Upland Rice Growing in Papua New Guinea

A practical handbook written from the experience of Simbu farmers for other farmers in the Highlands

Highlands Institutional Food Security Project, 2002

A Practical Handbook
written from the experience of
Simbu farmers

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VSO

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UPLAND RICE GROWING

in

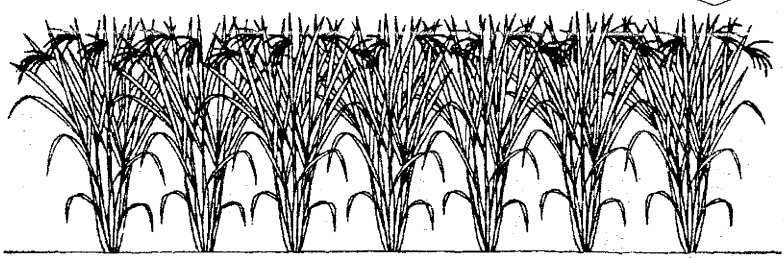
PAPUA NEW GUINEA

Using improved growing methods supported by good understanding of the rice plant, land up to 1500 metres above sea level in the highlands region of Papua New Guinea can provide farmers with 2 tons per hectare (rugby field) of high quality organic rice grain

This has been widely demonstrated in the village farming systems of several districts of Simbu and Eastern Highland provinces during the last 2 years

The purpose of this leaflet is to share with other farmers in the highlands this recently gained experience of practical rice growing, processing and storage methods

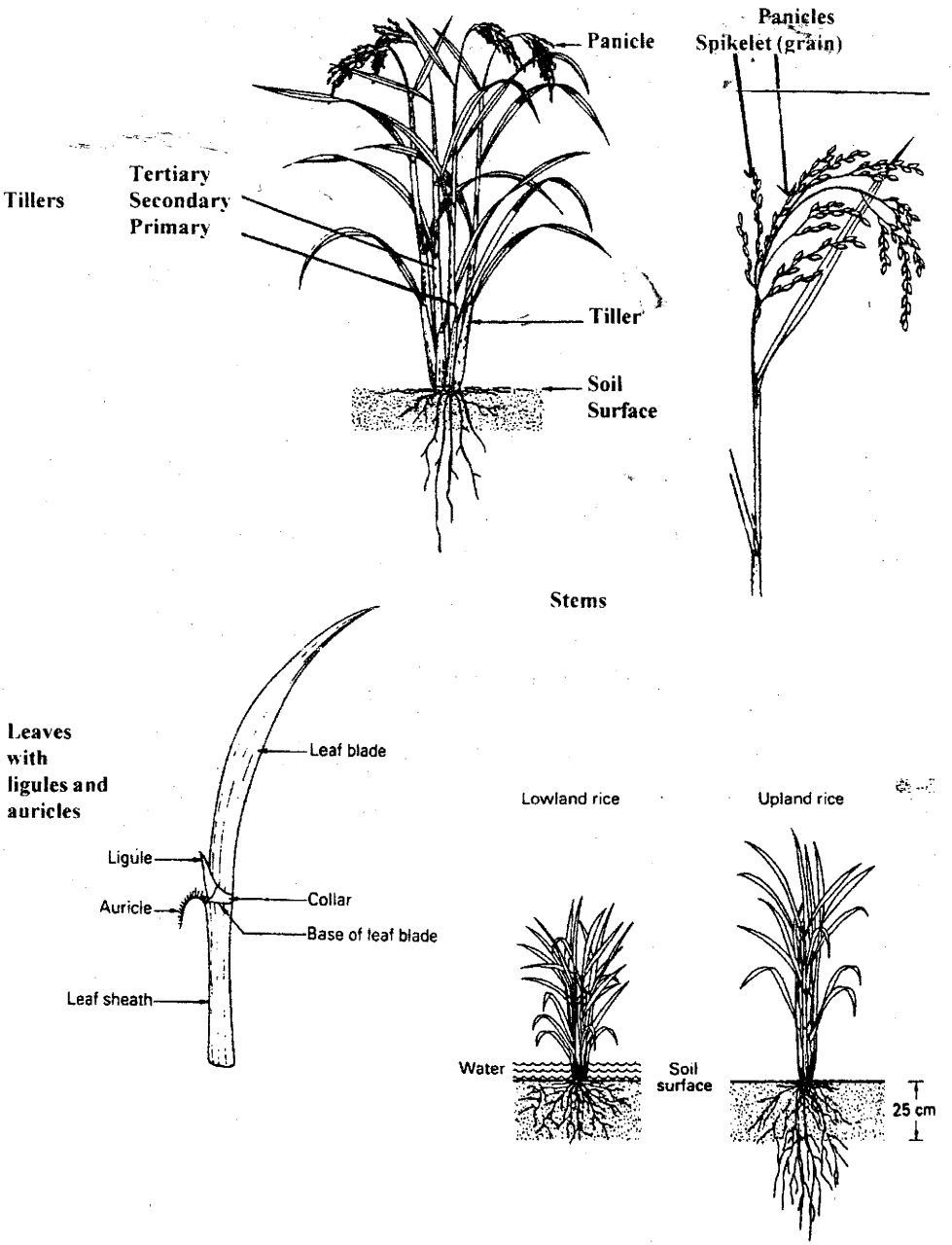
In addition, the leaflet provides some technical information which will widen knowledge and enable farmers everywhere to continue to adapt methods to suit their own land and climate



The rice plant, and its use in a range of farming systems across the world, is one of the most studied, used and enjoyed food crops. Rice growing is relatively new to the Highlands of Papua New Guinea, but a combination of the natural skills of highland farmers and the natural capacity of the rice plant could prove to be a winning one to every man, woman and child there.

This leaflet should be used by all farmers and their families; by all District Rural Development and other Primary Industry officers; by teachers and students in all levels and types of schools and colleges; by those in corrective institutions and non-government organisation staff concerned with food supplies and the local economy. Its contents can make a real impact upon improving the day to day food security situation for families across much of the Highlands of Papua New Guinea.

THE RICE PLANT and TECHNICAL TERMS



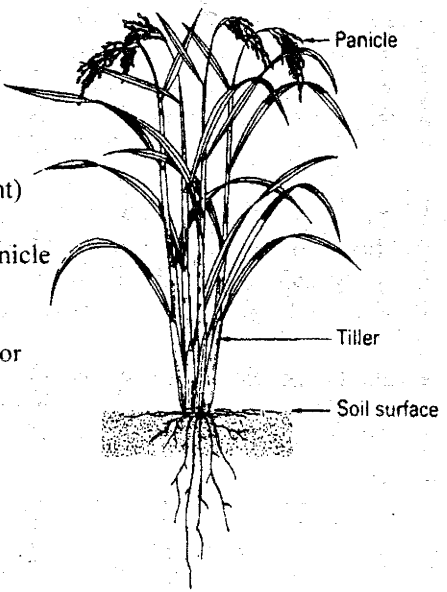
UPLAND RICE PLANT TYPES

Looking at the new rice gardens in Simbu and Eastern Highlands, you will see 2 main rice plant types; one tall and one short. The pictures below demonstrate them clearly, together with the main features of each type:

TALL TYPE (traditional)

Fewer flowers

Height:	up to 180cm(man's height)
Tiller number:	up to 4
Panicle (flower) size:	large, 200+ grains per panicle
Total grain yield:	low to medium
Length of growth period:	around 150 days
Strengths:	root system, adapts to poor environment
Weakness:	more height usually means lower yield



INTERMEDIATE/SHORT TYPE (modern)

Many flowers

Height:	around 80cm (under a metre)
Tiller number	at least 10
Panicle (flower) size:	medium, 100 grains per panicle
Total grain yield:	medium to high
Length of growth period:	around 120 days
Strengths:	good yield potential, but dependent on good farming practices

Note: the number of tillers (side shoots producing panicles) and their full development is a key part of rice growing methods.

