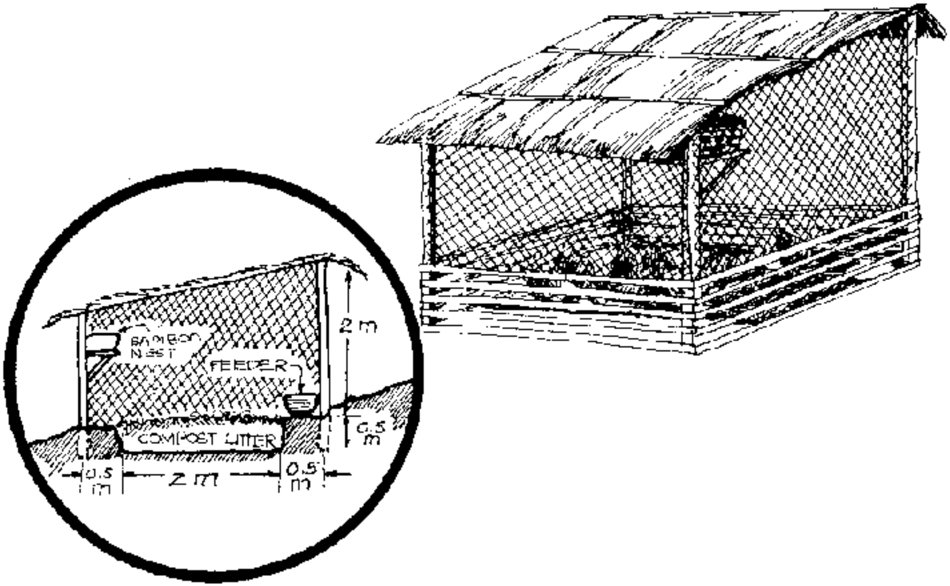
· Scooping the fry with a fine net early in the morning and late in the afternoon. The fries swim at the edges of the pond at this time of the day.
· Introducing predators into the pond such as mudfish (dalag) and catfish (hito) at 2% of

the total stocking rate. To prevent predators from preying on the original stock, the size of the predators must be smaller than the original stock and should weigh less than one gram.

7. HARVESTING

· After 4-5 months, the bigger fish can already be harvested. Catch them with a hook and line using earthworms or golden snails as bait or use a sweep net.
· Harvest only enough fish for the family to consume.
· To ensure a continuous supply of fish for the family, replace the number of fish harvested immediately by collecting fingerlings from the breeding/hatchery pond.

Backyard poultry project using compost litter system



Backyard poultry project using compost litter system

With the high cost of producing imported breeds of birds for meat and eggs, the current trend for farm households is to revive the traditional family backyard poultry project using local and upgraded birds. These local breeds survive the adverse conditions found in the rural areas.

By using improved feeds and management practices, these local and upgraded birds can provide at least 130-200 eggs and extra poultry meat throughout the year for the family. These birds can be allowed to search for feed on the range or in confinement using a low-cost poultry compost litter system, practiced by some farmers in Cavite, Philippines. This

system can sustain 6 hens and 1 rooster or 3 hens, 30 chicks and 1 rooster for at least 3 - 4 months. The compost litter is then removed and used as organic fertilizer and a new batch of farmyard manure is added. Production of a small flock in the backyard can help fill the family food requirements for eggs and meat, provide extra family income and utilize the manure as an excellent organic fertilizer.

BREEDS AND BREEDING:

The farm family should properly select an upgraded rooster (Cantonese, New Hampshire, Plymouth Rock breeds) and hens/layers.

Other poultry birds, like Muscovy duck. native or Pateros ducks, Peking duck, geese and pigeons are hardy and can also be raised under backyard conditions. They do not require elaborate housing and can subsist on inexpensive feeds.

HOUSING REQUIREMENTS:

Construct the house using local materials to minimize expenses, (cogon/nipa for roof, bamboo or used fish nets for siding' end ipil-ipil/madre de cacao as posts). The house should be located in a dry, well-drained area. Perch racks, roosts, nests, feed hoppers and waterers made of low-cost materials should also be provided.

The house should not be less than 2.0 m in height with a floor area of 3 m x 3 m. The house should be fenced; or if the hens are raised with chicks, they can be raised in a separate open house.

Before constructing the house, dig a pit in the floor 1/2 m deep, extending the length of the house (3 m) and 2 m wide. Once the building is completed, the pit should be filled with fresh manure of cattle, carabao or goat. Keep the manure moist for one week (to encourage the growth of worms and maggots as feed for the chickens) and then place the

upgraded/native birds in the poultry house. While scratching the ground, the birds will be eating as well as hastening the composting process.

FEEDS AND FEEDING:

The family should provide extra feed supplements, like kitchen refuse, fish entrails, corn/sorghum, ipil-ipil leaves and others. Clean, potable water should be always available.

Home Made Chicken Ration

· 4 parts yellow corn, broken rice (binlid) or sorghum. Boiled gabi, fresh ubi, camote or cassava (bitter type should be boiled) can also be substituted.
· 1.5 parts rice bran (darak). Dried azolla or filter cake (from sugar mills) can replace rice bran.
· 1 part dried fish meal or 2 parts fresh fish/golden snail
· 1.5 parts cope/oil meal
· 0.5 part ground sitao/mongo (mung)/patani (lima bean)/soybean/kadios (pigeon pea) seeds
· 0.5 part dried ipil-ipil leaves
· 1 tbsp salt
· 1 handful powdered oyster shell/agricultural lime

Note: Double the recommended amounts if ingredients are not in dry form.

Other Low-cost Poultry Feeds

Carbohydrate Sources	Protein Sources
- Bananas	- Azolla
- Gabi	- Earthworms

- Ubi	- Filter cake (dried and powdered)
- Cassava	- Kitchen leftovers
- Camote	- Mole crickets
- Spoiled papayas	- Sorghum
- Rice bran	- Fish fingerlings
	- Crushed golden snails
	- Termites
	- Tadpoles
	- Fly maggots

HEALTH MANAGEMENT:

Regular immunizations against Avian Pest, Fowl Pox and Fowl Cholera must be followed. A regular schedule of deworming, according to local conditions, must also be followed.

OTHER MANAGEMENT PRACTICES:

Other management practices like brooding, rearing the chicks, culling and selection and record-keeping should be practiced.

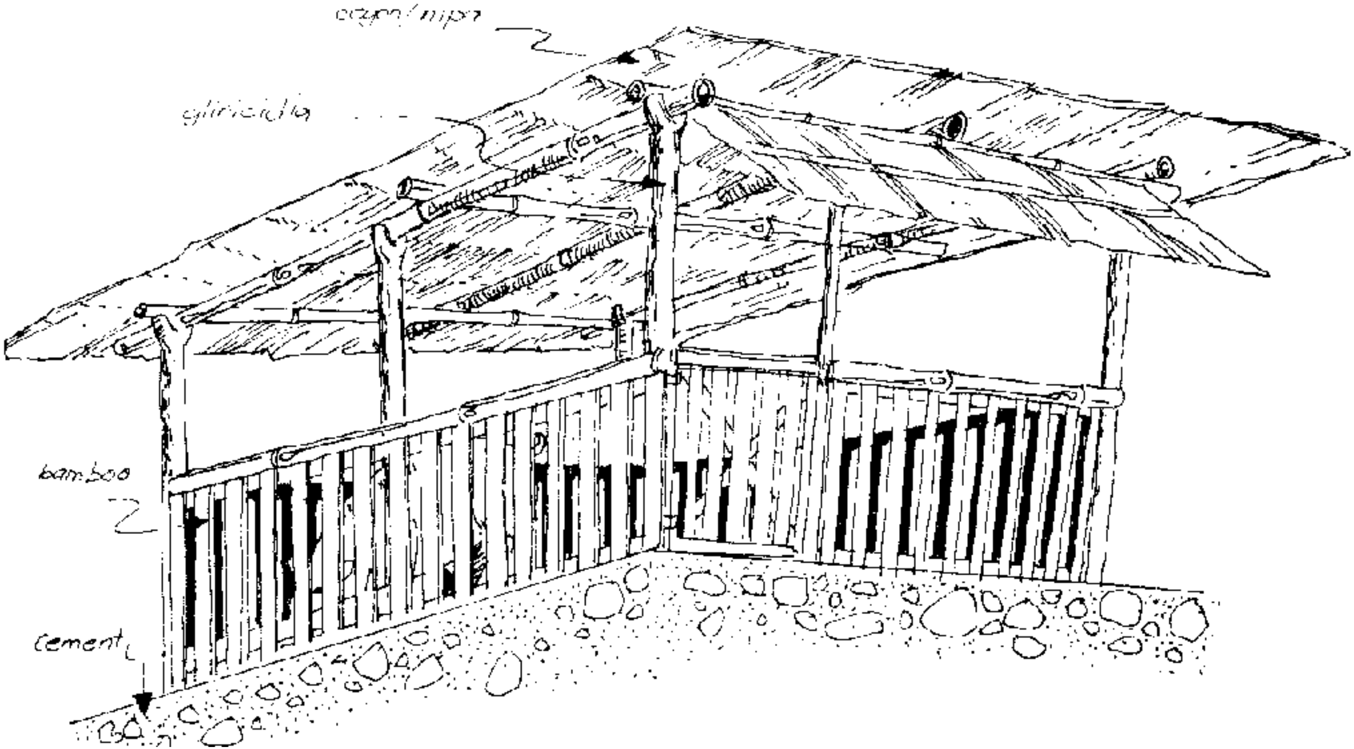
Backyard piggery project

Although demand for pork in many areas is high, the rising cost of production discourages many small farmers from attempting to raise swine on a small scale. The use of commercial feeds is one of the main reasons for high production costs. Purchased feeds can constitute 60-80% of total expenses. Once an animal is sold, the amount of return received, after paying the feed bill, is often too low to purchase another animal and sustain the cycle of production. Therefore, for farmers with little capital to invest, an

