Upland Rain-fed Rice Production Training Guide
Upland Rain-fed Rice Cultivation
Training Guide

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Preface

This manual was developed with the aim of providing basic relevant information about the rice plant, its cultivation and uses to farmers in Papua New Guinea. This manual is developed mainly for upland rice cultivation but it can be modified for irrigated rice cultivation if need be or where it is applicable. It is hoped that this manual is not only limited to training workshops but could be used as a reference, to grow rice for their own consumption and sale of surplus for income generation.

This is a simple book modified from several sources developed by International Rice Research Institute, Department of Agriculture and Livestock, Papua New Guinea University of Technology, Trukai Industries and National Agriculture Research Institute.
Rice

Introduction

A large amount of rice is consumed in Papua New Guinea, but nearly all is imported mostly from Australia and South East Asia. The consumption of rice is increasing every year. In 2005, nearly 400 million Kina is spent on rice yearly. Some rice is being grown here in Papua New Guinea. If the amount of rice being grown here can be increased, this will save Papua New Guinea a lot of money.

Most of the rice in Papua New Guinea is grown in Oro Province, Morobe Province, North Solomon’s and the Central and Sepik provinces. Other provinces are also growing rice but in small amounts and the number of farmers growing the crop is increasing.

Rice is a useful crop because it does not go bad as quickly as our traditional root and tuber crops. It can be stored for a long time. However, takes a lot more work and process to grow and consume than the other traditional staple crops. For rice it involves many processes such as land preparation, cultivation, crop management, harvesting, drying, milling and storage.

Dry rice and Wet rice

There are many ways of growing rice but the one that is grown in Papua New Guinea at the moment is the “dry rice” or “upland rice”. This rice is planted like corn and depends on the natural rainfall to grow.

The other kind of rice is called “wet rice” or “irrigated rice”. It can grow in places where there is plenty of water to irrigate the rice. The rice is grown in ground that is kept covered with water until the rice is nearly ripe. This helps to stop weeds from growing. Wet rice usually gives more rice than dry rice.

This book is about how to grow dry or upland rice.

Where can it be grown?

Rice can be grown on all suitable soils up to 1900 meters above sea level (masl) in PNG. Specifically, the lowland rice varieties grow well from seas level up to 1000 meter above sea level while the highland or cold tolerant rice varieties grow well from 900 masL to 1900 masl. It grows best in areas that have a definite wet and dry season. Rice is planted at the beginning of the wet season and harvested in the dry season.
Choosing the land

A fairly heavy soil is best for growing rice. A heavy soil contains clay. Clay soils become sticky when they are wet. Rice needs a fertile soil. Land covered with bush or forest or rested for a long time (long fallow) is considered as fertile. A land previously used for growing legumes such as peanuts or beans is also fertile. Legumes plants add “nitrogen” to the soil, which is a plant food.

Avoid sandy soil, because they dry up quickly. Also avoid soil that contains coral. Do not use very wet soil or very dry soil. Also, do not use steep or sloped land. Also, windy areas are not good for rice. Rice may be planted in a new coconut, cocoa or rubber plantations. The rice is planted in rows in between the young coconut, cocoa or rubber trees during the first two years of the new plantation.

Getting the land ready

Prepare the land as for a food garden. Clear the bush and burn bigger parts of the plants. Leave some rubbish to cover the soil. Dig the soil to a depth of 15 centimeters, then smooth it and allow it to settle.

The soil for planting rice should be prepared like this
Choosing the seed

You need 80 to 100 kilograms of good quality seeds for each hectare. Do not use seeds that are bad, diseased or mixed with weed seeds.

There are many kinds or varieties of rice now available in PNG through different organizations. Should seek professional advice from agriculture officers from NARI, DAL, DPI or other organizations who knows about rice to advise you what kind or variety of rice is the right one to use in your area, and should help you to get the seeds.

You can get good seeds from NARI Research Center at Lae or the Taiwan technical Mission in lae or other reliable seed producers near you.

When you get your seeds from NARI or other reliable sources, plant them and select your own seeds from the crop for 2 to 3 years. After this get clean seeds from NARI Research Centre again and save your own seeds from the crops again.

Just before you plant the seeds, put them in a container of water. Good seeds will sink onto the bottom of the container, but bad seeds and the rubbish will float on the water. Dry of the good seeds properly before planting.

Remove the seeds that float on top of the water because they are not good for planting.
Planting

Just before planting clear off all the weeds and rubbish in the field again.

There are three ways or methods of planting. The first way is called “drill planting”. This is described in the following paragraph.