THE RICE PLANT LIFE CYCLE

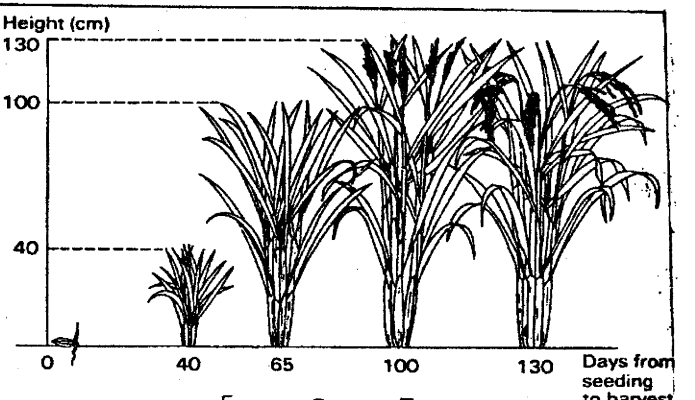
Rice is an annual grass species. In a typical highland farming year, it is quite possible for at least two rice life cycles to be completed successfully (sowing to harvest).

There are 3 distinct stages in each rice plant life cycle:

VEGETATIVE	6 to 10 weeks
REPRODUCTIVE	5 weeks
RIPENING	4 weeks

The total cycle can range between 80 – 180 days, depending on variety, soil and climate conditions. It is the vegetative stage that can vary the most and is the time when farmers must fully understand and observe the crop's progress. There can be up to one month's difference in length of the vegetative stage.

In a chart the cycle looks like this:

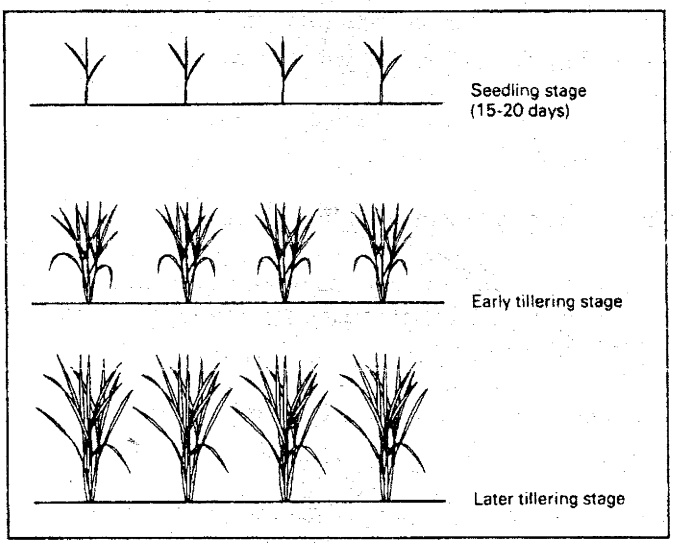


- The duration of the vegetative phase differs with variety.
- The reproductive and ripening phases are fairly constant for most varieties. The reproductive phase last about 35 days; the ripening phase lasts about 30 days.
- The time from sowing to harvest ranges from 80 to 180 days or longer.

RICE PLANT: VEGETATIVE STAGE

There are 3 distinct phases: SEEDLING
EARLY TILLERING
LATE TILLERING

They are all concerned with building up the resources and capacity of the mother plant. The more effectively this stage is completed then the better the eventual yield of the crop will be. The whole stage will take between 6 and 10 weeks, depending on variety, soil, climate.



The key things that are happening at this stage are the development of the rice plants

- LEAF NUMBERS)
- LEAF SIZES)
- LEAF SURFACE AREAS)
- TILLER NUMBERS)

remember – the leaves are the energy makers of the plant. All will combine to create the basis for a good yield of grain

The vegetative phase can be lengthened by factors such as low temperatures and rainfall/water supply. These factors cause plant stress and slow down the vegetative stage, making it less efficient.

So the farmer must try to minimise the effect of the temperature and water problems above.

THE RICE PLANT – REPRODUCTIVE STAGE

This stage starts with the formation of the panicle, at the tip of the growing shoot in each tiller on the rice plant. It is protected by the leaf sheath, and you will be able to feel a bulge in the plant stem about 6 to 10 weeks after sowing. The panicle emerges as a flower about 35 days later. The flower may contain between 60 to 200 spikelets, each one capable of producing one grain.

One day after the panicle emerges, pollen dust is produced and this fertilises the eggs in the ovaries deep inside the spikelet (self pollination). Low temperatures (i.e. below 25degrees C) delays the production of the pollen. It usually takes around 7 days for all the spikelets in a panicle to open and commence the self pollination. In most crops not all the spikelets complete the process and fill up properly. After this stage, the grains start to ripen.

Filling of the spikelet grain

This important process can be seriously affected by:

- Drought between panicle formation and flowering. Each period of very dry conditions or poor availability of soil moisture during this 35 day period will reduce the % of filled spikelet grains
- Drying out of plant leaves, disease of leaves or damage by insects will affect % of filled spikelets
- Low temperatures and/or high humidity at flowering time may present spikelets from opening and allowing self-pollination to occur
- Low temperatures at panicle formation can cause the tiny spikelets to die back
- High temperature (over 35 degrees C)
- Too much added fertiliser

Therefore, TEMPERATURE and MOISTURE continue to be very important factors during this stage of the plant life cycle.

THE RICE PLANT – RIPENING STAGE

This stage starts at flowering and lasts about 4 weeks. It is the important stage that affects the eventual weight of grain produced. 1000 good quality grains should weigh at least 25 grams at harvest. Factors that will effect the amount of ripe grain are:

- Very dry periods will reduce grain weight
- Rainy, cloudy and cool days will lengthen the stage and reduce grain weight
- Low fertility levels in the soil can reduce grain weight
- Poor green leaf growth in the mother plant can reduce grain weight
- Very hot and sunny periods will shorten the ripening period and this can reduce the grain weight

Some of the above conditions can be improved for the rice crop by the farmer; so don't forget to continue helping your crop all the way to harvest.

Harvesting should begin only when the grains are hard – you can just crack one open between your teeth. You will hear it crack. Also the panicles will start to bend over as the grain weight increases. By the time the grains are ripe then the mother plant will have died and all green leaves and stem will have turned brown or white and be crisp to touch.

One problem you will have now is that anything moving about in the crop – the wind, heavy rain, people or animals and even birds - will cause the flowers to shatter, and the ripe grain will fall to the ground.

This is what nature intends; the mother plant lets go of the new seeds and they start to produce the next generation.

SUMMARY – THE RICE PLANT LIFE CYCLE

From the earlier pages, we can see that the rice plant is continually changing and preparing for the next stage. While the rice cannot talk, it shows us daily how well it is suited to the local conditions, provided we look carefully at the plants, every day.