alternative mode of production must be advocated. This alternative includes the utilization of low-cost materials and feeds available within the farm. Of particular importance is the potential to reduce feed costs.

BREEDS AND BREEDING:

Upgraded cross-breed animals are recommended.



Housing requirement

FEEDS AND FEEDING:

1. Low-cost Feeds

Commercial feeds, while complete and usually available, are costly, thus driving up the

cost of production for a swine project. However, a variety of non-conventional or traditional foodstuffs can be utilized to provide low-cost feeds to swine.

Below is a list of common on-farm resources which can be used as carbohydrate and protein sources and several ration formulas (with Crude Protein percentage) using some of the following feedstuffs:

Carbohydrate Sources		**Protein Sources (% Crude Protein)**	
Coconut oil meal (sepal)	3	Brewer's spent grain (15.4)	2
Rice middlings	1 or 4	Copra meal (19.42)	2
Rice bran	2	Cowpea (33.89)	4
Banana trunks	3	Fish meal (53.44)	2
Sweet potato (leaves, vine end tuber)	2	Jackbean (25.75)	4
Cassava ([eaves end tuber)	2	Pigeon pea (20.46)	4
Taro (leaves, stem and tuber)	1 or 2	Mung bean (22.66)	4
Kangkong	1	Peanut oil meal (43.65)	2
Ulasiman	2	African snail (45.91)	1
Banana (peers end rice fruit)	2	Soybean meal (soya) (43.70)	2
Banana (raw fruit)	1	Rice bean (tapilan) (17.42)	2
Papaya (green)	1	Velvet bean (24.02)	4
Papaya (ripe)	2	Hyacinth bean (3.6)	1
Muskmelon	2	Leucaena leaves (17.52)	2
Jackfruit	1		
Pineapple	2		
Elephant yam (pongapong)	1		

Yam bean (singkamas)	2		
Ubi peelings	1		
Leafy vegetables	1 or 2		
Water lily	1		

1 -- Needs cooking.
2 -- Can be given fresh or as is.
3 -- Should be mixed with rice bran or commercial feeds.
4 -- Needs soaking.

LOW-COST SWINE RATIONS

Ration 1	**Parts by Wt.**
Rice bran	60 kg
Yellow corn	10
Coconut (bagasse)	10
Leucaena leaf meal	5
Rice middlings	5
	---------
	100 kg
Crude Protein	12.881%
Ration 2	**Parts by Wt.**
Rice bran	80 kg
Gabi tuber/Cassava	20
Japanese/Golden Snail	10

Ground yellow corn	10
Leucaena leaf meal	10
	---------
	100 kg
Crude Protein	14.91%
Ration 3	**Parts by Wt.**
Rice bran	80 kg
Leucaena leaf meal	15
Rice middlings	5
	-----------
	100 kg
Crude Protein	14.9175%
Ration 4	**Parts by Wt.**
Rice bran	60 kg
Swamp cabbage leaves	30
Yellow corn	5
Coconut bagasse	5
	---------
	100 kg
Crude Protein	9.965%
Ration 5	**Parts by Wt.**
Rice bran	60 kg
Banana trunks (chopped finely)	30

Leucaena leaf meal	10
	----------
	100 kg
Crude Protein	10.591%
Ration 6	**Parts by Wt.**
Dry camote	57 kg
Rice bran	30
Copra meal	4
Fish meal	5
Soybean oil meal	5
	----------
	100 kg
Crude Protein	10.6%
Ration 7	**Parts by Wt.**
Cassava or sweet potato	25 kg
Rice bran	50
Copra meal	25
	-----------
	1 00 kg
Crude Protein	11.45%

2. Proper Feeding

a. Leftover food scraps from the house should be cooked to kill germs and remove toxin

present in the foodstuff.
b. Unconsumed feeds in the troughs should be discarded before giving new feed to the animals.

3. How to Prepare Feeds for Swine

a. Chop all ingredients into small pieces.
b. Boil hard ingredients first (i.e., pongapong, green papaya, water lily, etc.).
c. When soft, add other ingredients (i.e., kangkong, leftover food, etc.).
d. Cook until done.
e. Cool.
f. Add a pinch of salt before feeding to the animals. These cooked feeds should be mixed - with rice bran when fed to the animals.

4. Alternative Feeding Management for a Fattener

a. During the first 2 months, feed piglets with commercial feeds (if the necessary ingredients to make a homemade, nutritious feeds are not available) to promote and boost growth.
b. In the second month, gradually substitute commercial starter ration with grower ration and begin slowly incorporating cooked supplemental feeds into the diet.
c. In the third month, one quarter of the ration can be replaced with supplemental, low-cost feeds previously listed.
d. At the fattening stage (4-6 months), one-half or more of the ration can be supplemental, lowcost feeds.

HEALTH MANAGEMENT:

1. Animals should be purchased from a reliable source in order to insure their hearth. Newly acquired animals should be isolated and observed for at least 2 weeks to determine

their health status before introducing them into the pen area with other animals.

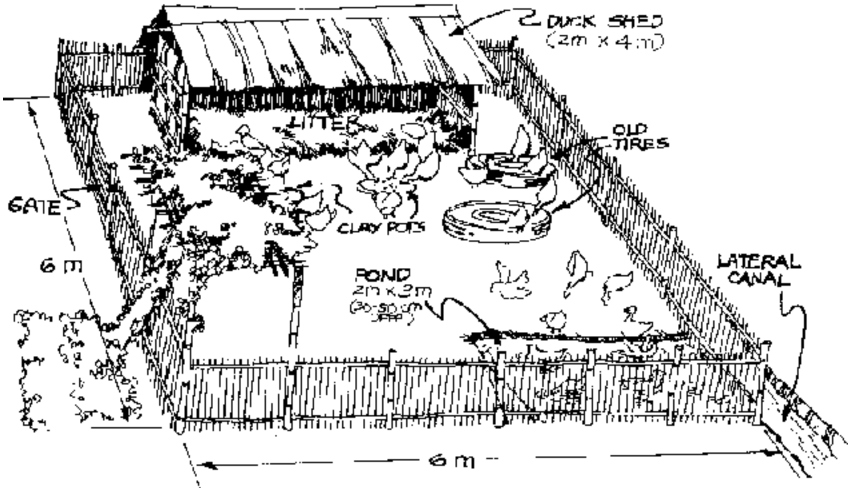
2. A regular schedule of vaccination should be followed to protect animals against swine diseases common in the area (i.e., hog cholera, etc.).

3. Animals should be regularly dewormed as needed or as local conditions dictate.

4. Improved sanitation ensures improved animal health:

a. Maintain clean pens.
b. Animals should be regularly bathed, especially during hot weather.
c. Excreta should be properly disposed, preferably composted in a pit or pile.

Backyard duck raising for meat and eggs



Backyard duck raising for meat and eggs

WHY RAISE DUCKS?

Ducks are one of the most practical, versatile and useful waterfowls to raise. Duck raising offers several benefits:

· Ducks are efficient producers of animal protein.
· Ducks provide both eggs and meat, for consumption or for sale.
· Ducks require limited space, simple shelter and minimal care.
· Ducks are resistant to diseases and thrive in harsh conditions.
· Ducks control harmful insects, unwanted aquatic weeds and golden snails.
· Duck manure is an excellent organic fertilizer.
· Ducks eat aquatic plants, grasses, vegetable trimmings, golden snails, insects and farm byproducts. Thus, providing feed is not a problem.

WHAT BREED TO RAISE FOR MEAT AND EGGS:

The Muscovy is a multipurpose breed for meat and eggs. The most popular Muscovy ducks raised are the white and black types. They lay from 80-120 eggs/yr and produce an excellent quality meat.

