RICE-GROWING RECOMMENDATIONS

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In recent years rice consumption in Papua New Guinea has increased greatly and now is equivalent to 90 000 tonnes of paddy rice per year. Consumption per head in 1971-72 was 35 kg.

Little of this is produced locally although rice was first introduced by missionaries and plantations at the turn of the century. The Sepik provinces produce most of the locally grown rice while there is some production in the Central and Madang provinces, and other provinces.

Conditions suitable for growing rice

Rice is grown in other countries under widely differing climatic conditions, being cultivated as far north as 45°, through the tropics and subtropics to 40° south.

Rice varieties which have been introduced to Papua New Guinea do not grow well above about 1 300 m. The International Rice Research Institute (IRRI) in the Philippines is looking for varieties suited for higher altitudes.

Generally, rice flourishes under conditions of high temperature, prolonged sunshine and adequate moisture.

Rice may be grown on dry land, in which case it is dependent on rainfall, or it may be irrigated.

Adequate moisture is the most important factor in assuring high yields. Rainfall requirements will naturally vary with soil type, drainage and evaporation, but generally at least 25 mm per week is required by the crop until flowering (about 2½ to 3½ months, dependent on variety) and later 50 mm per week. As all precipitation is not available to the crop a rainfall of 40 to 50 mm per week initially, increasing to 80 to 100 mm at flowering, would generally be ideal.

Unsuitable rainfall patterns make it impossible to grow dryland rice in some areas of Papua New Guinea.

In the upper Markham Valley and upper Ramu Valley rainfall is usually adequate for the early and mid season varieties, which mature in 120 to 135 days. The late varieties sometimes run short of water.

Sunshine and daylength are important. Rice flourishes during long periods of sunshine. This means that rice yields in temperate areas, which have longer day length, are generally higher than yields in the tropics.

However, varieties have been obtained from IRRI which are suitable for growing in Papua New Guinea.

Adequate sunshine during ripening is beneficial. Without adequate sunshine at this time crops tend to be more susceptible to disease and are harder to harvest.

Lack of sunshine at harvest time also makes some areas of Papua New Guinea unsuitable for growing rice at certain times.

Variety

The variety currently recommended, NG 6637* (referred to as 6637) has performed well both under dryland and irrigated conditions in the Markham Valley and under dryland conditions in the Sepik.

Yields of around 5 000 kg/ha as irrigated rice and around 3 000 kg/ha under dryland conditions can be expected with this variety.

Soils and fertilizer requirements

Rice can be grown on a variety of soils and can tolerate some quite acid and alkaline types. Generally speaking, soils of medium to medium-heavy texture are favoured, for dryland rice because they retain moisture better, and for irrigated rice as they are less likely to lose substantial amounts of water through excessive drainage. However, good crops of dryland rice have been grown on very light soils.

It is difficult to generalize about fertilizer use as specific soils will have specific requirements depending on the inherent make-up of the soil as well as any treatments the soil has undergone. Generally speaking, soils previously under bush fallow will have few fertilizer requirements while grassland soils almost inevitably require nitrogen.

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* NG. . . Papua New Guinea plant introduction number.

Trials of irrigated rice in the Markham Valley. Photo B. Singh.

Nitrogen

Under most circumstances the new high-yielding IRRI varieties will respond to additions of nitrogen (N).

Under dryland conditions in grassland areas which have only had a short period between initial ploughing and seeding heavier N applications are generally necessary. Under these circumstances sulphur (S) may also be needed.

At least 100 kg/ha of N are recommended and heavier applications may be worthwhile.

It has also been noted that very heavy applications (200 kg/ha and more) can cause lodging.

Where the soil has been fallowed for a reasonably long period (i.e. five or six months) or rice follows a legume crop, applications of around 50 kg/ha should suffice.

Generally, heavier soils require less N than the light soils, and on light soils split applications may be beneficial. This latter observation has been very obvious at Umi in the Markham Valley where the soil is very light and gravelly. Marked responses to split applications have been obtained.

As conditions under irrigation are usually better than under rainfed conditions, yields can be expected to be higher and hence nutrient requirements are greater.

At Gabmazung 80 kg N/ha appeared adequate on newer paddies, but 120 to 150 kg/ha were required on an area continuously cropped for some years. High rates of N caused lodging and also enhanced leaf hopper attack. At this site applications of zinc (Zn) were necessary and this will be mentioned later.

Nitrogen is generally added before puddling.

