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Guide to rice production in Borno State, Nigeria

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Guide to Rice Production in Borno State, Nigeria

Promoting Sustainable Agriculture in Borno State (PROSAB)

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PROSAB
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Ownership

The ownership of this guide primarily belongs to the PROSAB (Promoting Sustainable Agriculture in Borno State) project funded by the Canadian Agency for International Development, IITA, and BOSADP (Borno State Agriculture Development Project). Some of the resource materials used in the preparation of this guide were obtained from the training manuals of PROSAB, CTA (Technical Centre for Agricultural Rural Cooperation), IITA, NAERLS pesticide manuals, and from major pesticide manufacturers and distributors in Nigeria.

As this guide is also accessible to the public we have taken extra care to ensure that the guide is a well illustrated document that extension agents, contract sprayers, and pesticide dealers can use to assist farmers on learning how to use pesticides effectively and safely. We hope that this guide will also raise awareness about both the benefits and the hazards of pesticide use. It is very important that farmers are properly informed about critical aspects of pesticide use, as presented in this guide.

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Introduction

The purpose of this guide is to provide a reference material for extension agents and lead farmers, including the wider public in Borno State who are engaged in upland rice production. A proper understanding and creative/ innovative application of this guide will assist the prime beneficiaries to improve their rice production and management practices.

Rice is one of the most important cereal crops in Nigeria. Rice consumption is increasing rapidly in Nigeria because of urbanization, relative ease of preparation, and convenience in storage. It is commonly boiled and eaten with stew or vegetable soup. It is also used in the preparation of several local dishes that are eaten in every home, especially during festivals and ceremonies. However, rice supply falls short of the demand; the country depends heavily on rice importation of over 5 million tons annually, equivalent to over $US 800 million in foreign exchange. Recently, the Federal Government of Nigeria raised the tariff on rice importation to 75% to "protect local producers against massive imports of rice". This policy is stimulating interest in the domestic production of rice.

Currently, most of the farmers producing rice rely on traditional technology with low use of improved inputs. Average rice yields in the country are low and range between 1 and 2.5 t/ha. To increase rice production and productivity in the various states in Nigeria, including Borno, improved varieties need to be adopted and farmers must have good knowledge of rice agronomy. The emphasis on the promotion of improved rice production technologies gained a fresh momentum after the recent announcement of the policy on rice import restriction; it also warranted the need to equip extension agents with up-to-date information on crop production practices.

In this guide, we present the recommendations for getting a high rice yield in Borno State from IITA in Ibadan, the West African Rice Center, (AfricaRice), in Cotonou, Bénin, and the National Cereals Research Institute (NCRI) in Badeggi.

Constraints to rice production in Borno State

Drought

Drought is a major constraint to rice production in Borno State because rice requires a lot of water for optimum growth and yield. Rice requires about 1200 mm to 1600 mm of rainfall evenly distributed throughout its growing period. This volume of rainfall is rare even in the southern parts of the State that usually receive more rain than the northern parts. The severity of drought is higher in the uplands than in the lowlands (*fadama*). Rice varieties recommended for Borno State therefore fall within early and medium maturity classes that have tolerance for and/or capacity to withstand drought.

Poor soil fertility

Soil fertility in Borno State has progressively declined because of increased pressure on land resources arising from rapid population expansion, forcing farmers to adopt continuous cropping. Fertilizer use is low. Studies by PROSAB and its collaborators have shown that the soils in Borno State are deficient in nutrients, being far below critical levels for the production of most crops including rice. The total nitrogen of the soils in the State ranges from 0.136 to 0.151% in the southern Guinea savanna, from 0.16 to 0.194% in the northern Guinea savanna, and from 0.141 to 0.153% in the Sudan savanna. Available phosphorus and exchangeable potassium are similarly low. Studies by PROSAB have also shown widespread micronutrient deficiency across the State. The studies also indicated a need to avoid acid-forming fertilizers and suggested a review of current fertilizer formulations to include micronutrients to enhance rice yields in the State.