The Khaki Campbell breed is more efficient for egg production as compared to other breeds. A single duck is capable of producing 250-350 eggs/yr.

HOUSING REQUIREMENTS:

Since ducks are small, a simple shed with one open side can provide adequate shelter. A 1 1/2 m x 5 m x 1 m high shelter can accommodate 40-50 adult ducks. To prevent the ducks from destroying vegetables and other crops, they should be confined in a fenced structure

made from locally available materials.

Farm litter (e.g., rice straw) should be placed in the shed for laying and brooding purposes.

STARTING A BACKYARD PROJECT:

A beginner can start with 7 ducks -- one male (drake) and 6 female (ducklets). It is preferable to acquire ducks that are from 1-2 years of age.

FEEDS AND FEEDING:

Muscovy ducks are voracious eaters and eat practically anything they are fed. For maximum growth, ducks should be fed with natural, local feeds such as empty grains (rice), rice and corn bran, ipil-ipil leaves, golden snails, duck weed, Azolla, banana trunks, worms, etc. They should be fed three times a day and provided with fresh water always. Used tires or old cookings utensils can be used for waterers and feeders. Twenty-five ducks can be raised in a 1-hectare farm using onfarm feeds without commercial feeds.

HEALTH MANAGEMENT:

To prevent a disease outbreak, animals should be regularly vaccinated against common diseases (e.g., Newcastle, Fowl Pox or Fowl Cholera). Deworming and other health care practices, such as proper sanitation, correct feeding and proper care and management, must be strictly implemented to ensure a disease-free flock. New birds introduced into a flock should be quarantined to ensure that they are disease-free. Sick birds should also be isolated from healthy stock during treatment.

OTHER MANAGEMENT PRACTICES:

Hatching

Ducks start to lay eggs after reaching 6 months of age. One medium-size duck is capable of hatching 12-15 eggs during the 30-33 day incubation period. Layers are usually productive from 1218 months. At the end of that production period, layers should be culled and eaten or sold.

The fertility of eggs can be determined using a simple technique known as candling. Eggs should be candled (on the 15th day of incubation) in a dark room using at candle, lamp or flashlight. Fertile eggs reveal a small dark spot with a network of blood vessels branching out from it or the eggs appear dark. Infertile eggs are clear with the yolk appearing as a floating shadow. Do not throw away infertile eggs; they are delicious as well as nutritious and can be eaten or processed into salted or hard-boiled eggs to be sold for extra income.

Duckling Rearing

Young ducklings must be kept warm and dry. It is best to keep them out of water until they are 2 weeks old. However, they must have a constant supply of fresh drinking water. The ducklings should be fed fine rice bran and boiled rice. Cracked corn or rice should be fed to them after they are several weeks old.

It is very important to protect the ducklings from predators such as cats. dogs; rodents, birds, etc. One method of protecting the ducklings is to confine the hen and her brood in a covered pen each night until the ducklings are 6-8 weeks old.

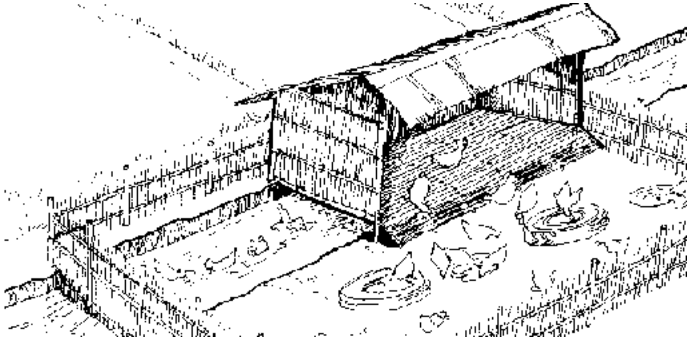
Marketing

Meat-type birds are ready to be slaughtered, dressed and marketed at 5-6 months of age.

DUCK MANAGEMENT WITHIN A RICE SYSTEM:

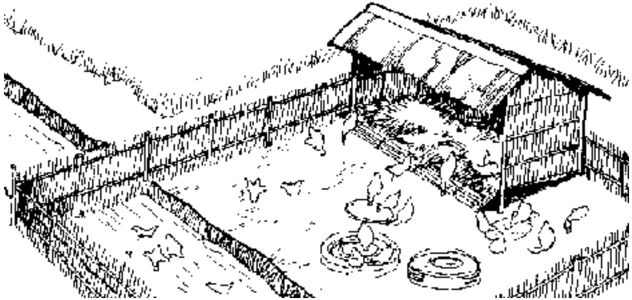
Two pen/shelter design options are presented here:

The duck pen and shelter is constructed over the irrigation canal The floor is made of bamboo slats spaced so as to allow the droppings to fall into the water below, but not to trap and injure the ducks' feet. The floor should slope slightly to allow the eggs to collect on one side of the pen, thus facilitating daily egg collection. This design allows the duck droppings to fall directly into the water and be carried to the rice paddies through the irrigation canal. One disadvantage to this design, however, is the possible danger of housing the ducks directly over the water during colder times of the year



The duck pen and shelter

The other design places the shelter near, but not over, the irrigation canal. Cover the floor with 4-6 inches of dry bedding material i.e., rice straw. Remove the old bedding materials weekly and place them in a compost pit for future incorporation into the rice paddies as fertilizer.



The is shelter near, but not over, the irrigation canal

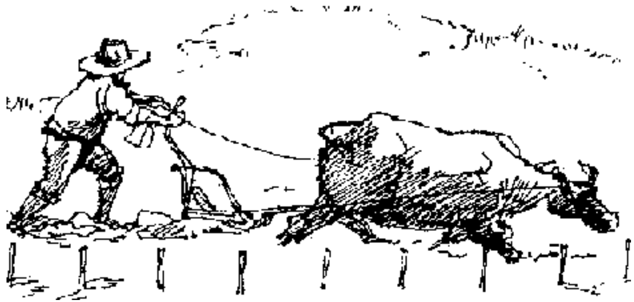
Ducks should be given adequate time to forage for their food. The ducks should be released from their house in the morning after they have laid their eggs (about 7:00 a.m.). The most important consideration is that the ducks be released at the same time every morning. If they are released at different times every day, the change can upset them, causing them to stop laying eggs and even begin to molt. They should be herded back to the pen about 5:30 in the afternoon. Giving them some feeds regularly at this time also trains them to return to their pen.

Ducks should be released onto the ricefields only at certain times:

- During plowing and harrowing
- After the tillering stage, but not during the flowering and heading stage of the ricecrop
- After the rice has been harvested and threshed.

When it is not possible to release the ducks into the ricefield, they should be taken to an area where no crops are grown. If no such area is available, the ducks can be fed in confinement.

Backyard carabao raising for draft and milk



Backyard carabao raising for draft and milk

The carabao (swamp-type buffalo) is a prized symbol of a farmer's wealth and is an integral component of Philippine agriculture. Millions of crop farmers rely on this animal as the main source of draft power for almost all farming operations despite the introduction of small power tillers. The carabao provides animal protein in the form of meat and milk; as well as hides and horns (which have many economic uses) and manure, a potential organic fertilizer for the farm.

Carabaos are also excellent potential sources of milk as they can produce 300 to 800 kilograms of milk during a lactation period of 180 to 300 days. Murrah crossbreeds can produce 42% more milk than the native caracows. Carabao milk has a higher nutritive value than cow's milk and can be easily used in the production of soft white cheese (kesong puti).

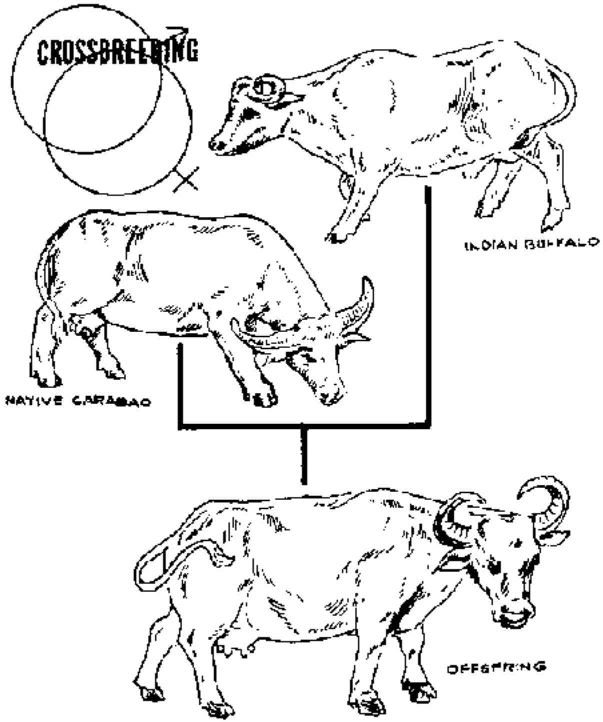
MANAGEMENT PRACTICES AT BACKYARD LEVEL:

A. Breeds and Breedings

1. Carabao breeds commonly found in the Philippines:

a. Draft type -- Philippine carabao and Thailand buffalo
b. Dairy type -- Murrah and Nili/ravi

2. Selection of breeding animals



Selection of breeding animals

a. Caracow/caraheifer to be selected should be 3-4 years old, with well-developed udders, large and uniformly shaped teats, possess a docile and good dairy temperament, angular form, be more lean than meaty and be an offspring of a known good milker.

b. Carabull or carasteer to be selected should be 4 to 6 years old, healthy and vigorous, possess a masculine character, medium to short neck, massive with a blocky conformation and have a heavy and welldeveloped body. Additionally, the animal should have well-developed fore and hindquarters, be powerful, low-set and alert and of good temperament. The male animals are best used for work purposes.

c. Judicious culling and selection of animals must be practiced in order to maintain the best animals in a herd.