We recommend that:

- Farmers make daily observations of their crops, especially the first few times they grow rice
- Farmers keep a record or diary of what they see
- The record should note information about soil conditions, rainfall, winds, temperature (night and day), humidity, as well as the condition of a sample of leaves, stems, tillers, flowers, spikelets and eventually grain. Occasionally, one plant should also be dug up and the condition of the root system examined

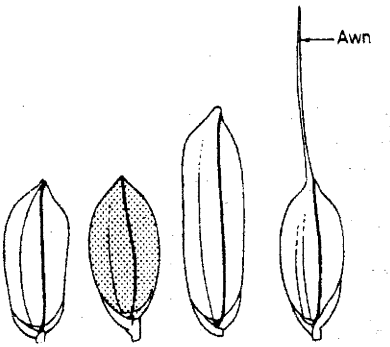
Gradually, over perhaps 2 years, the farmer will be able to decide, for a particular area of land, what will be the best time of year to start a new crop after calculating the expected length of time to harvest and likely pattern of weather. If necessary, the farmer can prepare to supply extra requirements to the crop such as:

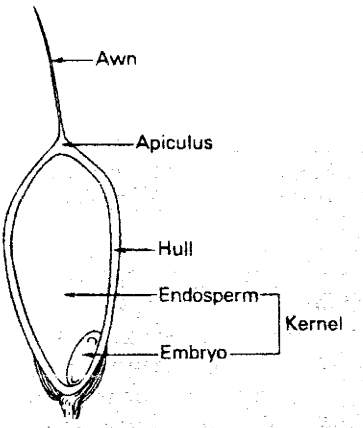
- Water, through simple irrigation from fish ponds or small reservoirs
- Mulch between rows of the crop to retain moisture and lower the soil temperature
- Shade or shelter through some taller companion crops in a mixed cropping system
- Extra soil nutrients targeted at particular growth periods
- Scarecrows to frighten birds away at particular time of grain formation

Many farmers may decide that the best practice will be to start small plots of rice every few weeks all the year round. This will require an even work load and smaller areas of crop at any one stage which may be easier to manage. These continuously ripening small crops may suit regular family food needs, and at each harvest a small amount of the grain can be stored for food security purposes in case a future crop fails.

RICE SEEDS AND SEEDLINGS

Do not expect all rice seeds to look the same. They can vary in size, shape, colour and length of awn or spike, see below. However, good seeds will always be plump and well filled, and covered by a hard cover called the hull. The hull is what enables us to store the rice grain for a long time before eating it. Before we can digest the rice grain in our stomachs, we have to remove the hull.

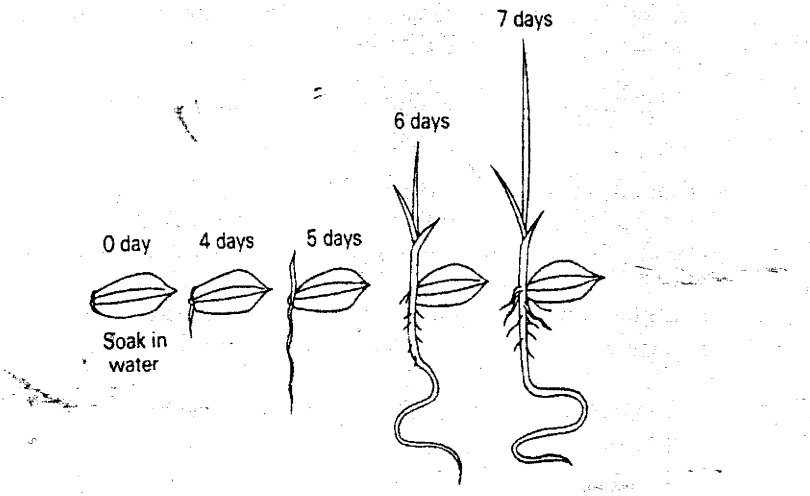




Seed cut lengthwise

SEED GERMINATION

Water must penetrate the hard hull before the embryo develops into the young shoot and roots of the new rice plant. Water, air and a good warm temperature (around 30 degrees C) are all needed for the seedling to grow strongly and compete against weed seedlings in the soil. High soil temperatures and dryness will delay or prevent seed germination.



STARTING TO GROW THE RICE CROP

Select good, plump seed. This can be done by putting a sample of seed in a pot of water. The top quality seed, being heavy, will sink to the bottom of the pot. Any seed that floats is weak and should be thrown away.

Then you have a choice of methods:

1. you can make a nursery bed to raise young seedlings before transplanting

or

2. you can sow the seed directly into shallow lines (drills) in the field

There are advantages and disadvantages to both methods. Evidence from the work of hundreds of smallholder farmers in Simbu is that, for small plots of rice, we recommend making nurseries and then transplanting the seedlings.

1. NURSERY METHOD

- soak good seed in water for 24 hours
- drain off the water and put the damp seed in a cotton bag and hang up in an airy, warm place for 48 hours
- this allows the seed embryos to incubate and small white shoots begin to break through the hard hull
- the seeds are then scattered closely into a small nursery bed, which contains the best soil mix, is watered 2 or 3 times a day and is covered with a light shade. The soil mix contains cooked soil so that weed seeds will have been killed
- within 4 or 5 days, the seed bed should be a mat of green seedling leaves
- the nursery grows for about 3 weeks, until the seedlings all have a least 3 strong leaves; gradually the shade material is removed during this time
- at about 3 weeks, the seedlings are transplanted into their final growing place, choosing a cooler day to do this if possible

The reasons the farmers growing small plots of rice use this transplanting method include:

- they transplant only top quality seedlings, usually in small groups of 2 or 3 seedlings
- they can space the seedlings carefully which helps best growth later
- the well grown seedlings compete well against younger weed seedlings emerging in the rice plots
- the area of the plots are small, up to 10 metres by 10 metres usually, so the amount of work in transplanting is not great

They have developed this method through experimentation and it works very well for them.

2. DIRECT SOWING METHOD

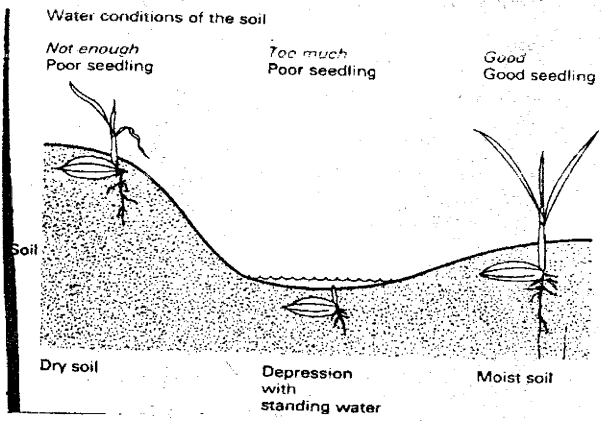
The other method is direct sowing of the seed. The seed may or may not have been incubated before sowing. Advantages of this method are that:

- the seedling is not disturbed after it has begun growing in the plot: this can have a big effect on later development of the plants
- for large plots or fields, the labour required is of course much less than in transplanting seedlings

Disadvantages include:

- a proportion of seeds may not germinate, leaving gaps in crop, which weeds can dominate and spread from
- if there are drier conditions, the seeds may be delayed in germinating and competing with young weed seedlings

So prepare your soil well avoiding very uneven surface conditions (see below)



Other important points:

- when direct sowing, it is important to put the seeds at the correct depth (around 2 – 3 cms) and to cover them with soil so that birds or rodents or hot air do not affect them
- sow in rows, about 20cms apart (a hand span)

Most Simbu farmers have tried both methods and there is no doubt that for small areas the transplanting method is preferred. If rice farms become larger, probably machinery and weedkiller use will assist the direct sowing method to increase.

EARLY GROWTH IN THE RICE CROP

This is the seedling phase of the VEGETATIVE STAGE of the rice crop. Either you will be transplanting 3 week old seedlings from your nursery or you will be watching your direct sown seeds emerge.