Mark the rows where the seeds will be planted or use a pre-marked rope to guide you. The rows should be 20-30 centimeters apart. Use a sharp stick or another tool to dig the soil about 3-5 centimeters deep along the rows.

 Rows should be 30 centimeters apart and the seeds should be planted by spreading them lightly along the furrow.

Drill method of planting seeds along a row.

Lightly spread the seeds along the rows and cover them with soft loose soil up to 2-3 centimeters. When the plants are two weeks old thin them to a spacing of 2-3 centimeters between plants.
The second method of planting is the “dibbling method”. Prepare the soil as for the drill method of planting; then make holes with a stick. Make the hole 3-5 centimeters deep and 10 to 15 centimeters apart along the row. The holes should be 4 centimeters wide and the rows should be 30 centimeters apart. Plant 3 to 5 seeds in each hole, and cover them with soil up to 2–3 centimeters.

![Diagram of dibbling method]

This picture shows the second method of planting

The third method of planting is the “transplanting method”. This method should only be used in wet paddy or heavy clay soils or on dry land should only be done in the wet season. First the seeds must be sown in a nursery bed or trays and transplanted after three weeks or at 3-4 leaf age stage. The nursery bed should be prepared close to the garden or in nursery trays for ease of carrying to the field. The nursery bed should be about 1m wide for easy reach from both sides and the length depends on the quantity of seedlings required to cover the prepared land or field. Prepare the soil as for the drill method of planting; then make holes with a stick. Make the hole 3-5 centimeters deep and 10 to 15 centimeters apart along the row. The holes should be 4 centimeters wide and the rows should be 30 centimeters apart. Plant 2 to 3 seedlings in each hole, and press the soil at the base of the seedlings firmly.

Looking After the Garden

Weeding
The rice garden should be weeded at least three times during the life of the rice. The first weeding should be done after 2-3 weeks after planting. The second weeding should be done 3-4 weeks after the first weeding. The third weeding should be done 3-4 weeks after the second weeding. Thereafter, weed the garden if necessary or required.
Weeding in a rice garden when the plants are small

When new land is used, very little weeding is needed. Also, less weeding is needed if the land has been growing with a legume plant. Plants like peanuts and beans and some other cover crops such as mucuna and puraria belong to the legume family. A cover crop is grown on land that is being given a rest or fallow. This protects the land from sun and from wind and rain water carrying away the soil (erosion).

Plants from the legume family improve the soil by adding a plant food called nitrogen to the soil.

Fertilizer
Chemical Fertilizer is not needed if the land has been cleared from a bush or it has been growing legumes. Sometimes fertilizer can be very expensive to buy. You can also use other methods to improve the soil without the use of fertilizers. These methods cost little or nothing.
One will have to use chemical fertilizers on land that has been used over and over again. In this case use 100 kilograms of nitrogen (N), 50 kilograms of phosphorus (P) and 50 kilograms of potassium (K) per hectare. The short way for writing these plant foods is “N, P and K” at a rate of 100:50:50.

The three types of fertilizers that contain a high percent of these plant foods are:

1. Urea contains 46 percent of nitrogen.
2. Muriate of Potash contains 60 percent of potassium.
3. Phosphate contains 48 percent of phosphorus.

Store fertilizer in a dry and well-ventilated place or shed

Your agricultural officer will help you work out how much fertilizer you need to buy. He will also show you how to apply it.

Apply half the recommended amount of nitrogen and all the potassium and phosphorus, in the ground before planting. About 25 - 30 days after planting apply half the amount of nitrogen, which was put aside. Then apply the rest of the nitrogen fertilizer 35 days after the second application.

Sometimes rice can lack a plant food called “zinc”. Plants that lack this plant food show signs such as yellowing of lower leaves, brown leaf tips, and fewer tillers or shoots than usual. In this case apply 30 to 50 kilograms of zinc sulphate per hectare.

Pest
Pest can be problem in Rice. Rice can be attacked by pests like rice bugs, leaf folders, Brown plant hoppers, Stem Borers and armyworms.
**Rice Bug**

This is a major pest of rice in Papua New Guinea. It stops the rice grains from growing (filling), by sucking the juice from the young rice grains. These bugs live on wild grasses growing near the rice garden, and when the rice grains start to develop, they move into the rice garden.

![Adult rice bugs](image)

It is expensive to spray to get rid of the bugs. It is best to make the rice garden in a place where there is bush all around. There will not be many bugs in the bush. If the rice is in a grassy area, there will be more bugs.

**Leaf folder**

The caterpillar of this insect folder the rice leaves and eat the inside surface of the folded leaves. The damage is indicated by a white stripe on the leaf. This damage becomes worse during the flowering stage.