Phosphorus

Additions of phosphorus have been shown to be essential with dryland rice at Umi, beneficial at two other sites and possibly beneficial at another. The amount applied was 50 kg/ha, with 100 kg/ha N. One trial with irrigated rice at Gabmazung gave no response to phosphorus. This does not mean that additions of P are not necessary in other areas.

Further studies are being carried out.

Other nutrients

Zinc deficiencies have been noted at sites as wide apart as Bubia and Cleanwater. Zn deficiency is much less likely with dryland rice than with irrigated rice.

Deficiencies of trace elements, especially

The rice plant on the left was fertilized with zinc, while the one on the right which did not receive any zinc shows zinc deficiency. Photo B. Singh.

Zn, are often more likely on relatively alkaline soils (pH 7.5 to 8.5) and this is especially so if irrigation water used is high in bicarbonate.

The severity of Zn deficiency varies. At Ganip and Cleanwater, applications of about 50 kg/ha of zinc sulphate per crop (irrigated rice) are essential, while at Gabmazung, results are relatively slight, and only one application every three crops might suffice.

Sulphur deficiency is a definite possibility, especially on grasslands where there has been little opportunity for organic matter to break down. This is being investigated.

Water requirements

The quality of irrigation water can be a limiting factor, especially if soils were already high in soluble salts and are difficult to "wash" by percolating water down. Water sources with high levels of soluble salt and high sodium need to be treated with care. High levels of bicarbonate and chloride can also be deleterious.

Land preparation

Dryland rice

The aim is to create good conditions for germination as well as to kill any emerging weeds. A fine seedbed is preferable. In grassland areas the initial ploughing should be carried out sufficiently early to allow plant material to decompose before harrowing to form a final seed bed.

Under Markham Valley conditions in 1974-75 three ploughings (commencing five months before seeding) followed by three harrowings were found to be necessary in a commercial block for dryland rice.

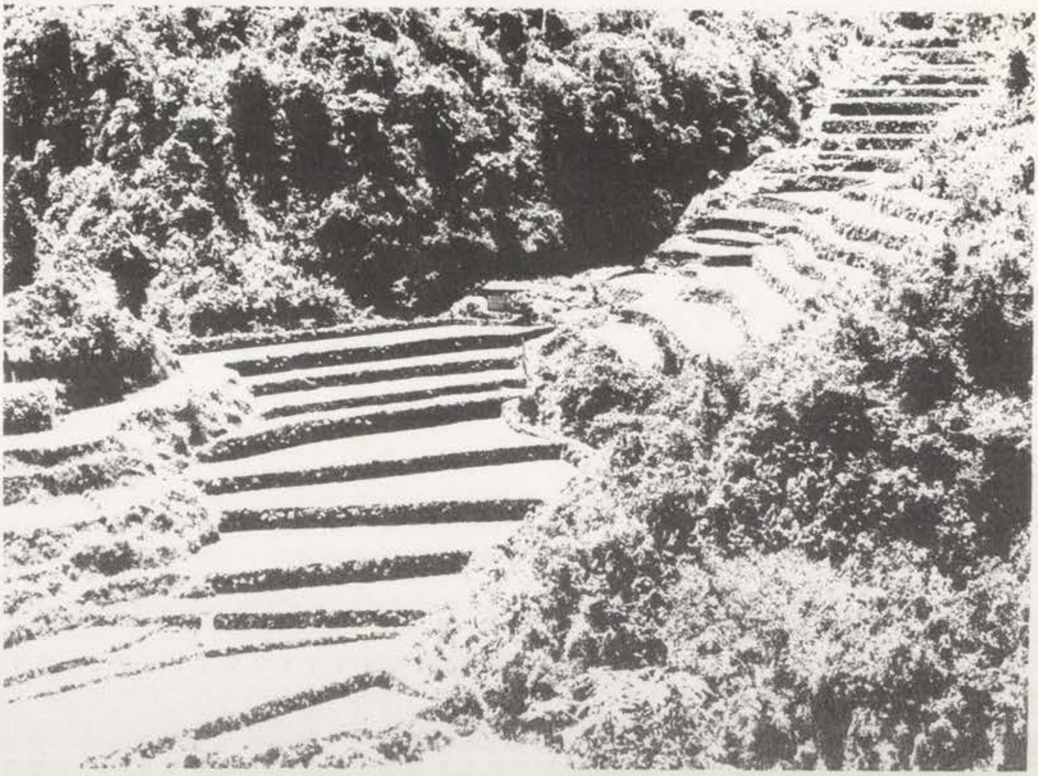
The number of workings will vary for different areas, of course. In the Sepik provinces land preparation is limited to clearing and burning of secondary scrub with the bigger logs and stumps being left. The ground is not worked at all and rice is hand-sown in holes made by planting-sticks.