3. Breeding:

a. Natural breeding is the common practice using the best carabull available to mate caracow/caraheifer. This is considered the best due to the silent heat (30-56%) among caracows.

b. Artificial insemination (A.I.), however, is considered the easiest and cheapest method of improving local animals using prostaglandin hormone end frozen semen, if AI technician and equipment are accessible in your area.

4. Reasons to crossbreed native caracow (Philippine carabao) with selected Indian Murrah buffalo bull (for more comparative information see Table 1).

a. The offspring is bigger, taller and more active.
b. Crossbreed caracows produce more milk (42% more) than native caracows.

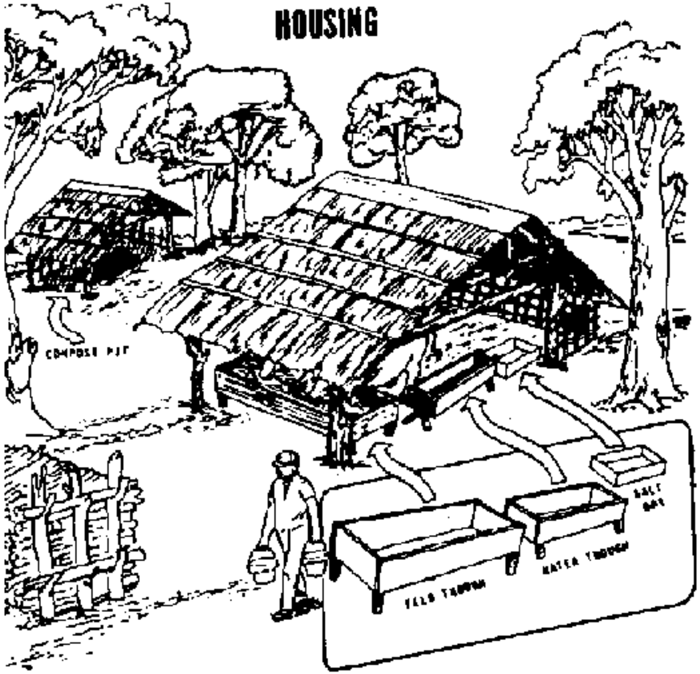
c. Crossbreed offspring have a higher growth rate (30-40%) than native carabaos.
d. Crossbreed animals possess better draft ability in upland condition.

Note: Based on research studies, crossbreed caracows in the third generation (5/8 Murrah and 3/8 Philippine carabao), when compared with pure breed animals, have comparable levels of milk production.

B. Housing Requirements

1. Provide a dry, clean and well-ventilated shed made of nipa, bamboo and/or wood. It is advisable to cement the floor to facilitate cleaning. Trees can be grown around the shed, to serve as a windbreak and provide extra shade during the summer months. Animals should always be kept in dry stalls in the evening and under the shed during the summer months.

2. Construct a compost or manure pit nearby for disposal of left-over feed litter and manure. A carabao produces 10.8 kg. manure/day or 6,853 kg. in 360 days (1.22% N. 0.85% P and 0.79% K)



Housing

C. Feeds and Feeding Management

1. Carabaos are usually raised in semi-confinement, which involves tethering the animal for 810 hours/day on native pasture.

2. Low-cost feeds for carabao

a. For light to medium work (4 to 6 hours/day).
b. Before and after work, carabaos should receive plenty of clean drinking water. When in a heated condition, however, they should be allowed to cool off before watering. Work carabaos may lick salt in a box or may receive salt in their feed, (for example, one handful/head, three times a week.)

3. Supplementation of urea-molasses-mineral block to diet of rice straw or summer grazing pasture is sufficient to maintain liveweight.

4. Clean feed, water and a source of salt should tee constantly provided to animals in the pen/stall area.

D. Health Management

1. Immunization against hemorrhagic septicemia and foot and mouth disease should be administered every six months or at least once a year. Animals should be dewormed against liver fluke and intestinal worms as a preventive measure et least once a year using herbal treatments (betel nut & ipil-ipil) or commercial dewormers.

2. Control lice and other external parasites at least 34 times a year. During summer the common practice by farmers of shaving the body hair of their carabao helps to control external parasites.

3. Because carabaos have few sweat glands and little hair, the animals should be regularly bathed to keep the animal cool during summer months (especially draft animals).

E. Other Management Practices

1. Carabao as Draft Animal

Farmers use carabao as draft in their farming system for the following reasons:

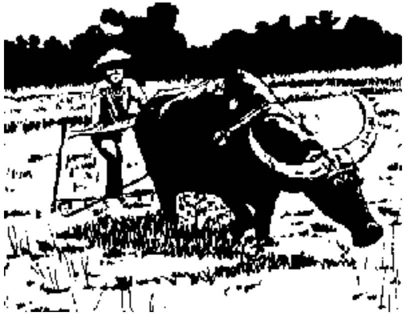
a. It is an affordable, low-cost technology and the investment can pay for itself in a short time period.
b. The carabao and harness are available locally and maintenance can be conducted by the farmers.
c. After a carabao can no longer serve as a draft animal, it can become a source of carabao meat and meat by-products. Carabao meat (carabeef) has 46% less cholesterol than beef.

A well-trained carabao works efficiently and will demand a higher price. Ideally, farmers should raise their own draft carabao or purchase them while they are still young. Young carabao (about 2 years old) are easier to tame and train.

The draft capacity of an animal increases with its weight. For example, a 300 kg. carabull can pull a moldboard plow or harrow with a 30 kg. draft requirement for 8 hours. But, if the animal is made to pull 130 kg. it will only work for 3 to 4 hours before tiring. The animal must be allowed to assume a natural pace to produce an extended, rather than a concentrated effort.

To prevent abortion, a pregnant caracow should only be made to work on a limited basis. especially during the first 6 months of pregnancy. A newly calved caracow should not be used for draft until the calf reaches 3 to 4 months of age.

Tips on training carabao for work



Training carabao for work

a. Touch the animal constantly.
b. Slowly expose the animal to crowded places (i.e., along the side of the road) by riding its back.
c. Training can be done from 1 to 3 hours during cool periods of the day (i.e., early morning or late afternoon).
d. While leading the animal to pasture, place a well-fitted yoke with a smooth surface on the animal's neck and attach a sledge to train the animal to pull.
e. Then, train the carabao to pull the harrow on loose ground for an easy start.
f. Finally, train the animal to pull the plow on a plowed field during cod periods until the animal gets used to pulling heavy loads.

2. Carabao as Source of Milk

Although the carabao is a slow milk producer, its mliking capacity can be improved through proper management, systematic breeding and proper milking techniques. Local carabaos and upgrades should be tapped as a major source of milk and milk byproducts. A caracow can produce 2 to 2.5 liters of milk daily by hand-milking.

Milking Procedures and Management:

Caracows should be milked in a clean, dry place. The caracow should be cleaned to remove dirt that may fall into the milking can. The calf is allowed to stay with the caracow for 2 to 4 weeks after birth and then separated in the evening to prevent the calf from suckling. After milking, the calf can stay with the caracow.

The most common milking method is hand-milking.

1. The animal is tied to protect the milker.
2. The milker should wash his/her hands with soap and water.
3. Prepare a clean milking bucket, properly covered with a clean cloth.
4. Wash and massage the udder and teats with a clean cloth soaked in warm water.
5. Strip the teat to check if the milk is clean (organo/eptic test) and if no abnormalities are observed.
6. If nothing abnormal is observed, milk the animal until the milk flow stops.
7. If possible, the animal should be milked at the same time everyday by the same person. Concentrate should be provided at milking time (helps to increase milk output).
8. Pasteurize the milk collected from the caracow. Do not attempt to add wafer or en adulterant as it will spoil the quality of milk. Heat the milk up to 145 F on a double boiler. When it starts boiling, continue to stir the milk with a spoon while heating for 30 minutes. Then cool the milk by replacing the hot water with cool water for 30 minutes at about 42 F. Place the milk in a bottle. The milk is now ready for market or can be stored in a refrigerator for 3-4 days.