![Adult leaf folder](image)
Brown Plant hopper (BPH)
Both the young and adult brown plant hoppers suck the juice of the stems and leaves when the rice plant is in the growing stage. As a result of the damage and plant turns yellow and dies. This pest is one of the major causes of crop losses in PNG.

![Adult male and female Brown plant Hopper](image)

Stem borer
The larvae (young insects) feed inside the rice stem. Rice plants damaged by this insect produce brown shoots during the vegetative stage and white heads with empty seed-cases at heading.

![A young stem borer](image)

Young Stem borer

Army worms

These insects cut and chew the rice plants.

Insect pests may not be too bad the first time the rice is grown but they may increase to a dangerous level if rice is planted on the same land 2 or 3 times. It is best to grow rice in a different place every year. Make the new rice garden far away from the old garden.

Except for the rice bug and BPH, most of the pests do not cause serious damage. However, if any of these insects become a problem, see your agricultural officer. He/she will advice you on how to use chemicals such as “Orthene (acephate 0.1%)” or karate to control the insects. Remember insecticides are
poisonous to you and the insect. Use proper protective gears to spray the insects with chemicals and use at the appropriate recommended rates or doses. Never use an insecticide without the advice of an agricultural officer.

**Birds, wild pigs, goats or cattle**

Sometimes birds eat the rice grain while they are ripening. To avoid the birds, harvest the rice as soon as it is ripe. Also, make a man-shaped toy (scare crow) and place it in the garden. The birds will think that a man is in the garden and they will stay away from it. If other animals are a problem, build a fence around the garden.

**Diseases**

There are many diseases infecting rice in other part of the world, but there are almost no serious rice diseases in Papua New Guinea. However, in 1983 one of the most important diseases of rice, “rice blast” was found at Kokabagu in the Rigo District of Central Province. It is caused by fungus. Sometimes rice can get a disease called “brown leaf spot” on the leaves. This is caused by fungus. It is found especially if rice is grown on poor soil such as sandy soil or used soil.

Diseases will remain on old rice plants. Burn all old rice plants that are left on the land before planting rice again.

Sometimes rice diseases are carried by the seed. Put a fungicide on the seeds before planting them. Ask the agricultural officer to help you do this. Do not save seeds for from diseased plants.

Diseases are usually a problem with rice plants that are not strong. Rice plants growing in poor soil or in a garden that has too many weeds, are more likely to be attacked by disease.

**HARVESTING**

As rice gets ripe, the plants and the seeds begin to turn yellow. The seeds become hard and dry. Rice ripens unevenly. Do not wait till all the heads of rice are yellow, because the heads that ripen early will begin to drop their seeds.

Rice is ready for harvesting when more than 80% of the rice seeds (spikelets) are yellow. This is usually about 30 to 40 days after flowering. The seeds that are not quite ripe will ripen after rice is harvested.
Farmers harvesting the rice

Harvest the rice on a dry day. Do not harvest the rice when it is wet. If the rice is wet it will go moldy (fungus will grow on it).

Cut the whole plants at the ground level, and tie them into bundles. Hang the bundles over sticks for 3 to 5 days or thresh them immediately if necessary. The seeds will take goodness from the leaves and stems and become hard while they are hanging.

Rice hanging under shed to dry

Protect the bundles from rain. To do this, build a shelter out of bush material. Put sticks inside the shelter and hang the bundles on them.
**Threshing**

When the heads are dry, the rice grains can be shaken off the stalks. This is called “threshing”.

Threshing can be done in many ways. You can use a machine or use other ways to separate the rice grains from the stalk. If there is no machine then use one of the ways described in this book.

You can use a 44-gallon drum for threshing. Hit the bundles of rice on the inside of the drum, as in the picture below. The rice grains will fall into the drum.

Another way of threshing is to hit the bundles on a table made of a wire netting or pieces of bamboo. The rice grains will fall through the holes and can be collected on a mat.

Another way is to place a log on a mat and hit the rice bundles on it or just hit them with a stick on the mat.

*Threshing the rice*

Threshing can also be done using bamboo sticks. Bend or partly spilt a bamboo stick. Place rice bundles between the bamboo and pull them.

The rice grains, which fall off, are still covered with a shell called the “hull”. The name for rice grains, which are still covered by this hull, is called “paddy rice”.