Irrigated rice

For irrigated rice there are additional requirements. With this type of rice the paddies are covered with water from transplanting or an early seeding stage to shortly before harvest. This supplies the rice with unlimited water and controls most weeds (which can be a problem in dryland rice).

An even depth of water throughout the paddy is essential and this is achieved by mechanized levelling, where land is already quite flat, or by contouring and levelling in hilly areas. Irrigated rice is grown extensively throughout south-east Asia where intricate systems of terraced farming have been evolved.

Once paddies have been levelled it is generally necessary to plough and allow the soil to dry for two to three weeks. Another cultivation may be necessary and this can be carried out in the same operation as fertilizer application. Water is then run on to the paddies and a rotary hoe is sometimes used to puddle the soil (that is, to partially seal the soil and prevent excessive water loss through drainage), and to mix the fertilizer. On a small scale this can be done by treading or using implements drawn by oxen or buffalo. Three or four days are allowed for clay particles to settle and provide the seal and then seedlings are planted.



Terraces, like these in the Philippines, are used for planting rice in many parts of Asia. Photo Julia Farley.

Sowing date

Dryland rice

When there is a distinct wet-dry rainfall pattern, dryland rice must be sown during the wet season. Ideally the first three to three and a half months should have ample rainfall and after that there should be ample sunshine and less rain so as to allow the crop to ripen and be successfully harvested. Excessive rain during rippening can severely hinder mechanical harvesting operations.

In the upper part of the Markham sowing should be done in early to mid January as generally reliable rain can be expected until mid April. Further down the valley (i.e. Leron Plains to Erap), it should be sown in December as the wet season tends to finish earlier. Dryland rice is a riskier proposition in this latter area.

If a real distinction cannot be drawn between seasons, dryland rice can be sown at any time of the year provided rainfall is adequate. Under such conditions the risk of diseases and difficulties during harvest are greater.

Irrigated rice

Irrigated rice can be sown at any time of the year, but highest yields can be expected during periods of high sunshine. If a definite wet season does occur it would be wise to avoid maturity coinciding with the wettest months.

Sowing rate

Dryland rice

Dryland rice is generally sown by planting seed directly into the field. Seed can be sown by hand or by machine. Many small-scale farmers sow by placing seed into holes made by planting-sticks on cleared ground. This method appears to be quite adequate provided holes are placed at regular intervals. Trial work to date has indicated that closer spacings are beneficial. It is suggested that 5 to 10 seeds be placed in holes 20 to 25 cm apart.

Where an area has been adequately worked, seed can be broadcast by hand or machine and turned in with harrows or rakes.

A new, shorter variety of rice at left is contrasted with the older tall variety of rice which used to be grown in Papua New Guinea. Photo M. Wright.

Turning the seed into the ground minimizes loss to birds and mice and ensures better conditions for germination.

Large areas are generally sown with adjustable drills. A depth of 2 to 4 cm is suggested.

For the recommended variety, NG 6637, the recommended seeding rate is 120 to 150 kg/ha.

Irrigated rice

Rice which is to be irrigated can be sown by transplanting seedlings from a nursery, by broadcasting as pregerminated seed, or by drilling seed before flooding.

Method 1. The first method assures good, even establishment but is labour-intensive. Nurseries are established by seeding heavily and covering with fine soil. It is important to keep seedlings well watered and fertilizer (generally nitrogenous) is sometimes used. A nursery area of 30 to 40 m^2 is generally sufficient to transplant 1 ha of paddy. Seedlings should be 4 to 5 weeks old when they are transplanted.

Method 2. Seed is sprouted in bags by watering two or three days before broadcasting. Sprouted seed can be hand-sown or broadcast aerially, with the latter method being widely used in Australia and the USA where labour is expensive. Sprouted seed is usually broadcast into freshly drained fields and then flooded and drained two or three times until permanent standing water is introduced. The importance of having flat paddies is self-evident.

Method 3. Ungerminated seed can be drilled into a moist seedbed which is flooded when seedlings are two or three weeks old.

As with dryland rice, establishment is probably more important than seeding rate. Although it is likely that optimum spacing will vary from area to area and variety to variety, a 20 x 20 cm spacing with 2 or 3 plants per site is suggested for transplanted rice in Papua New Guinea. Where rice is broadcast or drilled a rate of 80 to 120 kg/ha is suggested.