Comparative Gross Composition of Carabao's Milk, Buffalo's Milk and Cow's Milk

MILK			
Properties	**Carabao (%)**	**Buffalo (%)**	**Cow (%)**

Fat	9.65	7.31	3.80
Protein	5.26	5.74	3.40
Lactose	5.29	4.89	4.85
ASL	0.95	0.81	0.75

LOW-COST FEEDS FOR CARABAOS:

1. For light to medium work (carabao working for 4 to 6 hours/day)

Feeding Ration Recommended for en average-sized Carabao

	RATION (Kg)				
	1	**2**	**3**	**4**	**5**
Rice bran	3	3	4	2	3
Copra meal	2	2	-	-	-
Napier grass	25	35	25	-	-
Peanut hay	5	-	-	-	-
Ground corn	-	2	-	-	-
Soy bean (soilage)	-	-	15	20	-
Sugar cane tops	-	-	-	25	20
TOTAL	35	42	44	34	43

2. Hard Work -- Carabao employed whole day for plowing/cart work/pulling heavy logs in the forest with only 2 hours rest at noon.

Feeding Ration Recommended for en average-sized Carabao

	RATION (Kg)				
	1	**2**	**3**	**4**	**5**
Rice bran	6	4	7	5	5
Copra meal	3	3	-	4	2
Napier grass	35	25	20	-	-
Peanut hay	-	5	-	-	-
Soybean (soilage)	-	-	20	-	25
Sugar cane tops	-	-	-	35	20
TOTAL	44	37	47	44	42

SOME IMPORTANT INFORMATION ABOUT CARABAO AND ITS UPGRADES

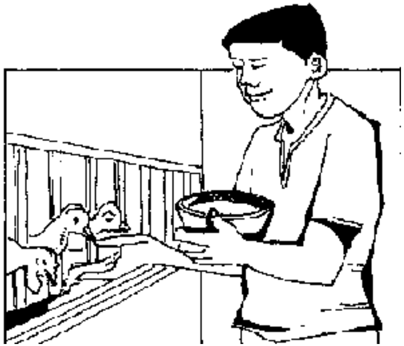
	Philippine Carabao (PC) (Draft)	**Murrah Buffalo(Dairy)**	**Carabao Buffalo* Philippine Carabao**
Body Weight			
- at calving	27 kg.	29 kg.	34 kg.
- at six months	110 kg.	134 kg.	130 kg.
-yearling weighs	141 kg.	241 kg.	208 kg.
- two years old	272 kg.	306 kg.	340 kg.
- three years old	480.8 - 515 kg.	525-625 kg.	557.36-609.62 kg.
Milk production - liter per lactation	528 (8 months)	1,149 (10 months)	1,032 (10 months)
Age at first fertile mating	859-885 days (2 years, 4 months-2 years, 6 months)	1,275 days (3-1/2 year) months)	844 days (2 years, 3

Age at 1st calving	1,342 days (3 years, 7 months)	1,582 days (4 years, 4 months)	1,178 days (3 years, 3 months)
Estrus cycle	21 days	21 days	21 days
Estrus period (watch for silent heat)	5 to 36 hours	24 to 72 hours	24 hours
- onset of estrus	dawn/early morning	dawn/early morning	dawn
Ovulation time	15 hours (after end of estrus)	11 hours (after cessation of estrus)	14 hours (after end of estrus)
Gestation period	320 to 325 days	310 days	316 days
Calving intervals	1 1/2 year	1 1/2 year	1 1/2 year
Breeding season*	August to January	August to January	August to January
Calving months	July to September	July to September	July to September
Post-partum breeding	60 days	133.82 ± 78.93	133.82 ± 78.93
Incidence of twinning	2:10,000	-	-

*** Breeding occurs any time of the year but more during the rainy season and cooler months.**

Azolla meal for layers and broilers

Although most people think of Azolla as fertilizer, one way of beating the high cost of feeds for farm animals is by supplementing the animals' regular diets with Azolla. Drying, ensiling and other feed treatments using fresh Azolla are simple and effective ways to ensure that optimum benefits can be obtained from Azolla by farm animals.



Azolla meal for layers and broilers

MATERIALS NEEDED:

· freshly harvested azolla
· commercial layer or broiler rations
· trays with slits or perforated bottoms for drying Azolla
· commercial grinder (gilingan) for grinding Azolla into powder or feed bag for holding Azolla during manual crushing
· empty motor oil can (1 liter) for measuring the ingredients.

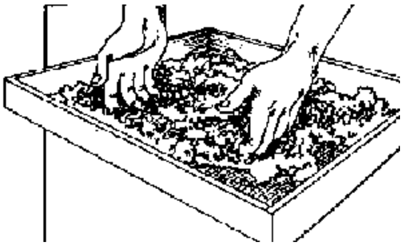
Materials needed

PROCEDURE:

1. Harvest Azolla from the propagation pond. Wash thoroughly to remove soil and other residues. Do not use Azolla which has been exposed to pesticides.

Procedure

2. Place the Azolla on trays and sundry it for 3-7 days or until it-turns brown. Azolla is sufficiently dry when it crumbles when squeezed.



Place the Azolla on trays

3. Grind the dried Azolla to form a powder resembling coffee. If no grinder is available,

place the dried Azolla in a feed bag and step on it until it is crushed.

Grind the dried Azolla

4. Combine the Azolla meal with commercial layer or broiler rations at a ratio of 1:9.

Combine the Azolla meal with commercial layer

Note: For growing native and upgraded chickens like Cantonese, Azolla meal can be given as a supplement to ordinary low-cost feeds.

SOURCE: UPLB, National Azolla Action Program

Azolla silage as feed for growing pigs

Aside from being used as green manure by farmers, Azolla can also be used as feed supplement for growing pigs. It has a crude protein content of 17-28% and contains amino acids, vitamins and trace minerals. Unlike ipil-ipil (Leucaena), Azolla has no toxic substance (mimosine).

When Azolla is ensiled, its moisture content is lowered to a manageable level, improving its nutritional value. When the silage is added to commercially available concentrate mixes, the resulting mixture easily meets the nutritional requirements of growing pigs.

Azolla silage as feed for growing pigs

The following materials are needed in preparing Azolla silage:

· net bags or sacks for drip-drying Azolla

· trays with slits or perforated bottoms for further drying
· empty kerosene and motor oil cans for measuring ingredients
· pails for storing the ensiled Azolla
· plastic sheets and rubber strips for sealing the pails.

PROCEDURE:

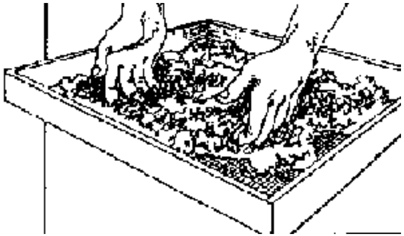
1. Collect Azolla from the propagation pond. Make sure the Azolla is free from soil and other debris by thoroughly washing it. Do not use Azolla which has been exposed to pesticides.

Collect Azolla from the propagation pond

2. Place the harvested Azolla in net begs or sacks and allow to drip for 2-3 hours.

Place the harvested Azolla in net begs

3. Transfer the dried Azolla to the trays to allow further drying and to provide good ventilation. Spread out the Azolla end turn over 2-3 times a day for even drying.



Transfer the dried Azolla to the trays

Azolla is dried from a moisture content of 95% to 65-70%*. Drying takes about 2 days during sunny weather and 3 days in cloudy weather.

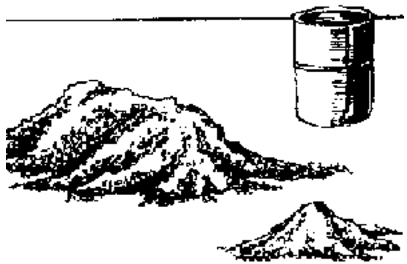
TWO AZOLLA SILAGE FORMULATIONS:

Sillage 1

· **Sillage 1 - 70% Azolla + 30% corn**

Mix 1 kerosene can (balde) of dried Azolla, with 4 1/2 motor oil cans of corn. Place the mixture in a pail. (If possible, use plastic pails for storing ensiled Azolla. Pails made of tin will rust.) Use plastic sheets to cover the pails and rubber strips to tightly seal the container and keep oxygen out. Let the mixture ferment for at least 1 week.

· **Silage 2 - 70% Azolla + 25% corn + 5% molasses**



Silage 2

Mix 1 kerosene can of dried Azolla, with 4 motor oil cans of corn. Add 1/3 motor oil can of molasses. Follow the same succeeding procedures as in Silage.