**Drying**

The paddy rice must be properly dried before it is milled. When the moisture in the rice grain is about 12 - 14 %, that is the best time to mill the rice. But moisture meter is very expensive to buy. A simple method is to dry the grains on a canvas or mat on a flat surface under direct sunlight. Turn the rice every 3 hours for at least 3 to 5 days. Keep away from any water like rainwater. After 3 to 5 days it should be ready for milling. Put a grain in between your teeth and
bite the grain and if the grain “snaps” then it is ready to be milled. Well-dried rice should be hard to break with your teeth, while the still wet grain should not snap but smashed and these are not good for milling.

Use a canvas to dry the rice seeds out in the sun.

**Winnowing**

Winnowing is to separate the rubbish such as bits of rice plants from the paddy rice and unfilled grains. Do this by throwing the rice in the air and letting it fall back on the mat. The wind will blow away the rubbish. It can also be done by pouring the rice grains from one bowl to another. The drier the grains and the rubbish the easier it is to blow away by the wind. Sometimes the rice can further be dried after winnowing.

**Storing**

Rice seeds are easily attacked by insect pests and fungus if not dried well or stored in proper places or containers. In Papua New Guinea, weevils are found everywhere and will very quickly get into the rice. If you are going to store rice, then it is best to store it as paddy rice. Store the bags of paddy away from the pigs, poultry and rats; store it in a clean dry building where there is plenty of
air blowing freely. Well dried paddy rice can be stored for two years or more. It is important that rice is dried properly before it is stored. It can be stored in sealed drums, buckets with lid or in bamboo baskets.

Rice Milling and Methods:

What is milling?

- Milling is the process of separating the husk (hulls) and bran from paddy rice (rough rice) to get white rice (milled or polished rice).

Definitions:

*Rough rice.* This is sometimes called paddy rice. Rice as it comes from the field. Rice kernels are still inside the hull.

*Brown rice.* This is sometimes known as husked rice. It is the least processed form of rice without the husk but still retains the bran layers that give it a characteristic tan color.

*Milled rice.* It is commonly called white rice. This is the final product obtained after bran removal or the whitening process during milling.
Polishing of brown rice.

*Rice husks.* This is also called the rice hulls. It is the outer skin of the rice. After milling you are left with the brown rice and the husks.

*Rice bran.* This is also called the pollard. From brown rice it is polished to get white rice. After polishing you are left with white rice and rice bran.

The Different Stages of Rice:

![Rice stages](image)

100kg → 80kg → 70kg

10kg rice bran

20kg rice husk

Methods of milling rice

Village methods

*Jeans Method*

Paddy rice is filled into a cut of jeans and pound against a hard surface to remove the husk. (The husk is later removed by winnowing).
**Tong Tong Method.**
This is the mortar and pestle method where the paddy rice is pound to remove the husks.

![Tongtong mill](image)

**Tongtong mill**
Hand pounding of paddy in a mortar with a pestle, or “tongtong” as it is commonly known throughout PNG, it is the traditional milling process in rural villages. Pounding the paddy induces upward and downward forces on grain against grain that removes the husk and bran layers. The pounding also breaks up fissured grain. The final cleaning is by winnowing in a woven bamboo tray. The winnowing process to separate un-milled paddy grain is an art.

**Tajat Kiser? Roller Tontong method**
This was introduced from across the border (West Irian)
Roller tong tong (Kisser) method.

This method involves the rubbing of the weight of the top log against the bottom piece. The rice is held steady between the groves cut out on the top of the bottom piece. The constant movement removes the husks from the grains. The hulls are later winnowed using the wind.

All this village methods only produce a small amount e at a time. This is convenient for a family unit. The rice produced is brown rice, which is nutritious for the body because of the nutrients that are good for the body is found in the brown layer.

**Motorized Mills**

**a). Micro-mills**

- Diesel engine operated
- Ideal for village situations or family units
- Can produce 150 – 250 kg per hour, some even more
- Can be obtained from Brian Bell, Farmset, Agmark etc

**Micro-mill**

**b). Motorized rubber rollers**

- modern rice mills, good for commercial or large-scale operations
- operate on electricity, expensive to purchase
• all in one operation (husking and polishing)
• output capacity of up to 1600 kg per hour
• Cost range K20000-K30000

In some rice growing areas of PNG NGO groups, government or individual provide small rice mill. But there is some payment to be made as “milling fee”. Some mill operators charge a milling fee of K0.20 – K0.40 per kilo for milling.

d) What is required for producing good quality milled rice?

There are three requirements for producing good quality milled rice:

• the starting quality of the paddy is should be good and paddy should be at the right moisture content (14%) and have a high purity

• the rice mill should be clean and well maintained, avoid other materials like stones and sticks these materials can damage your machine and at the same time the milled rice will be full of rubbish and

• the mill should be operated by a skilled operator.
Further information and copies can be obtained from
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