Weeds and their control

Rice seedlings are quite slow to establish and therefore compete poorly with weeds. Dryland rice is especially vulnerable in this regard as growth for the first 2 to 2½ months is slow. Aside from assuring an optimal water supply, flood irrigation also controls most weeds, but there are some weeds which can flourish under flooded conditions, and therefore prove a hindrance. Weeds, aside from competing directly with rice, can also act as alternative hosts for a range of pests and diseases. Infestations of tall weed species can make mechanical harvesting dificult or even impossible.

Sound water management prevents the establishment of most weeds in irrigated rice. On the dry land surrounding the paddies, weeds can be effectively controlled by slashing, hoeing or the use of chemicals. Planting of suitable legume species is recommended.

In Papua New Guinea, as elsewhere, the main weed in irrigated rice is barnyard grass *(Echinochloa crus-galli)* which can compete strongly with rice and is also an alternative host to leptocorisa. Sedges *(Cyperus* spp. and *Scirpus* spp.) can also be a nuisance.

With dryland rice weeds can be a very real problem and can preclude economic production in some situations.

Under a long fallow, shifting system where rice is grown on a small scale, weeds are usually not a major problem, as the site is usually abandoned or given to alternative crops once weeds become prominent. Under Papua New Guinea conditions, two or three weedings are generally carried out.

Theoretically, on virgin land, weeds should not be much of a problem for the first and perhaps second crops. This may be true where weeds do not occur near the cultivation. However, it has been evident in commercial-scale plantings in the Markham Valley in 1975 that on virgin land or land uncultivated for at least six years weeds were a problem. Ingress of weeds was presumably by wind (*Digitaria insularis, Amaranthus* sp.) and by water (*Portulaca* sp. especially) and at least one weeding was needed.

There are a number of ways of minimizing weed infestation—

(1) Thorough land preparation can help, with several harrowings, timed to coincide with weed emergence. Also it is sensible to ensure that machinery is free of weed seeds. Spread by machinery has undoubtedly contributed to rottboelia infestations in the Markham Valley. It is also advantageous to spray or slash areas around the crop before the weeds flower.

(2) Weedicides will sometimes be essential. Three pre-emergence weedicides, diuron (Diurex), linuron (Afalon) and amitrol (Amitrex), are all effective. Diuron may be used at a rate of 1 kg active ingredient (a.i.)/ha aplied with 300 l/ha of water. Linuron and amitrol may be applied at 4 kg a.i./ha.

A typical Sepik subsistence garden of dryland rice. Photo B. Singh.

Other weedicides which were tried but are not recommended are alachlor (Lasso), propachlor (Ramrod), trifluralin (Treflan), chloramben (Amiben), dichlorbenil (Casoran), asulam (Asulox), simazine (Simatox), Cobex and Bladex.

Postemergence spraying with propanil (Stam F34) at a rate of 3 kg a.i./ha is also effective. It may be used 23 to 37 days after sowing.

(3) The use of rotation could be expected to help weed control although this has not yet been demonstrated on a large scale in the Markham Valley.

When grass species become uncontrollable a legume crop (e.g. soya beans, peanuts, cowpea) may be planted for a period. Chemical methods may then be used to control the weeds in that crop. To control problem weeds more vigorous crops such as maize or grain sorghum can also be included in the rotation, with either herbicides or interrow cultivation used to control weeds. A pasture phase may also be beneficial.

Pests and diseases

There are a multitude of pests and diseases that can affect rice. Fortunately some of the more serious do not occur or have not been recorded in Papua New Guinea to date, but could well be disastrous if they were introduced. For this reason unprocessed rice is a prohibited import into Papua New Guinea. Introductions of new varieties are being made by the Department of Primary Industry but only after strict quarantine procedures have been observed.

Insect pests

Leptocorisa, of which there are three species in Papua New Guinea, suck out the contents of developing grains and are the most serious and widespread pest. In grasslands in parts of the Sepik, where alternative hosts are numerous, they can preclude rice cultivation. In some areas they are seasonal and sometimes their incidence can be reduced by indentifying and reducing alternative hosts (usually grasses). Often this would not be practical. Spraying (with lindane, carbaryl) helps but its effect may be only short-term if large numbers of the pest exist outside the sprayed area. A number of cultural practices help. As the life cycle of the pest is short it can multiply quickly and affect later flowering plants more severely. Crops should be planted so that the flowering or ripening crop does not overlap with a new flowering crop. The pest will move from a ripe crop to a flowering one at or before harvest.