Note: If corn is not available, other carbohydrate sources like rice bran. cassava meal, etc., can be used.

It is recommended that each pail of ensiled Azolla be enough for one feeding to minimize oxygen combining with the mixture when the cover is removed. Oxygen must be kept out to prevent the growth of mold and worms (maggots) in the mixture.

When, the Azolla silage is fed to growing pigs, it may be added to mixed grower ration (MUIR) or commercial grower mix (CGM)

Ensiled Azolla can be stored up to 2 months without affecting the nutritive value of the feedstuff, as long as the container is kept sealed. Once opened, the silage must be consumed within a week.

Amounts needed at 25 percent Azolla silage supplementation

Weight of Growing Pigs (kg)	Amount of Azolla Silage (kg)	Amount of MGR CGM (kg)
20 - 35	1.50 - 1.80	1.00
36 - 50	2.00 - 2.50	1.50
51 - 60	2.50 - 3.00	2.00

Amounts needed at 10 percent Azolla silage supplementation

Weight of Growing Pigs (kg)	Amount of Azolla Silage (kg)	Amount of MGR CGM (kg)
20 - 35	0.50 - 0.80	1.40
36 - 50	1.00	1.80
51 -60	1.00	2.25

**SOURCE: National Azolla Action Program c/o Office of the Dean UPLB College of Agriculture
College, Laguna 3720**

Multipurpose trees for the lowlands

Trees are an important component of the lowland ecosystem. They provide readily available firewood, poles and stakes and protect the field from strong winds. Trees also improve the microclimate of the farm and attract birds and other beneficial insects, thereby reducing insect infestation.

Multipurpose trees give additional incentive for cultivation. The leaves are excellent for green manure. They grow fast and coppice easily thus reducing the need to replant after every harvest.

There are different species of multipurpose trees. For lowland areas, however, they should be tolerant or moderately tolerant to occasional water logging.

SPECIES	LOCAL/ COMMON NAME	COPPICING ABILITY	USES	HEIGHT AT MATURITY (M)	SEED TREATMENT/ PREPARATION	SITE REQUIREMENTS
Acacia mangium	Mangium	poor	Land rehabilitation, erosion control, N-fixing pulp, timber, firebreaks, fuelwood	25-30	Immerse for 30 seconds in boiling water and soak overnight in cold water	Tolerates infertile acidic soil, rainfall 1500-300 mm/yr
Albizia lebbek	Langil	vigorous	Fodder N-fixing, medicinal shade for plantation crops, fuelwood	up to 30	a) Immerse in boiling water for 2 minutes and soak overnight in tap water b) Immerse in hot water and soak for 24 hour	Rainfall 600 - 2,500 mm, tolerates wide range of soils, 2-6 months dry season, adaptable but not suited for every graded sites.
Calliandra calothyreus	Calliandra	vigorous	N-fixing, erosion control, land rehabilitation, green manure, bee forage firebreaks, coffee shade, fuelwood	4-10	a) Immerse in hot water and soak for 24 hrs in tap water b) Soak in cold/tepid water for 24 hrs c) Immerse in boiling water for 2 minutes and soak over overnight in tap water	Optimum rainfall 2000-4000 mm/yr but withstands less, tolerates dry season of 3-6 months and grows well on depleted soils and steep slopes 250-800 m.

Species of multipurpose trees for lowland areas (1)

SPECIES	LOCAL/ COMMON NAME	COPPICING ABILITY	USES	HEIGHT AT MATURITY (M)	SEED TREATMENT/ PREPARATION	SITE REQUIREMENTS
Causarina equisetifolia	Agoho, Aroo, Agoso	vigorous	Coffee shade, N-fixing, dune stabilization, live fencing, fuelwood, shelterbelts	15-50	None required	Tolerates diverse and difficult sites, coastal areas, limestone, 6-8 months dry season, does poorly on heavy clays.
Derris indica	Pongam, Ponga, Karanda	vigorous	Lamp oil, fodder, erosion control, roadside tree, live fencing, fuelwood, pest control	8		Drought resistant with rainfall requirements of 500-1500 mm/yr, tolerates sandy, rocky or saline soil, up to 1200 m, shade tolerant
Gliricidia sepium	Madre de Cacao, Kakawati, Mexican lilac	vigorous	Coffee shade, green manure, N-fixing, trellis tree rat poison, fodder, fuelwood, shelterbelts	10	a) Soak in hot water and cool overnight b) Scarify mechanically	Highly adaptable, tolerates low soil fertility, tolerates long dry season 6 months or more, but needs at least 1000 mm/yr rainfall, windfirm.
Leucaena diversifolia	Acid Ipil-ipil	vigorous	Pulp, poles N-fixing, fuelwood	18	a) Soak in hot water for minutes b) Immerse in boiling water for 5 seconds	500 mm/yr minimum rainfall with up to 8 months dry season, somewhat tolerant of acid soils (pH) 50 up to 1000 m.
Leucaena	Ipil-ipil,	vigorous	Timber, poles,	20	a) Soak in tap water for	Tolerates 5 months dry

leucocephala	Kariaka, Kumpitis, Sta. Elena		fodder, N-fixing, green manure, fuelwood, shelterbelts		36 hrs b) Immerse in hot water for 2-3 minutes and soak in cold water for 24-72 hrs c) Immerse in hot water 2-3 minutes and soak for 2-3 days d) Immerse in boiling water for 2 minutes and soak in tap water overnight e) Soak in hot water for 12 hrs	season with best rainfall range 600-1700 mm/yr, does not tolerate acid soils, elevation up to 500 m.

Species of multipurpose trees for lowland areas (2)

SPECIES	LOCAL/ COMMON NAME	COPPICING ABILITY	USES	HEIGHT AT MATURITY (M)	SEED TREATMENT/ PREPARATION	SITE REQUIREMENTS
Pithecellobium dulce	Kamachile	vigorous	Construction, poles, fodder, fruits, N-fixing, erosion control, live fencing, bee forage, medicinal use, shelterbelts	18-20	None required	Adapts to variety of soil conditions and 8 months dry season
Samanea saman	Rain tree, Acacia	vigorous	Timber, craftwood, fodder, roadside tree, fuelwood		a) Immerse in boiling water then soak 24 hrs in tap water	Rainfall 600-2500 mm/yr with dry season up to 6 months, prefers good soils

					b) Immerse in hot water for 3 minutes and soak overnight in cool water	but can grow on poor acid soils. up to 500-700 m
Sesbania bispinosa	Prickly sesban	moderate	Fuelwood, fodder, green manure, gum, pulp, fiber, erosion control	3-5	Soak in water for 24 hrs	Grows best in moist climate but is also drought-resistant. Rainfall range of 570-2200 mm/yr, grows on difficult sites including saline and alkaline soils. Tolerates waterlogging, elevation-sea level to 1,200 m.
Sesbania grandiflora	Katurai, Agati, Diana	moderate	Fuelwood, forage, pulp and paper, green manure, food, gum and tannin	10	Soak in cold/tepid water for 24 hrs	Rainfall exceeds 1,000 mm/yr and only a few months of dry season. Widely grown in areas with extensive irrigation or flooding though the species can also grow in semiarid.
Sesbania sesban	Sesban	moderate	Food, fuelwood, fodder, fiber, erosion control, N-fixing	33-7	a) Soak in cold/tepid water for 24 hrs b) Immerse in hot water and soak overnight in tap water	Rainfall at least 1,000 mm, can grow on swampy ground, lives longer in wetter conditions, can withstand acidic soils, periodic flooding and water logging and is relatively resistant to salty conditions.

Species of multipurpose trees for lowland areas (3)

Additional livestock feed resources

Additional livestock feed resources

The fact that the best land is devoted to food or cash crop production should not allow livestock production to be ruled out. Marginal lands can be used to pasture animals as well as to produce animal fodder in order to optimize scarce land resources. Farmers view livestock production not in competition with crops, but rather as a complementary farm operation which can convert crop residues and farm by-products not fit for human consumption or market into valuable animal products.

Increasing the supply and quality of livestock fodder has positive effects for the whole farm system, in addition to improving the health and productivity of the animals. Livestock are an integral component of the nutrient cycling system of a farm and directly or indirectly affect three aspects of nutrient cycling:

1. Nutrients are redistributed on the farm when they are brought up from deeper soil levels by trees whose leaves are fed to livestock.

2. Nutrient availability to plants is increased when crop residues and other feeds are converted to manure.

3. An increase in nitrogen supply is brought about when legume forage are grown and fed to the animals.

Therefore, there is a need to integrate livestock production into other farming components by harnessing marginal farm areas for the production of livestock resources.