In both cases, you must plan ahead so that your young rice plants will grow up with enough space, but not too much. By the end of the vegetative stage you want your row of plants to have their leaves touching across the rows. This should be achieved by 6 – 10 weeks, and will shade out most of the competing weeds.

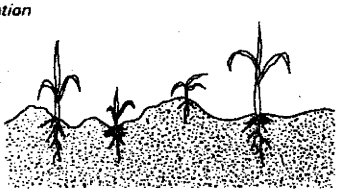
We recommend that you space your rows at about 20cms apart (one large hand span). Also you should prepare your soil well so that you avoid the problems below.

Remember – POOR EARLY GROWTH OF CROP WILL RESULT IN A POOR FINAL HARVEST

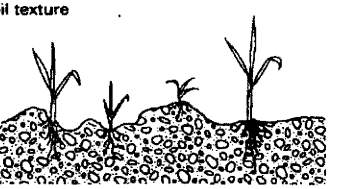
Transplanting method: plant 2 or 3 seedlings together in rows. 20cms (hand span) between each group.
Direct sowing method: sow seed 1 or 2cms apart; fill in gaps if necessary after two weeks.

Land preparation

Poor

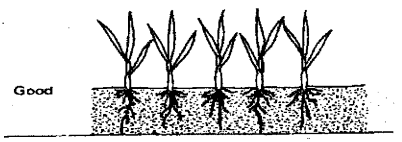


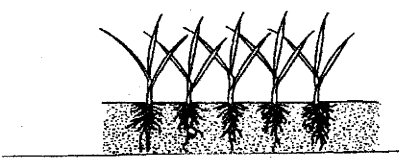
Coarse soil texture



EARLY and **GOOD WEEDING**
Weeds are the most important constraint to strong seedling growth

Good





Many weeds: weak seedlings

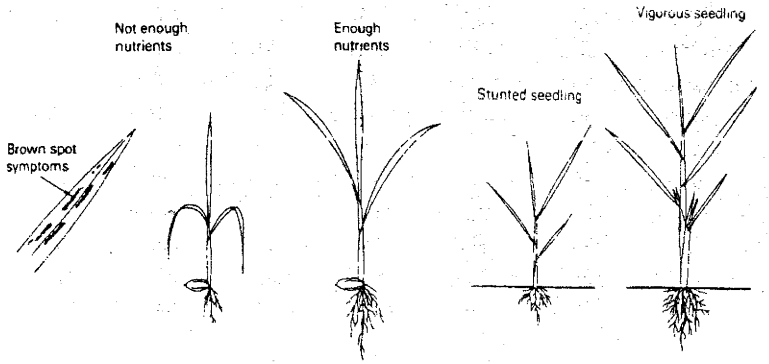
Few or no weeds: strong seedlings

FOOD FOR THE YOUNG RICE PLANTS

As well as good soil preparation, sufficient rainwater or soil moisture (natural and added), a warm temperature (at least 25 degrees C during the day) and bright sunlight, the young rice plant needs a good supply of nutrients (food). For the first 10 – 12 days of life, the rice plant uses food stored in the seed. Then it must absorb nutrients through its roots and then manufacture new plant cells in its leaves with the help of the sunlight. The farmer must consider whether the soil has sufficient nutrients naturally to grow a strong rice crop. Most soils can be helped to grow larger crops by the addition of nutrients.

There are two main methods of doing this. One costs money; the other, time, organisation and forward planning. For most families in the highlands, we advise the second method, at least to start with (see next page).

If the availability of nutrients is not carefully considered, then the problems below can develop, all of which badly reduce the strength of the plant roots and leaves, which are the twin engines of the crop.



Main nutrients required: ***THE BIG FIVE***

NITROGEN: all leafy plants respond well to good supplies of this mineral but too much can be as much of a problem as too little. High rainfall in highlands depletes nitrogen level in soil

PHOSPHORUS: very important because highland volcanic soils can be low in available phosphorus and become acid (sour – add lime). Too little affects the plants' ability to use nitrogen

POTASSIUM: usually sufficient in highland soils. Digging in the old rice stems adds potassium

OXYGEN} these are freely available from the air, providing leaves are
CARBON} strong and healthy

ADDING NUTRIENTS TO THE SOIL

Two main methods:

1. Buy bags of manufactured nutrients (artificial fertiliser) and mix with the soil. Quick and efficient, but expensive, especially in the small quantities that a small plot of rice requires.

2. Build up the natural level of nutrients in the soil over time. The ways to do this include:

- adding well rotted animal manure and dead plant material (compost) to the soil
- growing certain crops (green manure) such as any legumes (beans, peas) which can capture free nitrogen from the air and store it in their roots. When these roots die and decay, the nitrogen is released into the soil. Dig these crops into the soil complete for best effect
- grow different crops in rotation; the crops vary in their nutrient absorption so do not reduce the levels all the time
- reduce quick drainage of rain water through the soil which can cause the wash out (leaching) of nutrients. Prevent erosion if your land slopes
- after harvest, mix the crop remains (rice stalks) back into the soil, do NOT burn them
- between crops, let pigs or poultry spend sometime living on the plot; their manure will enrich the soil
- develop a system of mixed crop growing e.g. rows of beans between small plots of rice. While one crop removes nutrients, the other is returning some
- add natural sources of limestone (calcium) powder and ensure that the acidity (sourness) of the soil does not prevent plants making efficient use of the existing nutrients

8 practical things you can do

all are available to YOU

The only cost is your time and energy.

If you can retain a good level of natural nutrients in your soil, you will be able to grow medium sized crops which are ORGANIC and, therefore, healthy for you and your family. Much of the world now is willing to pay more for ORGANIC food. Highland food should try to remain organic and, therefore, healthy.

USE OF NITROGEN TO FEED THE RICE CROP

Rice responds very quickly to the nitrogen levels in the soil. It is important to understand its effect on the plant if you decide to add extra nitrogen to raise yields of grain. You will have to spend money to purchase nitrogen and you should be sure to get a good return for this expenditure.

- A lot of applied nitrogen will not be used by the crop you give it to. About half will be taken up by the crop; about a fifth will be held in the soil to be used by the next crop, and over one-third will be lost, usually washed through the soil by rain water or will escape as a gas

- Therefore, in the wetter highland areas where over 2,000mm of rain falls during the year and light intensity can be low (clouds), extra nitrogen will be used to grow too much leaf and produce shade. This will reduce the yield of ripe grain. So, use low extra nitrogen rates or else you risk wasting your money

- Extra nitrogen will be used more efficiently to produce more grain by the shorter, modern rice varieties. Tall rice types may become even taller and grow weaker stems which may fall and produce too much shade.