Pests attack

Pests, especially birds, and *Striga* attacks are major constraints in rice production in the State.

Site selection

In Borno State, rice can be grown in two main areas:

- Lowland areas: These are lowlands on the edges of flooded fadamas (inland valleys) and irrigation schemes where water is available for 4½ to 5 months. In some areas water may be available for more than 5 months.
- Upland areas: These are areas with good soil and rainfall of over 700 mm.

Select fertile land.

Recommended rice varieties

The recommended rice varieties for Borno State are presented in Table 1. These varieties introduced by PROSAB mature earlier and produce significantly higher yields than the varieties which farmers in Borno State have been growing. Research by PROSAB (Fig. 1) has shown that with good management, up to 8 t/ha of paddy yield can be obtained with some of the recommended varieties. The recommended varieties also produce more tillers and compete better with weeds than the farmers' varieties.

Select the variety most suited to the land from among the recommended varieties.

Table 1. Average paddy yield from farmers' fields of rice varieties recommended for Borno State.

			Paddy yield (kg/ha)	
Variety	Type	Days to maturity	Northern Guinea savanna	Southern Guinea savanna
NERICA 1	Upland	95–100	4987	3740
NERICA 2	Upland	95–100	–	3372
NERICA 3	Upland	95–100	4906	2985
NERICA 4	Upland	95–100	3729	3032
NERICA –L- 41	Lowland	110–120	6127	–
NERICA –L- 42	Lowland	110–120	6255	–
Farmers' variety	–	–	1948	1948

Source: PROSAB Annual Report 2006.

PROSAB scientist examines the NERICA-L-42.

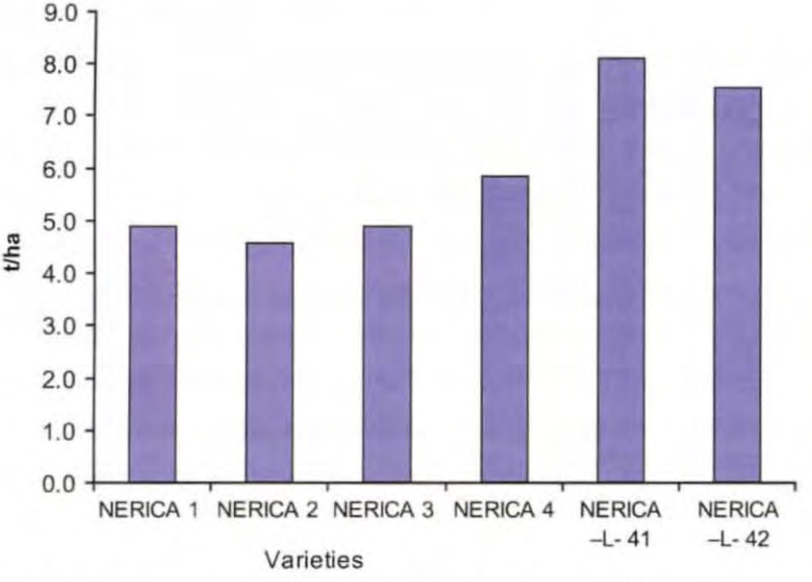

Fig. 1. Paddy yield from PROSAB trials in Borno State.

Land preparation

Proper land preparation is necessary for rice production to minimize competition with weeds. Harrowing twice provides sufficient tilth for rice growth. Ridging is not necessary and is often a waste of space. In the southern part of the State where the soils are more fragile and prone to erosion, minimum or zero tillage is recommended. Where zero tillage is to be adopted, the field should be sprayed with glyphosate at the

Land preparation for rice production.

rate of 4 L/ha (about 2⅓ Peak milk tins of chemical /15-L sprayer) to kill emerged weeds. About 10 days after spraying glyphosate, slash or mow the dead weeds.