Stem borers, of which there are some 22 species, are serious rice pests in other countries but to date have not been a major problem in Papua New Guinea. There has been one species only reported to date in the Markham Valley *(Sesamia inferens)* but several other species of borer occur in other parts of the country. They cause damage by boring into seedlings and eventually preventing nutrient and moisture flow into the head. As a result heads are characteristically white and empty. Suggested control measures are crop rotations, stubble destruction and application of diazinon granules at 20-day intervals under irrigated conditions.

Leafhoppers and planthoppers, of which there are numerous species, can reduce plant height and tiller numbers if they attack in the early stage. They have, on occasion, greatly reduced yields on irrigated rice at Gabmazung. Additionally these pests can carry virus diseases such as yellow dwarf, orange leaf, tungro, grassy stunt and transitory yellowing (none of which have been identified in Papua New Guinea yet). Varietal resistance does occur but is liable to break down—this has recently happened in Guadalcanal (Solomon Islands). The use of chemicals (carbaryl, lindane) can help, provided the pest is recognized early enough.

There are a multitude of other pests but few (aside from armyworm in one instance in the Markham Valley) have caused major damage to crops in the Markham Valley or Sepik. Some of these potential pests include armyworm, cut worms, case worms, leaf rollers, leaf folders, green vegetable bugs and shield bugs. Mole crickets have been observed feeding on rice roots both in the Sepik and Markham Valley recently.

Diseases

Rice in Papua New Guinea to date has been relatively disease-free. A leaf spot caused by *Drechslera oryzae* has been the main pest and can cause considerable yield depression by loss of effective leaf area and damage to the grain. It is worse under rainy conditions. Some varieties show considerable resistance to the disease and the variety 6637 appears to be one of the less susceptible ones. Assuring crop evenness, use of fungicide-treated seed from disease-free crops will give some measure of control. Blast *(Piricularia oryzae)*, a fungal disease, could be particularly disastrous if introduced to Papua New Guinea. Other diseases reported overseas include stem rot, sheath rot, Bakanae disease, sheath blight, false smut, bacterial leaf streak and bacterial leaf blight. Virus diseases have not yet been recorded in rice in Papua New Guinea.

Harvesting

Time to maturity varies greatly between varieties. Of those introduced to Papua New Guinea the maturity period varies from 100 to 160 days. In relatively humid environments, it is important to harvest at the correct time otherwise problems in harvesting, storage and processing will result.

Generally under lowland PNG conditions it takes about 30 days from flowering to ripening, although extremes of 14 and 56 days occur depending on variety. A moisture content of 20 % at harvest is desirable.

Harvesting techniques vary. In Papua New Guinea individual plants are cut and bundled, while overseas, sickles and various types of knives are used to cut individual ears. The rice is then threshed by beating against planks or by beating with wooden implements or by treading.

Large areas are usually harvested by tractor-drawn or self-propelled harvesters which carry out harvesting, threshing and winnowing in one operation. Threshed rice is termed "paddy" rice.

Storage

It is essential that rice be thoroughly dried before storage.

Before storage, rice should be winnowed and dried, ideally to 13 to 14 % moisture if it is to be milled soon, or to 10 % if it is to be stored for a while. A storage percentage of 10 % may be impossible to maintain under hot, humid conditions. Good storage facilities are necessary.

Processing

Before consumption, rice must be hulled. Paddy rice is fed into machines (either hand or machine-operated) where it moves between rollers to remove the outer husk. The de-husked rice is termed "brown" rice. Where machines are not available, husking can be carried out by using mortars and pestles.

"White" rice is produced by polishing to remove the closely adhering coat or testa. It is nutritionally undesirable as most of the vitamins as well as other nutrients are removed in the testa. White rice imported to Papua New Guinea from Australia contains vitamin-enriched pellets to make up for much of this loss.

PNG'S FOURTH AGRICULTURAL COLLEGE

Papua New Guinea's fourth national agricultural college is to be established at the existing Bainyik Agricultural Extension Station in the East Sepik Province later this year.

The college, to cost about K1 million, has been included to be set up as part of the East Sepik Rural Development Project.

The report of the working party on Agricultural Education and Training in 1975 recommended to the Government the establishment of an additional agricultural college in Papua New Guinea.

The Government has selected East Sepik as the best location for the college.

The project Manager for the East Sepik Rural Development Project, Mr Bill Graham, expects construction work on the new college to get under way in July this year.

Provision is being made for both male and female students to be enrolled at the college.

Facilities to be provided at the college would therefore include two male and one female dormitories, kitchen-dining room, community hall, library, science and home science block and one double classroom.

The students would undertake two-year certificate courses at the college. The college will also offer one-year diploma level training after the certificate course, as well as some in-service training courses.