- Extra nitrogen will not be used efficiently during dry periods

- Time of adding the extra nitrogen is important. The best time is when tillering is just beginning which is when the rice plant is about one month old. A second good time is as the plants begin to form the young flowers, usually at about two months old. Adding extra nitrogen after these two periods is a waste of money

- If your soil cracks open then nitrogen can be lost from the soil as a gas. You can prevent cracking by regular hoeing of the soil surface. This also reduces weed growth, which will also take up some nitrogen. Always weed the crop before you add extra nitrogen

- When you add extra nitrogen, mix it in to the top soil thoroughly as this prevents nitrogen loss

- Do not add extra nitrogen when crop is wet or rain is expected. Rain can wash away the added nitrogen and it can stick to the crop's leaves burning them and reducing their strength

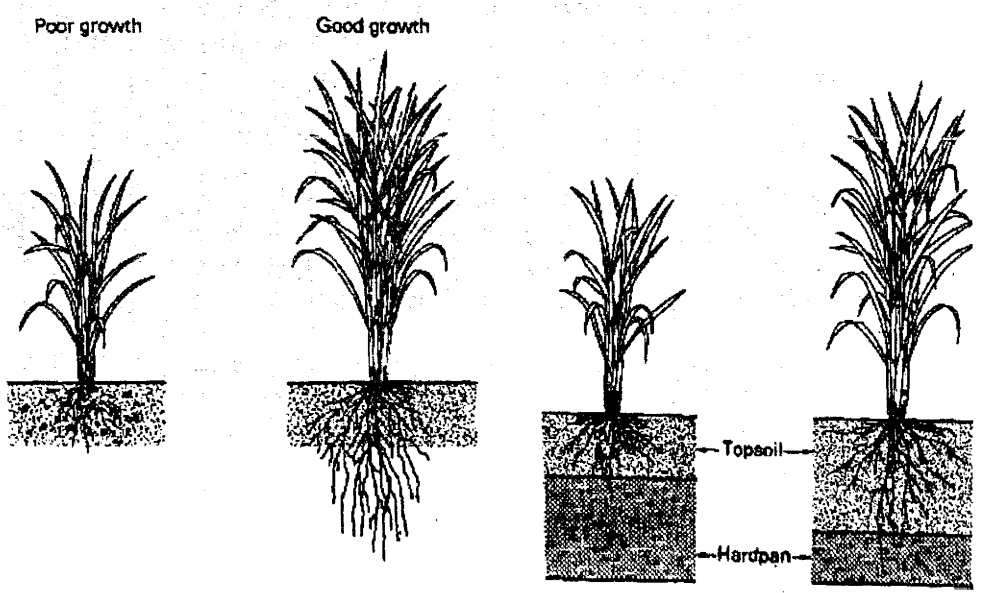
DON'T FORGET THE RICE ROOTS

When you inspect your young rice crop, your eyes and fingers will focus on the leaves. You will learn to "read" these leaves as they will tell you how well your crop is growing. The leaves will be changing every day.

To be a really successful rice grower, you must also remember the important ROOTS! Their condition will tell you at least 4 very important things:

1. the sufficiency of the nutrients in your soil
2. the effectiveness of your soil preparation
3. the adequacy of the available soil moisture
4. the suitability of your soil composition (mixture) for rice growing

Therefore, two or three times during the growth of your crop you should carefully uncover a small sample of rice plants (include one well grown and one less well grown) and examine their growth and strength.

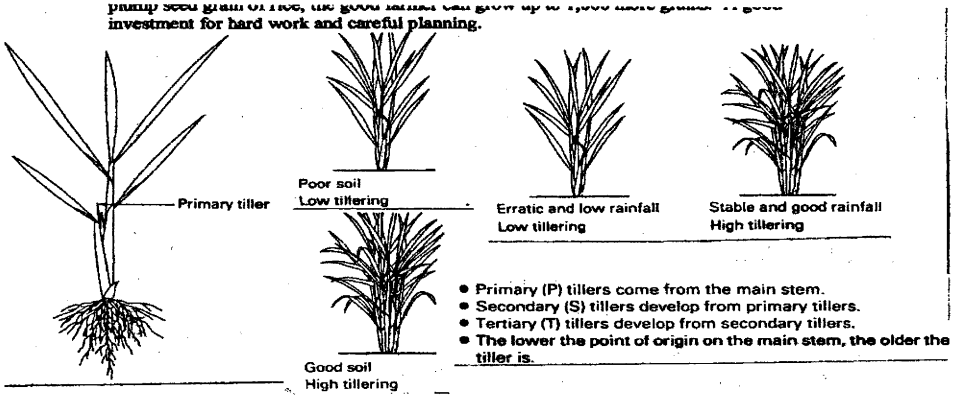


ROOTS must penetrate DEEPLY, SPREAD WIDELY and EVENLY for good uptake of water and nutrients from the soil.

TILLERING – THE SPECIAL POWER OF RICE

Why is rice grown so widely across the world? Why do rice plants give higher yields than other cereal crops such as wheat and maize?

Because the individual seedlings have the power, if well grown, of developing side shoots from the main stem, TILLERS, each of which can result in a full panicle and at least 100 grain of seeds. Tall, traditional upland rice types grow about 4 tillers. Modern, shorter type4s can grow 6 – 10 tillers. This means that from one good, plump seed grain of rice, the good farmer can grow up to 1,000 more grains. A good investment for hard work and careful planning.



Tillering starts 20 – 30 days after germination and reaches to maximum capacity 60 – 100 days after germination. Tillers produced after this point usually die back. Panicles of late produced tillers are often small, ripen late and spikelets are not well filled.

Rice varieties vary in their ability to tiller, but also important are:

- SHADING/PLANTS TOO CLOSE TOGETHER
- DROUGHT PERIODS during the 30 – 100 day period above
- LACK OF NITROGEN or other nutrients
- POOR SOIL COMPOSITION
- WEEDS

All these factors will limit the plants capacity to produce tillers. So, in observing your crop, pay special attention during the second month of growth – this is when you should see the plants producing their strongest and most productive tillers. Add water and a little extra nitrogen at this stage if required.

WATER AND THE RICE CROP

Water is one important factor in upland rice growing. Usually, in highland areas, there will be sufficient rainfall each year to supply the needs of the rice crop. However, the water from the rainfall needs some simple management so that the crop can progress even during dry periods.

One hectare (a large rugby field) of rice plants uses about 8 million litres of water from seedling to harvest. That is about 800 litres per square metre over the 4 or 5 month growing cycle. This is the equivalent to about 40 large, 20 litre kerosene cans for each square metre.

Rainfall of at least 2,000mm a year, which most of the highland region receives, is enough to supply the rice plants, UNLESS this water evaporates or drains away quickly.

1. Evaporation the rice also needs good warm sun to grow, mature and ripen. At times, the sun will be too hot and the plant must be cooled by water in the leaves evaporating. Most water is used in this way. If the rice leaves dry out, they close their pores, air cannot enter and growth slows down. Further drying out will cause the leaves to die; you will see the leaves rolling up and drooping when they become stressed. If this occurs at tillering or flower formation time, the rice crop yield will be very poor.

2. Drainage unlike the sweet potato and other vegetable crops, rice crops do not need drains to be dug, though water-logged seed beds will prevent good seed germination. For most of the growth cycle, the upland rice plot should retain as much of the rainfall as possible.

Also the soil composition should be selected and prepared to suit the rice crop. More organic matter and compost in a soil will help to absorb water, like a sponge, releasing it slowly to the growing crop.

And a shallow water table is ideal. This will be what exists where there are 20 – 30cms of top soil over a deeper subsoil of clay. The clay will hold the soil water back from draining away too quickly.

There are several practical things you can do to conserve the rainfall and make it available to the rice crop:

1. MULCHING water will evaporate directly from bare soil. When your rice seedlings are small, with bare soil showing between the rows of plants, you can cover the soil surface with dead organic matter. This mulch will cool the soil and reduce evaporation. It will also smother young weeds and help reduce soil cracking.

2. WEEDING keeping your crop free of weeds will reduce the evaporation loss of water from the leaves of weed plants.

3. BARRIERS surround your rice plot with shallow soil barriers to hold surface water back around your growing plants, after they have germinated and are strongly growing.