GRASSES AND LEGUMINOUS TREES ALONG EARTHEN DIKES, IRRIGATION CANALS AND ROAD BANKS:

These areas often constitute the neglected and waste areas of the farm and are usually left to grasses and weeds such as cogon (Imperata cylindrica), talahib (Saccharum spontaneum), aguingay (Rottboella exaltata), amorseko (Chrysopogon aciculatus). Paddy dikes are usually repaired before planting the rice and once the rice is planted, they can serve as animal fodder sources of grasses and tree legumes. Napier grass (Pennisetum purpureum) on dikes, for example, can produce more than 1.5 kg dry matter (DM)/yr/linear m. Andropogon yielded 36.7 tons of DM/ha when planted along the dikes. Leguminous trees and shrubs can provide high protein fodder using species such as madre de cacao (Gliricidia septum), ipil-ipil (Leucaena leucocephala), Sesbania (Sesbania sesban) and others. Two-year old Gliricidia, for example, produced 5 kg DM/tree/yr of top quality fodder when planted 2 m apart.

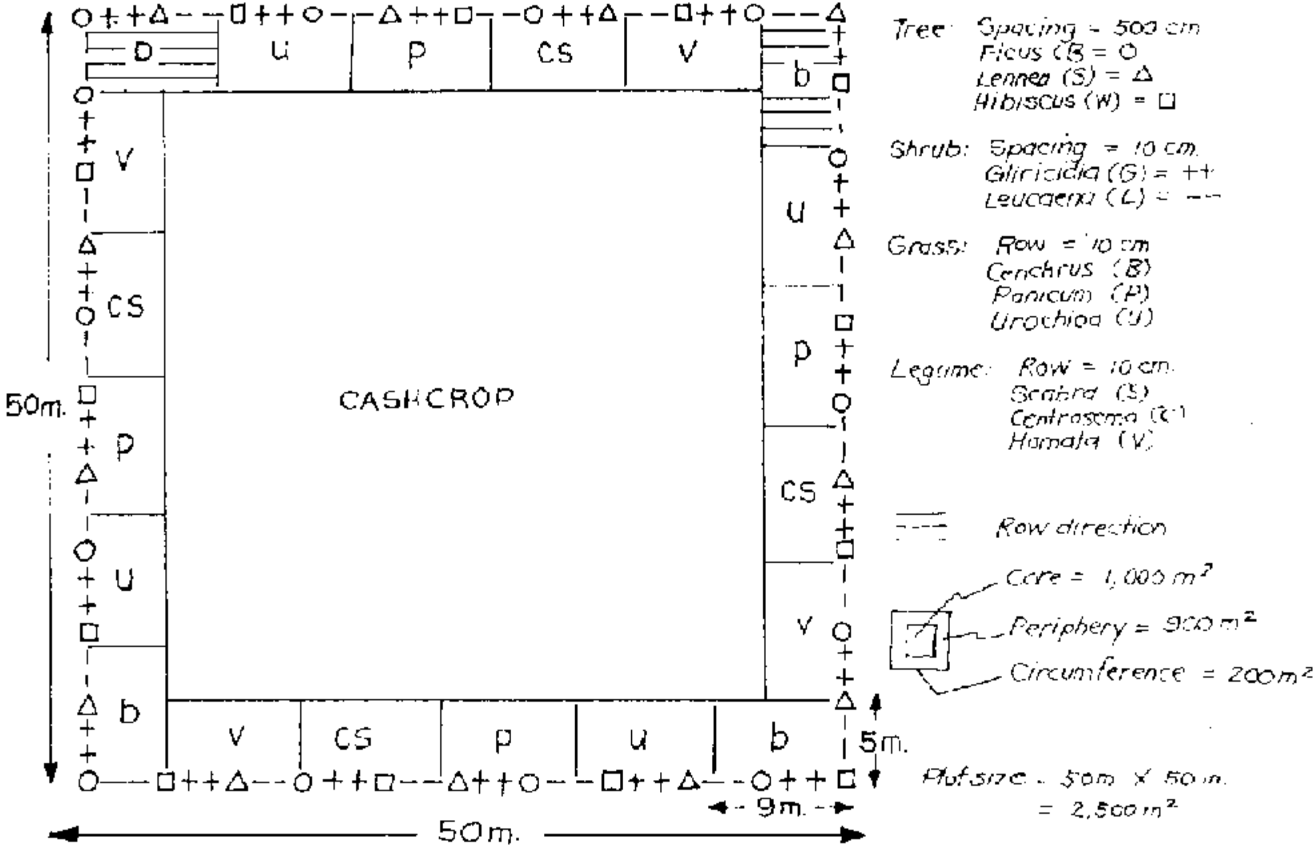
Along the banks of roads and irrigation canals, Guinea grass (Panicum maximum) and Napier grow well. In waterlogged areas, Para grass (Panicum purpurescens) thrives well even when it is cut at 4-6 week intervals.

Grasses and legumes planted along earthen dikes, irrigation canals and road banks not only provide feed, but also help to control soil erosion.

INTENSIVE FEED GARDEN ALONG FARM BOUNDARIES:

Other often-neglected areas are farm boundaries. Some farmers install live fences and barbed wire to control passage of humans and stray animals. Farmers in Batangas and Cavite (Philippines) maximize the use of farm boundaries by planting hedgerows of intensive feed gardens (IFG) as potential sources of fodder for their livestock. They interplant Leucaena and Gliricidia with Napier grass and/or other grasses. This system provides the livestock with nutritious fodder throughout the year. During the wet season (June- December), came feed on fresh grasses and legumes, while during the dry season (January-May), they eat green fodder from leguminous trees supplemented with hay (dried rice straw or corn stover).

In Bali, Indonesia, most farmers use a Three-strata Forage System (TSFS), a technology of planting and harvesting three different strata (one composed of a grass or ground legume, another of a shrub legume and a third of a fodder tree) to provide a source of livestock fodder throughout the year. The first stratum consists of grasses (Cenchrus ciliaris, Urochloa mosambisensis, Panicum maximum) and ground legumes (Centrosema pubescens, Stylosanthes hamata, S. scabra) which provide fodder during the wet season. The second stratum consists of shrub legumes (Gliricidia, Leucaena, Acacia vellosa) which provide fodder during the wet and dry seasons. The third stratum consists of fodder trees (Ficus poacellie, Lannea corromandilica, Hibiscus tilliaceus) which provide fodder during the dry season.



Intensive feed garden along farm boundaries

Note: Fodder grasses should be cut after leaf dew dries in the morning (between 9:00 and

10:00) as a precaution against possible liver fluke infection.

Planting Arrangement of the Grasses Legume Shrubs and Fooder trees in the TSPS.

The botanical composition of the forage offered to cattle will vary according to:

Season:	**First Stratum**	**Second Stratum**	**Third Stratum**	**Total**
During the first 3 years				
Wet Season	65 % +	35 % +	0 =	100 %
Dry Season	35%	65 %	0	100 %
During the 4th and succeeding years				
Wet Season	65 %	25 %	10 %	100 %
Dry Season	35 %	40 %	25 %	100 %

The TSFS offers many advantages to a small farmer with livestock. The utilization of small parcels of land is maximized by combining cash or food crops with animal fodder species. For example, the plot in this diagram is one-quarter hectare (2500 sq.m) and comprises three distinct areas and sources of production: a 1,600-sq.m core area planted to traditional cash or food crops (the crop residues can also be fed to livestock); a 900-sq.m peripheral area subdivided into 45 sq.m areas planted to improved grasses and legumes; and the 200 m circumference area planted to fodder trees and shrub legumes which form a hedgerow fence around the area.

Livestock, an income-generating farm component, are integrated into the farm using a cut-and carry and stall feeding system. With the increased supply of higher quality fodder, 12 % increases in growth rates have been documented and the carrying capacity of a 1 hectare area can be increased to 4 animals/ha. With the combination of the species within the three strata, forage production can increase by as much as 48%. Through the use of

drought-resistant species, forage is available throughout the year. The grasses, shrubs and trees also help reduce water run-off, thus reducing soil erosion. Lastly, the legume shrubs and trees can produce 1 1/2 tons of firewood/yr.

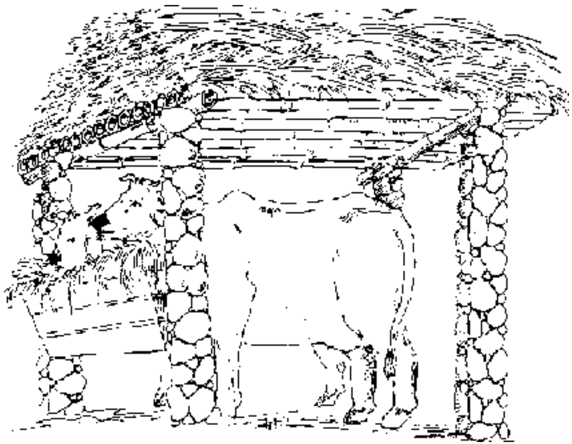
HAY PRODUCTION AND STORAGE:

The mandala or straw stack is a prominent symbol in rice-growing communities. Rice straw is the by-product of rice after threshing and is a potential feed source for carabaos during the summer lean months. It is rich in carbohydrates and is available when pasture grasses are affected by drought or when all of the farm area are planted to field crops.