Seeds and seed preparation

After deciding on the rice variety to use, select plump, viable seeds that will grow vigorously.

Sources of improved rice seeds

Contact any of the following sources nearest to you for your supply of viable rice seeds:

a. Agricultural Officer or extension worker
b. State Agricultural Development Project that includes rice in its production programs
c. River Basin Development Authority
d. Branch officer of the National Seeds Service
e. Seed companies
f. Other rice farmers

Procedure for sorting seeds for planting

- To separate the heavier seeds from the lighter ones, soak them in 12% common salt solution or muddy water for about two minutes.
- To prepare the salt solution, dissolve 2 Peak milk (standard size) tins full of salt in 18 L of water (about a bucket full).
- The seeds that sink to the bottom of the solution are the healthy seeds.
- Separate the seeds.
- Wash the heavier seeds free of salt.
- Dry the seeds after washing and then sow.

Accelerate germination by soaking the seeds in cold water for 24 hours or overnight; then drain and incubate them in a warm moist place for 36 to 48 hours. The germinating seeds should be sown immediately after incubation.

Tips for testing seed germination rate

- Select about 200 seeds randomly from the seed to be planted.
- Soak the seeds in water for 24 hours.
- Place a wet paper towel in a container.
- Arrange the soaked seeds in a grid pattern of 100 each on the paper towel and close the container or cover with another moist paper towel.
- Ensure that the paper remains moist but not too wet; otherwise the seeds will rot.

- Count the germinated seeds at 3 and 5 days and record the germination percentage.
- Seed should have at least 80% germination to be considered good.

Why it is important to use good rice seed

Good rice seed:

- Gives a higher level of germination
- Reduces the need to replant or fill the gaps
- Leads to more uniform plant stands
- Leads to more vigorous growth at early stages, which enables the rice to compete better with weeds
- Increases resistance to insect pests and diseases
- Increases paddy yield

Characteristics of good rice seed

1. Good rice seed is pure (usually of the chosen variety), mature and uniform in size, and viable (produces more than 80% germination with excellent vigor, free of weed seeds, diseases, insects, or other matter).
2. Good rice seed is usually properly labeled.

Note: Often harvested rice seeds include seeds of different sizes and other nonseed matter, such as weeds and trash. Such harvests should be properly cleaned by winnowing in natural air or with an electric fan. Winnowing can also be achieved by pouring the seed slowly from a height of 1–1.5 m.

Seed rate

It is advisable to use good quality seeds from a reliable source for sowing. If the farmers plan to use their own seeds, it is important to first sort out unfilled grains before sowing to enhance good germination.

Lowland rice: Use 50–60 kg/ha of seeds.
Upland rice: About 40–50 kg of seeds are required to plant a hectare when sowing is conducted by dibbling.

Time of sowing

Sowing rice in rows makes manual weeding easier.

Sowing rice in rows makes manual weeding easier. The time for sowing rice depends on the available kind of land, whether it is lowland or upland, and on the agroecology of the farm. The recommended time for sowing rice in Borno State is indicated in Table 2. The actual timing of sowing should, however, be adjusted in accordance with the time of establishment of the rains.

Lowland rice: From late May or early June, depending on the time of rain establishment or if irrigation water is available. As much as possible, adopt the recommended sowing date for your area as indicated in Table 2.

Upland rice: Sow seeds in late May to early June when the rains are well established and the soil is moist. If possible, sow the seeds immediately after a good rainfall.

Spacing

Lowland rice: Sow rice seeds by drilling in rows spaced 20 cm apart.

Upland rice: Dibble 5–6 seeds at a spacing of 20 cm × 20 cm or 30 cm × 30 cm and later thin to 3 to 4 seedlings per stand at 2 to 3 weeks after sowing.

Table 2. Time of planting rice in Borno State.