4. IRRIGATE dig small ponds or ditches close to the rice plot, line them with clay and use them as storage reservoirs from which you can channel or carry water, when required, to the rice plants. Some farmers have designed systems of a series of small fish ponds, surrounded by rice plots and have created a water trickle flow between them. This makes very efficient use of water.

5. LOCATION when you are choosing your rice plot location, look around for a natural low point in your land to which water always drains. This will provide the best location for planting your crop (unless you have a serious flood).

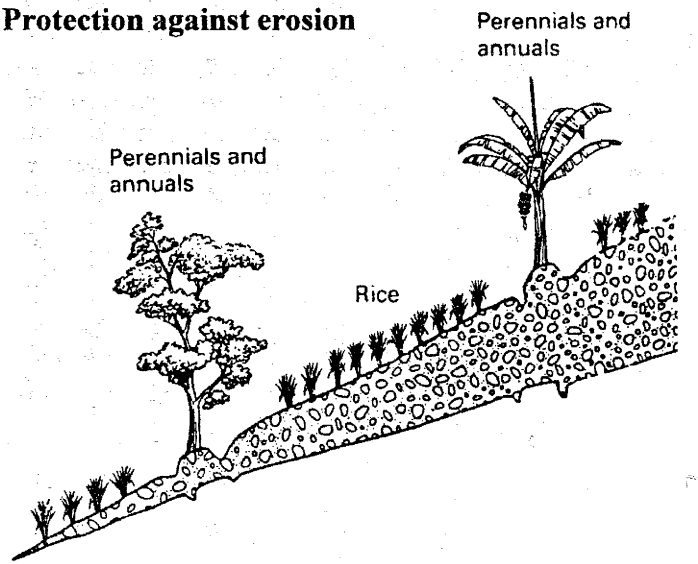
6. SHADE COMPANION CROP a few taller plants, such as corn, around the edge of your rice plot will provide some shade and coolness which will help reduce evaporation. Try to plant these other crops so that they will be harvested a few weeks before the rice, so that plenty of sun reaches the ripening rice grain.

PLANTING RICE ON SLOPES

Many farmers will sometimes have to plant rice on sloping land. Do not use very steep slopes for rice growing as the soil will probably be insufficient to produce a good yield of grain. Follow these general rules for planting on sloping land:

- Intercrop perennial plants (e.g. banana, wetiva grass, small trees) with the rice crop on levees or terraces that follow contour lines
- The steeper the slope, the closer/narrower the terraces should be
- Plant/sow the rice in rows that follow the contour lines
- Clear the land carefully; retain some existing perennial plants to help avoid erosion
- Try and mix the cleared vegetation into the soil rather than burning it
- Use large branches/trunks as erosion prevention barriers
- Try to slow down surface rainwater flows; angle terraces back into the hillside if possible. Do not have drains that run down the slope, channel the water across the slope

Protection against erosion



SOME COMMON WEEDS IN RICE CROPS

- Good weed control means large yield increases in rice, by allowing the rice full use of water, nutrients and sunlight
- If you are planning to use added nitrogen, you must clear your crop of all weeds first
- When direct sowing, you should make false seedbeds first so that emerging weed seedlings can be easily controlled before sowing your rice seeds
- Deep digging or ploughing of your soil before planting rice is good because more weed seeds will be buried
- The most important time to weed is during the first month of the crop growth
- Hand hoeing between the rows on small rice plots is the most effective method; this is best done just after light rain has fallen

broadleaved

Commelina benghalensis

Portulaca oleracea

sedges

Cyperus iria

Yellow-red fibrous roots

Cyperus rotundus

Underground stems and tubers

grasses

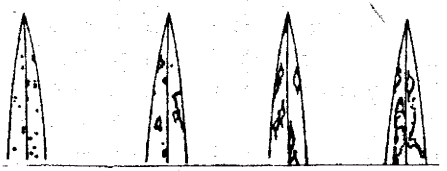
Eleusine indica

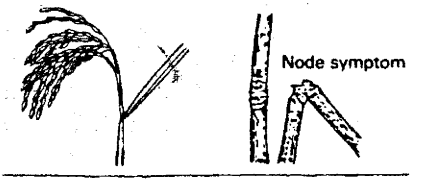
Digitaria ciliaris

SOME COMMON DISEASES OF RICE PLANTS

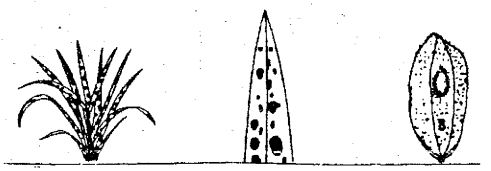
BLAST: this is the most severe disease in upland rice. It is a fungus that produces dark brown leaf spots, which are long and pointed. If the fungus affects the base of the flower then it turns brown and the stem breaks.

Too much nitrogen, cloud and frequent rain encourage this disease. Plant resistant rice varieties.

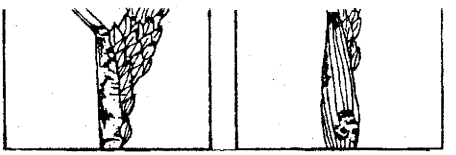




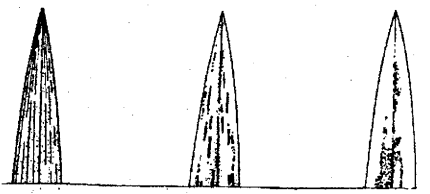
BROWN SPOT: dark brown round fungal spots on leaves, and then on the grains. Disease is common in poor and sour (acidic) soils when phosphorus, calcium or nitrogen are lacking. Improving soil can greatly reduce the disease, and some varieties are resistant.



SHEATH ROT: large grey/brown spots develop on the leaf sheaths that enclose the young flowers. This results in flower not fully emerging and the grains do not fill. Hot, humid weather favours this disease.



BACTERIAL LEAF STREAK: brown coloured lesions cover the veins of the leaves and they start to die off. Use resistant varieties



VIRUSES: cause white/yellow leaves, and short, stunted leaves. Transmitted by insects, especially leaf hoppers.

INSECT PESTS OF RICE

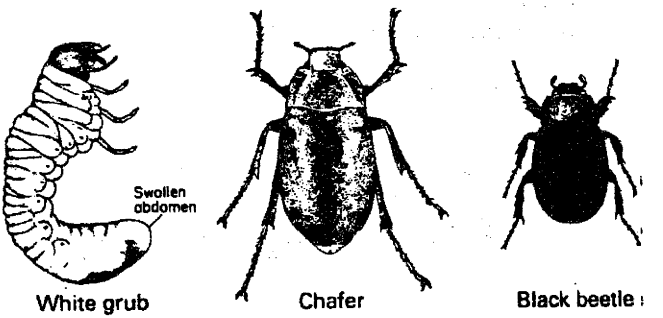
The only certain way of control of pests is by use of usually expensive insecticides. Generally, the small rice grower should accept some damage by insects and try to keep the crop well grown and strong enough to withstand small attacks. Also the cooler nights in highland areas reduces the number of insects that can multiply. So huge attacks on the crops are less common.

1. PESTS IN THE SOIL

- **Ants and Termites**
  Ants store rice seeds in underground nests
  Termites feed on the living rice roots
  Only become a problem during severe droughts

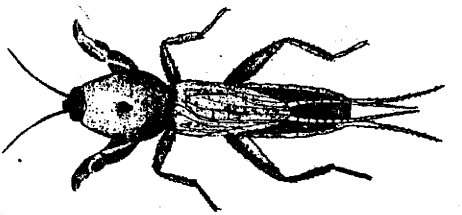
- **White Grubs**
  These are the larvae of insects such as chafers and black beetles. The larvae grubs feed on plant roots. Control is difficult, but usually only local attacks.