Farmers in the rice-producing areas of the Philippines store large quantities of rice straw after the rice harvest by sundrying and storing them as bales in a covered barn or as loose hay in the oval-shaped, compact mandala, supported in the middle by a bamboo pole firmly anchored in the ground. The mandala is located in an elevated spot of the farm near to where the livestock are kept. The upper portion should be covered to protect the straw from the rain. Rice straw can be stored longer if its moisture content (MC) is between 13-14%. But, if the MC is above 20%, heat may be produced, causing spontaneous combustion and possible fire or inducing mold growth which reduces the feed value of the straw. An average-sized mandala contains about 1,200 kg DM and has 3.3% crude protein (PCARRD, 1978).

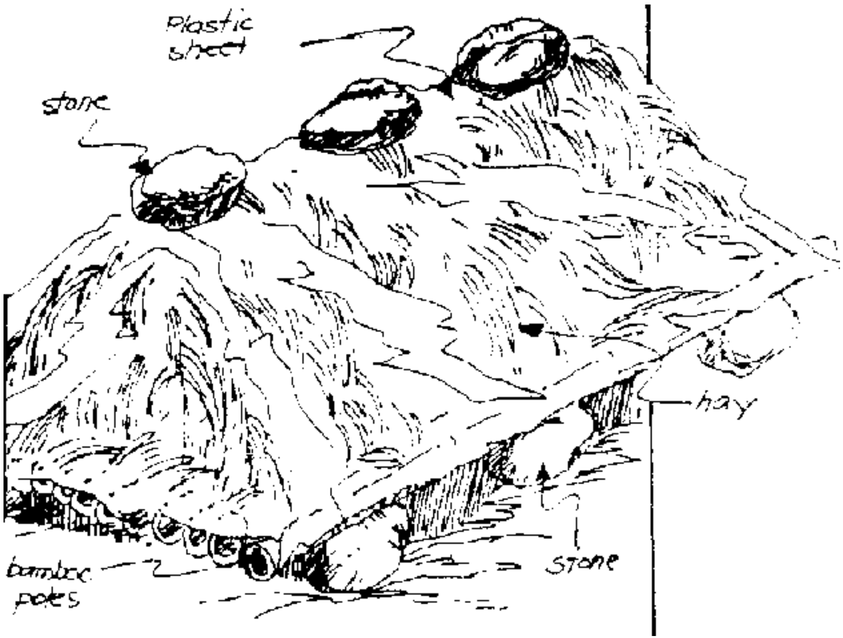
Hay production and storage

In India, the straw stack is located in one corner of a field or on the roof of the animal shed. The posts are made of cut stones and large- boulders are utilized for the foundation.



Straw stack

In other parts of India, another storage system is used. Large stones are used to build a foundation. Then, bamboo poles are laid upon the stones close to each other as a slatted floor. Rice straw, pearl millet and sorghum straw are tightly pressed and compacted into the space. The materials must be tightly compacted to prevent exposure to air which can cause spoilage. The top tapers to the sides and is covered with canvas or plastic sheets to protect it from the rain.



Plastic sheet

Another dried roughage which can be stored is corn stover, the portion of the plant left in the field once the ears have been harvested. The whole plant is left in the field should be stored and protected from rain, otherwise it mildews disintegrates, making it unfit for feed.

OTHER CROP RESIDUES:

1. Sugarcane (Saccharum officinarum)

In sugarcane plantations which use many carabaos, sugarcane tops comprise their only source of daily feed during the milling season. Instead of drying and burning the cane leaves and tops in the field, they should be collected,' cried and stored for future use. Whether sugarcane tops are dried or green, they are palatable and relished by carabaos and cattle. They contain a large amount of digestible carbohydrates in sugar form.

2. Pineapple (Ananas saliva)

In areas where pineapples are grown as a cash crop, the leaves and damaged fruit can be used as animal fodder. After the plants have borne fruit for 2 years, they are removed to make way for new crops. The plants are gathered and the spiny portion removed and cut into 2-3 inch pieces before given to the animals.

3. Peanut (Arachis hypogaea)

Peanuts not only produce quality, nutritious food legume! but can yield up to 8-10 T fodder/ha. Once the peanuts have been harvested, the vine can be fed as peanut hay. The nutritive value is high because of its protein content (10.8-11.9%), as well as its potassium, vitamin A and calcium contents. An additional advantage is its high palatability. For best

· results, the vines should be dried well and protected from rain and dew.

4. "Miramais" (tentatively identified as Sorghum bicolor)

Farmers in Pangasinan province (Philippines) use a portion of their farm to cultivate this indigenous grass, which is similar in appearance to corn. It is a hardy plant which grows well in well-drained, fertile soils and can withstand drought, pests and diseases. It is usually planted before the end of the dry season (October-November) and is cut 30 cm above the ground before it develops a tassel. The stems and leaves are fed and are relished by animals. The plant will develop a tiller and ratoon to produce more forage.

Shelterbelts for rice farms

Shelterbelts are windbreaks, specifically rows of trees planted to serve as protection from excessively strong winds. Shelterbelts modify a farm's microclimate and reduce crop damage from the force of wind. Depending upon the height, placement and orientation of the shelterbelt along a certain stretch, the shelterbelt can also:

· decrease temperature and relative humidity
· decrease plant and soil water loss (evapotranspiration) and the entry of hot air to the farm (advection)
· increase the rate of carbon dioxide replenishment.

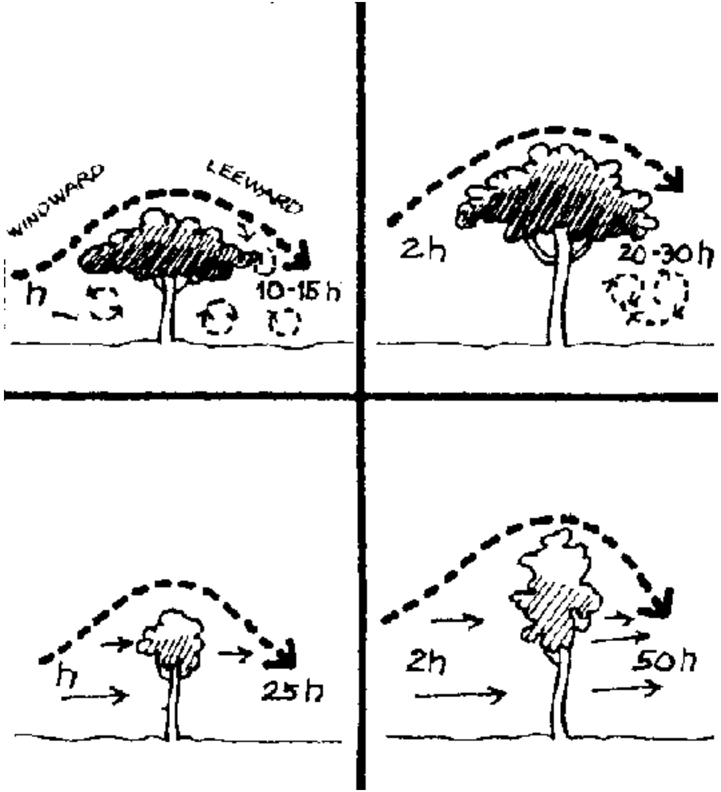
The most beneficial effect of shelterbelts is the reduction of mechanical injury, e.g., leaf defoliation and lodging in areas experiencing high wind speeds. There are reports showing that shelterbelts increase plant growth and yield.

The effectiveness of shelterbelts depends essentially on the interaction of two factors:

1. Height of shelterbelt: Higher shelterbelts protect a longer stretch of crops on the

leeward side (the side protected by the shelterbelt).

2. Porosity: The degree of perforation is usually dependent on foliage qualities such as leaf arrangements, sizes and shapes. More perforated barriers allow less turbulent winds to blow and protect an even longer stretch on the leeward side.



Porosity

2. Orientation. To effectively protect crops, 2-3 rows of shelterbelts should be oriented perpendicular to the predominant direction of strong or typhoon winds.

Orientation

3. Placement. Shelterbelts may be placed near farm boundaries, in areas not used for crop production, or near farm-house boundaries.

Unless rice bunds are widened to accommodate a row of shelterbelts, it would not be ideal to place shelterbelts in the bunds because:

- of waterlogging problems
- there will be competition among crops for water, light and nutrients
- it may be an alternate host to rice insect pests and diseases
- it may hamper field operations.