Ecology	Time of planting
Southern Guinea savanna	Between weeks 1 and 2 in June
Northern Guinea savanna	Between weeks 1 and 2 in June
Sudan savanna	Between weeks 2 and 3 in June

Depth of planting

Plant the rice seed at a depth of 2 to 4 cm. When rice is planted at a depth of more than 5 cm, the emergence of the young seedlings is delayed. Also, the seed may rot and plant stand will not be uniform.

Fertilizer

The amount of fertilizer to apply depends on the quantities and level of residual nutrients in the soil and the type of fertilizer materials available. It is advisable to apply fertilizer doses based on soil test results and expected yield. Studies by PROSAB and collaborators have found that soils in Borno State are deficient in key nutrients for rice production. The following recommendations for lowland rice are similar to those recommended for irrigated rice schemes and swampy areas where there is proper water control and distribution. It is essential that the water level on the field at the time of fertilizer application is maintained at 3–5 cm to ensure efficient use of the applied fertilizer. If the water in the field is more than 10 cm, it will cause a loss of nitrogen fertilizer through volatilization; therefore, drain the field before fertilizer application.

Lowland rice: Apply 60–80 kg of nitrogen and 13 kg of phosphorus (i.e., 30 kg P_2O_5/ha) and 25 kg potassium/ha (i.e., 30 kg K_2O/ha). The nitrogen should be applied in two doses in between rows and properly incorporated (buried) in the soil to avoid losses. This is about 4 bags of NPK 15:15:15 applied at sowing and about 2 to 3 bags of urea applied at 6–8 weeks after sowing.

Upland rice: Upland rice responds well to nitrogen fertilization. Application of 60–80 kg/ha of nitrogen and 30 kg/ha each of phosphorus and potassium (50–30–30) is recommended. This is about 4 bags of NPK 15:15:15 applied at sowing. Incorporate (bury) the fertilizer in the soil properly to avoid losses.

The second dose of about 2 to 3 bags of urea fertilizer should be applied at 6–7 weeks after sowing. For land that has been under one- to two-

year fallow that is cropped with rice, apply a moderate rate of N (60 kg/ha); on older soils, apply a higher rate (80 kg/ha). N fertilizer should be top-dressed (buried) between the rows. The P and K fertilizers may be applied by broadcasting before sowing, if applied separately.

Organic manure

Rice straw or husk/bran should not be wasted but used as organic manure, especially for sandy soils. Heap the straw after harvesting and water regularly if possible (see tips for making compost below). The straw will decompose and form manure. Apply the decomposed straw to the field at the rate of 500 kg/ha and mix thoroughly with the soil.

Undecomposed straw can also be used. Spread the straw on the field and flood the field thoroughly. After about 30 days, mix the soil and the straw and spread out on the field while applying fertilizers. Where organic manure has been used, the recommended rate of fertilizers should also be applied. If soil test results show that the soil has adequate nutrients, the rate to be applied should be adjusted such that enough nutrients are available to the rice crop. The application of straw will, however, improve the water- and nutrient-retaining capacity of the soil, thus raising yields, especially on sandy soils.

How to make compost from rice residues

After harvesting or milling, the rice straw and/or husks are often left in piles. Instead of discarding them, convert them into compost. Composting converts crop residues into organic fertilizer. Although organic fertilizers, including rice compost, are low in major nutrients, such as nitrogen and phosphorus, they can be highly beneficial because they contain micronutrients, enzymes, and microorganisms that are not found in inorganic fertilizers. Composted rice straw is richer in potassium (up to 2%) and calcium (up to 41%) than composted cow manure. The nutrients in compost are released slowly and are less likely to be lost by leaching.

The keys to good compost making are adequate nitrogen supply and moisture content as well as abundant microorganisms.

Choose a level, well-drained site under shade; chop the compost materials into small pieces of 3–5 cm.

Where possible, compost heaps should be built in layers consisting of cereal materials combined with legume or manure waste. This could be mixed in a ratio of 2:1.