Actual sizes



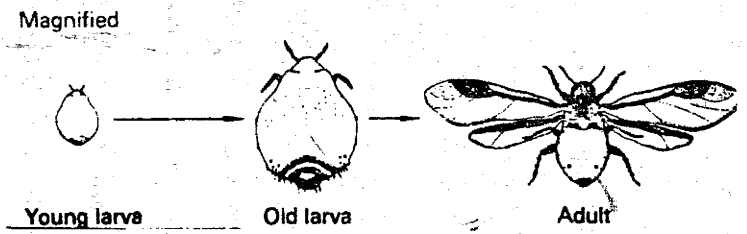
- **Mole Cricket**
  These feed on the roots of young plants, cutting them back. Whole plant is stunted.

Actual size



- **Root Aphids**

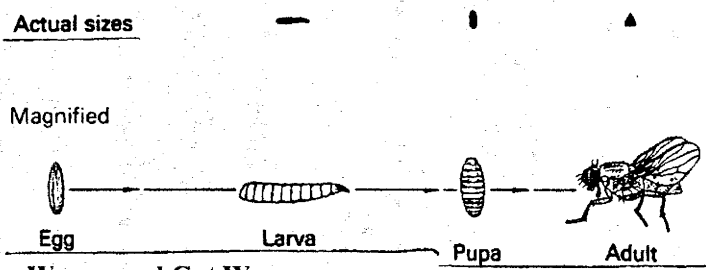
  Adults and larvae suck out fluids from plant roots, causing yellowing and die back of leaves



2. **PESTS DURING VEGETATIVE STAGE** (first 2 months)
mainly the larvae stage of flies and moths. Learn the life cyle of each one.

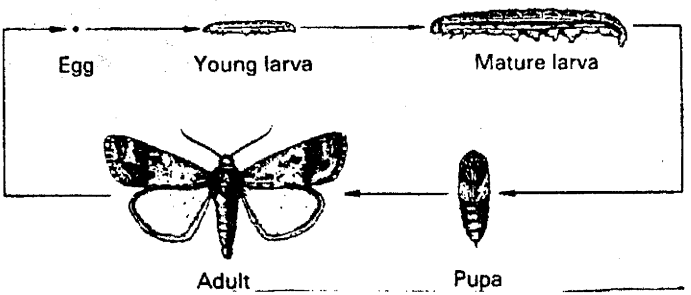
- **Seedling Maggots**

  Fly larvae feed on young tillers and cause dead hearts. Can sometimes completely destroy a crop. A leaf spray of insecticide or seed treatment may be necessary if problem persists.



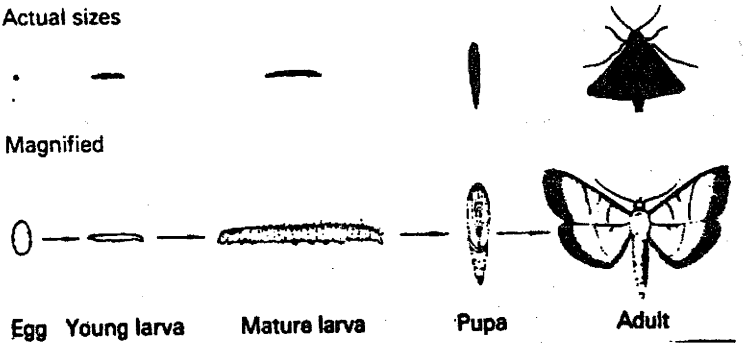
- **Army Worms and Cut Worms**

  Many different species. Larvae feed on tips and margins of leaves, and on young seedlings and emerging flowers. Grasshoppers and crickets cause similar damage.



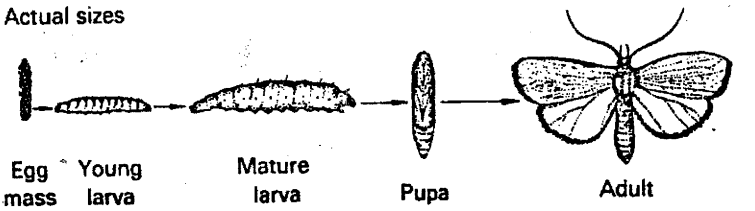
- **Leaf Folders**

  Larvae damage the leaves, causing long white streaks. The leaves then fold and dry out.



- **Stemborers**

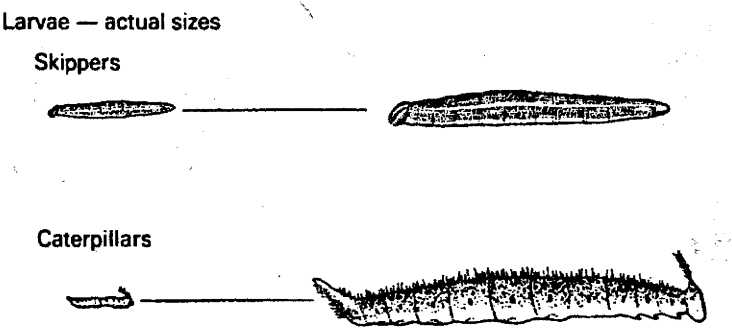
  Larvae eat into the leaf sheath, the tiller and the stems of the plant. This can cause leaf die back, dead hearts and empty grains. Too much nitrogen use can encourage; dig in the rice stubble quickly after harvest to reduce number of adults emerging from the pupae which mature inside the stems.



3. **PESTS DURING REPRODUCTIVE STAGE** (third month)

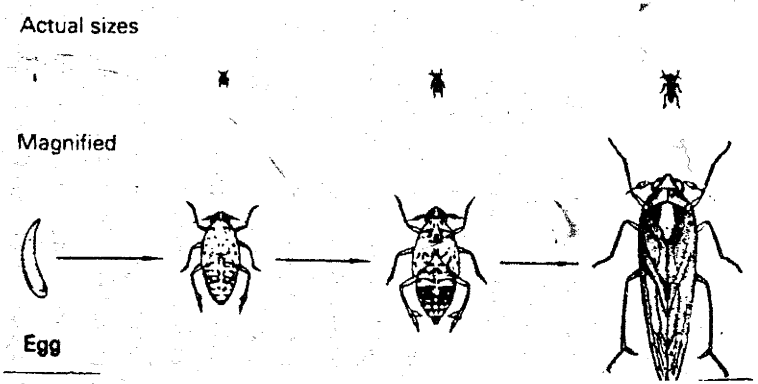
- **Caterpillars and Skippers**

  These are the larvae of certain butterflies. The larvae feed on leaf tips, removing the tissue and veins. Not usually a big problem.



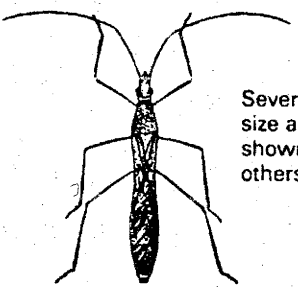
- **Planthoppers**

  Both larvae and adults suck sap from tillers and leaves. They transmit viruses, which cause yellowing of leaves and stunted growth. Damage can be severe.



- **Rice Bugs**

  Larvae and adults feed on the young rice grain reducing their size and quality. They also suck the plant sap.



Mixed cropping can help by providing other plants for insects to feed on. Cleanliness in digging crop remains into the soil, deeply and quickly after harvest; good rotations; using only top quality seeds for planting, and transplanting only the strongest and healthiest seedlings from the nursery will all help reduce the danger of large scale insect attack. Avoiding stress to plants by providing adequate water in dry spells is also advised.