Keep compost heaps moist but not too wet (water should drain from the compost pile; if straw cracks when bent, it is too dry).

To hasten decomposition, sprinkle over the compost heap decaying materials such as cow dung slurry, cow urine, or a diluted solution of nitrogen fertilizer such as urea.

Mix and turn the compost heaps every 2 weeks.

When moisture and temperature conditions are good, compost will be ready in 4–8 weeks.

Weed control

Several methods can be combined to control weeds in rice. Examples of such methods are fallowing, land preparation, use of a competitive rice variety, water control, hand weeding, and use of herbicides.

Hand weeding: Rice fields should be weeded regularly, especially during the early stages of growth. For lowland rice, maintain the field bunds which are essential for good water control. Maintain an even water depth of about 10 cm all over the fields except when fertilizer is being applied.

Table 3. Recommended herbicides for upland and lowland rice production.

Treatment formulation	Upland and Paddy Rate a.i. (kg/ha)[1]	Rate in L/ha	Time of application	Remarks
Propanil plus bentazon	1.0–3.	0 6 + 3	Postemergence	Apply 14–21 days in paddy after transplanting
Propanil plus 2.4-D Amine	2.4	6-9+ 1-1.5	*Postemergence	Apply 14–21 days after seeding or transplanting
Propanil plus Thiobencarb	1.5–3.0	6–8	*Postemergence	Apply 14–21 days after seeding or transplanting
Oxadiazon	0.6–1.25	4–5	Preemergence	For direct seeded (Apply 3–4 days after planting)
Butachlor	1.0–2.3	4–6	Preemergence	Apply within the first three days of planting (for direct seeded)
Pendimenthalin plus paraquat	1.0–1.25	3 + 3	Preemergence	Apply within the first three days of planting (for direct seeded)

*Use higher rates when the weed pressure is high. One L/ha is approximately 100 mL/15 L sprayer. Thus, 3 L/ha is approximately 300 mL/15 L sprayer. A Peak milk tin standard size is about 150 mL.

If the field to which rice is to be sown is well prepared, then the weed problem should be minimal. However, weeding should be carried out twice, at 2–3 weeks and 5–6 weeks after sowing. Pull out weeds by hand or with a small hand hoe; heap the weeds outside the field.

Note: Hand weeding can be relatively ineffective particularly in controlling many of the perennial weeds (e.g., *Cyperus* spp.) which have underground tubers and rhizomes from which they can rapidly reestablish.

Use of herbicides: Herbicides can be used in large- and small-scale rice farms, seed multiplication schemes, and in other schemes, particularly where labor is a constraint. Various types of weeds are associated with the rice crop; it is advisable to use a combination of herbicides that kill various types of weeds as recommended (Table 3). It is important to note that special skills are required in handling and using herbicides to ensure effectiveness and to avoid poisoning the user. Read and follow the instructions on the product label before using any herbicide.

Nonselective herbicides, such as glyphosate, are sometimes used during land preparation to reduce the problem of perennial weeds, such as *Cyperus* spp. and *Oryza longistaminata*, which are difficult to control with selective herbicides.

Pest and disease control

Rice is less affected by field and storage pests than other cereals grown in Borno State. The major pests of rice are borers and army worms.

Borers

These are one of the most destructive groups of insects that attack rice. They attack the crop from seedling to maturity. Borers lay their eggs above or below the leaves or leaf sheaths in clusters. The larvae which emerge later damage the internal structures of the stems. The damage caused by various borer species is identical, i.e., the borer cuts off the growing part of the plants from the base, feeds inside the stem, and causes the plant or tiller to die. This condition is commonly known as "dead heart", indicated by dried growing points especially in young plants. Borer attack during the flowering state usually results in empty panicles, i.e., "white heads". Some other borers do not usually result in the two problems above but they are manifested by reduced grain filling.

Cultural control: After harvest, burn all stubble from the previous crop. This will destroy the semi-active resting stages of the borers that normally inhabit the stubble. Alternatively, the infested rice field could be flooded after harvest for a week to completely submerge the rice stubble, thereby drowning the borers.

Chemical: Carbofuran 1.0 kg a.i./ha or 15.25 kg/ha of product, or Vectox 85 (Carbaryl) 1.65 kg in 2.25 kg/ha or Lamdacyhalothrin at the rate of 1 L/ha. Chemical control measures should be implemented when about 20% of the field is infested.

Army worms

Upland rice is also commonly attacked by army worms and termites especially when rain stops at the beginning of the season. Application of Vectox 85 (Carbaryl), Cypermethrin, or Lamdacyhalothrin at 1 L/ha is effective against army worms.

Termicot [Chlorpyriphos 20% E] at 4–5 L/ha is effective against termites.

Birds

Bird attacks are serious problems in rice production. Some varieties may have resistance to bird damage. Engagement of bird scarers is commonly adopted. Planting rice too early or late exposes the crop to severe bird damage, hence, planting should be properly timed.

Brown leaf spot

This is caused by the fungus, *Helminthosporium oryzae.* This disease is widespread on rice in many northern states. However, the intensity of the disease varies from one locality to another and from year to year. The disease is seed-borne and can be transmitted to new crops through infected seeds carried over from infected crop residues of the previous season, alternative crop and weed hosts, and contaminated irrigation water. Unlike blast, brown leaf spot is more severe on older plants than on seedlings. The disease is characterized by dark brown oval spots (about 3.8 cm long) on the leaves. The large spots usually have lighter colored centers and dark brown margins. The spots on the glumes are dark brown and in some cases the entire glume may be covered with a velvety black mass of spores. Late in the season, the fungus attacks the basal node of the rachis, producing a blast which can be distinguished from that caused by *Pyricularia* by the color and velvety appearance.

Cultural control: Burn all crop residues and alternative hosts and use seeds from healthy plants. Also apply fertilizer correctly at the right time and in the right quantity.

Chemical control: Apply Seed plus, Dress Force, Apron Star, or Super Homai at the rate of 10 g/5 kg seed before sowing. When symptoms are observed, spray Diethane M45 (Mancozeb) weekly at the rate of 1.5 kg/ha (this is about 2–3 small matchboxes full per 15-L sprayer) for 3 weeks.

Blast

Blast disease is caused by the fungus, *Pyricularia oryzae*. It is very prevalent in lowland rice. It damages plants especially during the seedling stage. It appears as neck rot and panicle blast after flowering. The disease appears first on the seedling leaves as minute brown specks which then enlarge to become spindle shaped, pointed at both ends. The center is greenish-gray, often with a water-soaked appearance. This later dries and changes to straw color with a brown margin. Under very damp conditions, several spots may conglomerate and the whole leaf then withers.

This is usually most severe on seedlings in the nursery where plants may be completely killed. Damage is most severe when the uppermost node of the flowering stem is attacked. The lesions often occur near the uppermost node, which is most vulnerable especially during the early emergence of the panicle. It becomes less susceptible as the panicle matures. Gray-brown lesions usually occur girdling the uppermost node. Eventually the node falls off. If the attack occurs before the milk stage the grains are usually empty. In a later attack, the grain may be partly filled, but the kernels are often chalky and brittle.

The disease may also appear on the nodes of the culms. When this happens the nodes are usually black and brittle.

Cultural control: Cultural control methods include planting resistant varieties and avoiding close planting in the nursery, and adoption of recommended fertilization regime.

Chemical control: Apply Mancozeb or Diethane M45 or Benomyl at l–1.5 kg/ha when the signs of disease are observed. Repeat application weekly for 2 weeks.