HARVESTING THE RICE CROP

At maturity, the individual grains are full-sized, hard and straw coloured. Test the grain by cracking it between your teeth. If you hear a sharp, clean crack then the grains are ready. The flower heads will also be hanging down with the weight of the grain. The whole mother plant will be looking straw coloured as it dies back.

Harvesting techniques vary in their efficiency. The most effective in gathering all the grain are, of course, the most time consuming and labour intensive. The growers of small plots of rice should consider these methods and, thereby, lose as little grain yield as possible.

1. Grains may not all be fully ripe at the same time. This means you should carry out the harvest more than once.

2. As soon as some grains are ripe, move carefully through the crop with a small bag and shake individual flower heads into it. The ripe grain will fall off, the unripe will remain attached to the plant. Repeat as necessary.

3. When the majority of grains are ripe (80%+), cut each flower head off individually and carefully and put in a bag. This will reduce loss of grain through shattering.

You are unlikely to be able to harvest more than 80 or 85% of your grain successfully even by the method above. If you start to grow larger areas then probably you will cut the whole crop at one time and use your judgement as to the best ripe grain stage; that is before too many ripe grains start to fall off the mother plant naturally.

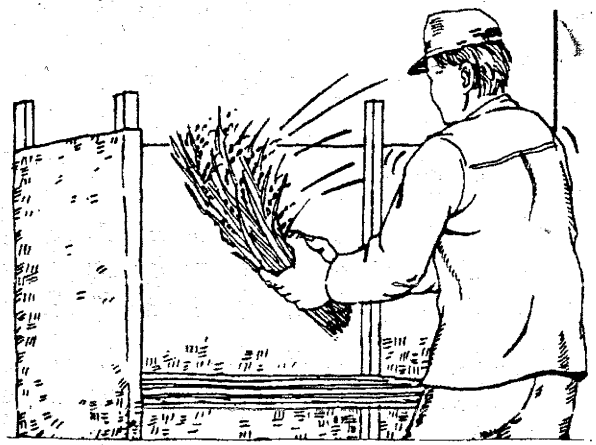
Whenever you are moving around the ripe rice crop do so very carefully; every move will cause some ripe grain to fall. If heavy rain or wind is expected at harvest time, try to cut your crop before they arrive. You may need to scare flocks of birds away.

After harvest, keep the cut flowers/stems in bags and do not let them get wet. Thresh as soon as possible (separating the grain from the flowerhead).

THRESHING, DRYING AND CLEANING YOUR RICE HARVEST

You should separate the grain from the rest of the rice plant as soon as possible. Small rice growers can do this by hand or feet.

By hand – hit the rice flowerhead hard as, for example, in the picture below. Make a frame of bamboo, put up catching screens and put bags or a sheet on the ground.



By feet – lie the rice flowerheads on bags and continuously walk on them, breaking off the ripe grains. You then have to remove the empty stalks and flowerheads.

Once you have a sample that consists largely of grain, you should then let the grain dry by putting it out on sheets in the sun for 1 or 1 days. Avoid very hot days as slower drying conditions will help the grain quality for storage later. Turn the grain as it dries.

To do the final cleaning of the grain and separate all the dust, small pieces of straw and empty grains, you can winnow it (toss it up and down from a large tray letting the breeze blow away the rubbish) or you can put it in water for a short time and remove all the lighter rubbish that will float to the surface. After this floating method, you will need to give the good grain a short further period of drying.

If you are going to store your grain for a long period, or, if you are going to take your grain to a mill for processing, the cleaning process is a very important stage. Rice for milling in machines should be as clean as possible, especially from small stones. Keep your rice off the ground and on mats or bags or sheets to avoid its further contact with soil and stones.

STORAGE OF THE RICE GRAIN

Rice seed is alive. It breathes, giving off carbon dioxide, water vapour and heat. If the grain produces too much of these and they are allowed to accumulate, then various microbes and bacteria will become active among the grain. This can cause moulds which eventually will make the grain decay and become unfit for human use.

Therefore, particular care must be given to the storage of grain, especially for long periods (over 3 months).

Growers of small rice crops, which will be used for direct family consumption, are advised to grow these crops regularly through the year. This will mean small harvests at regular intervals of a few weeks.

Storage of most rice grain can then be a short-term matter and, provided it is well dried (1 or 2 days, slow, sun drying after threshing), it can be kept in a strong rat and mice proof container.

A clean, empty 44 gallon oil drum should hold about 150kg of rice, which will be enough rice for a large family (up to 4 or 5 adults and 4 or 5 children) for up to 3 months, at average consumption rates.

Cover the drum, do not allow water in.

If storage of rice for longer periods is planned then more attention is necessary to the drying, which should be checked by taking the moisture content of the grain. 14% moisture content is the target.

Bags, boxes, tins or drums used for storage should be thoroughly washed in hot water with disinfectant and dried in the direct, hot sun.

The container should not be placed directly on the floor but on a pallet platform allowing air to pass all around the rice.

Tins or drums should have a few small holes punched in the bottoms and sides for passage of air.

Thoroughly clean the storage area and use insect and rat poison baits.

Check the store twice a week for signs of insects or rats.

Take a new moisture sample every few weeks and re-dry your grain if it measures above 14%.

Small supplies of your best grain samples for seed should be stored in cotton bags and hung up in warm, dry, shaded parts of the store.

PROCESSING THE RICE GRAIN

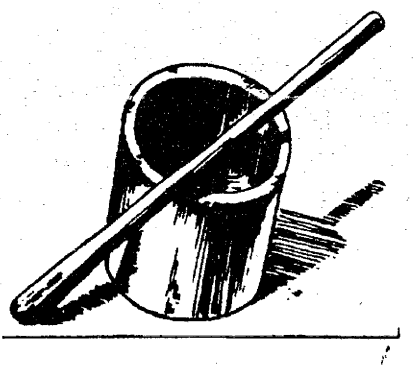
The hull or skin that is on the outside of the grain is very tough and is an excellent protection for the seed, providing that it is kept dry.

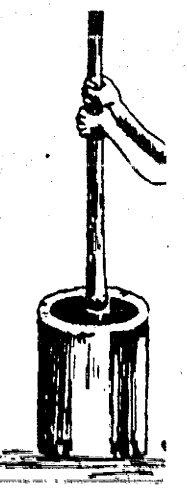
If we try to eat the whole grain including the hull, our stomachs are not easily able to digest it and so we cannot benefit from the rich energy supply inside the grain.

So, we have to break the hull and remove it before we use the grain for consumption. Once the hull is removed, the grain can quickly absorb moisture and, therefore, can go mouldy quite quickly.

Therefore, DO NOT REMOVE THE HULL until you wish to eat the rice, or else you must keep the rice in a good airtight and dry container.

For a family grower of rice, we recommend that you keep most of your rice in a drum or bag with the hull intact. When you need to prepare some, break the hull, wash and cook the rice. The easiest and cheapest way to do this is to make your own family rice pounder (mortar and pestle) like the one below:





All the family can help each day breaking the hull from the grain and winnowing/ washing the rice before cooking. DO NOT hit the grain hard; you are breaking the skin only, not grinding it to a meal. It will take you 15 – 20 minutes to prepare enough for a family of 4 – 6 people.

This method supplies you with brown rice. The brown colour is the rice bran. Underneath this is the white rice. **The bran contains an excellent supply of vitamins and minerals.**

Brown rice is a very healthy food and should be preferred