Striga attack on rice

Striga is increasingly becoming a serious problem in rice production in Borno State where *Striga hermonthica* also attacks maize and sorghum. This weed is a parasite which germinates only when the plants (hosts) which it attacks are present. *Striga* is common in soils that have been used continuously and are poor in nutrients. The symptoms of *Striga* damage on the host crop can be seen before the parasite emerges from the soil. Usually, the symptoms are similar to those on drought-affected crops and include stunted growth, wilting, yellowing, and scorching of the leaves, lower yield and plant death in severe attacks. *Striga* produces numerous tiny seeds which make it easy for the parasite to spread from place to place. The seeds can contaminate the crop during harvest (paddy/straw) which may be carried from one farm to another or by animals when they feed on the straw; seeds may also attach to the feet of animals as they go through *Striga*-infested areas or be carried by machine tools during land preparation. *Striga* seeds are also easily dispersed by wind and water.

***Striga* attack on rice.**

Control: Some of the measures recommended for the control of *Striga* in rice include the use of *Striga*-free seeds, proper cleaning of farm tools especially after working on infested fields, proper fertilization (use of organic manure and inorganic fertilizer), crop rotation especially with soybean and groundnut, and intercropping as well as timely weeding. Rice farms should be weeded before *Striga* produces seeds to reduce the *Striga* seeds in the soil. A combination of control measures often referred to as integrated *Striga* control approach is recommended and is more effective than the individual control measures.

Harvesting

Rice is ready for harvesting when the grains are hard and are turning yellow/brown (about 30–45 days after flowering). It is fully mature for harvesting when 80–85% of the grains are straw colored. To harvest, cut the rice stems with a sickle at about 10–15 cm above the ground. Tie the panicles in bundles. Then, place the tied-up bundles of harvested rice crop in an upright position for drying before threshing.

Threshing and winnowing

Thresh on hard surfaces by beating the grains out from the ears. Winnow to separate the chaff and empty grains from the well-filled mature grains. Dry the paddy to a safe moisture level of between 12% and 14% before storing. Freshly harvested paddy does not store well under high temperatures.

Remove foreign matter in the paddy to avoid localized heating spots. Drying should be on mats spread on concrete floors and should be done slowly for the first few days so as to reduce breakage during milling. Avoid drying on bare floors to reduce the introduction of sand, pebbles, and other foreign matter as they reduce the quality of the rice.

Storage

Rice paddy intended for storage should be properly dried. Clean the storage container such as a *rumbu* before pouring in your paddy. To

protect the paddy against insect pests, use 1½ match boxes full of Actellic 2.5 or Coopex 2.5 to dust about 25 kg of paddy.

Yield

Increase yield through improved agronomic practices, more use of fertilizers, and efficient water management. Shortage of water at the critical stages of growth, tillering, panicle initiation, and flowering will reduce yield considerably. Paddy yields of the recommended lowland varieties range from 6.2 to 8.0 t/ha, while for upland varieties paddy yields range from 4.0 to 6.0 t/ha.

Parboiling

All the varieties recommended above are medium to long grain rice, and therefore need parboiling. Parboiling involves soaking the paddy in hot water at specified temperatures that vary with the varieties. For all the recommended varieties, parboiling can be done by soaking paddy rice for 5–6 hours in hot water at 70 °C (hot enough for your fingers to withstand the temperature for about 2 seconds).

The paddy is later steamed for a short time (6–10 minutes) until the husks just open. Steaming dextrinizes the kernels and drives the vitamin thiamine and other water-soluble nutrients from the testa into the starchy core. After parboiling, dry under shade gradually to reduce breakage during milling.

Parboiled rice has better storage and cooking quality. It is richer in food value, devoid of unpleasant odor, and breaks less during milling. Parboiling can be done in an earthen pot or empty petrol drums depending on the quantity of rice.

Milled rice: After parboiling, store when thoroughly dry in clean, dry grain stores *(rumbu)*. Milled rice for sale is best kept in clean sacks in the grain stores until prices in the market are better.

Paddy: Where it is not possible to parboil, the paddy should be taken to the market as early as possible to avoid losses in storage.

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