Field Manual

Rice Production Practices for Low Altitude Belt

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ABOUT THE MANUAL

The low altitude sub-tropical rice growing areas, comprising of gently sloping foothills below 800 m in Samtse, Sarpang, Samdrupjongkhar and some parts of eastern Bhutan, are the least productive among the rice agro-ecological zones. The environment is predominantly rainfed, with poor soil conditions and frequent incidence of diseases, insect and vertebrate pests. Notwithstanding such problems, the lowland rice area is significant and even a modest increase in its productivity can greatly raise the overall rice production in the country. The primary intention of this field manual is just that – to contribute to the productivity of lowland rice through the application of recommended technologies such as improved varieties, better crop husbandry practices and effective management of pest and diseases.

The manual comprises of twelve sections that are arranged logically in terms of rice cultivation and management. Section one describes different seedling production methods such as semi-dry bed, wet bed, tray etc. Healthy seedlings are a pre-requisite to optimizing rice yields. Rice varieties, both popularly grown traditional cultivars and recommended high yielding varieties, form the subject matter of section two. The next section explains land preparation which is a crucial step for rice establishment in achieving higher yields. Section four deals with manures and fertilizers. The southern foothills are deficient in organic matter and plant nutrients and rice suffers from low yields. Proper management of soil fertility thus assumes greater significance. Section five illustrates various ways of growing rice, such as direct seeding or transplanting. It also explains the differentiation between rice cultural regimes such as irrigated, rainfed and upland.

The content of section six is water management, a critical requirement in today's context of water scarcity and emerging conflicts. The conventional wisdom of 'more water, more rice' is changing rapidly and new water saving techniques are being popularized. Section seven deals with important rice weeds and how best to manage them. Weeds reduce rice yields to the extent of over 50% and it is important to recognize and use techniques that control weeds effectively. Rice is attacked by several diseases of fungal, viral and bacterial origin. Section eight describes major rice diseases (both pictorially and in words) like blast, brown spot, sheath and bacterial blight. Control measures include both cultural and chemical methods. Insect pests and their control is the topic of section nine. Damage symptoms caused by insects like caseworm, leaf folders, stemborers and rice bug are explained and methods of preventing crop damage are provided. Section ten expounds on the importance of pure seeds and ways to genetically purify seeds in a simple and doable manner. Seed quality is often taken for granted but poor quality seeds definitely result in poor yields. Harvesting and post harvest practices are dealt in section eleven. The last section twelve of the manual gives details on rice double cropping, which is gaining popularity in the lowlands.

It is our sincere hope that our field extension colleagues will find this manual useful, informative and handy in the endeavour to improve rice production in their area. We welcome any constructive criticism, feedback or comments for improvement of future publications.

Authors

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SEEDLING PRODUCTION METHODS

1.1 Introduction

The low altitude belt or wet sub-tropical low altitude zone encompasses largely the rice areas in Samtse, Gelephu and Samdrupjongkhar. This zone accounts for Almost 40% of the national rice acreage. Elevation ranges from 200-800 m asl with an average rainfall between 2000-6000 mm annually. Diseases and pest incidences are common due to high rainfall and humidity in these areas. The zone is also characterized by poor soils, therefore the average rice yield of this area is very low.

This manual is intended as a guide for extension workers in the low altitude belts to improve the overall productivity of rice. It contains improved techniques of seedling production, land preparation, fertilizer management, water management, pest and disease management, seed production, harvesting and post harvest practices that are expected to increase rice production in the low altitude belt.

1.2 Nursery management

There are four recommended improved nursery management methods. Farmers can adopt of these methods depending on the water and labour availability, or time available to raise seedlings. Generally 20-25 kg of seeds are required to transplant one acre of land. Normal time for nursery establishment is in June.

1.2.1 Semi-dry bed method

This method is recommended in areas where there is shortage of irrigation water or in areas where wet-bed method is not possible. Follow the steps as below:

- Prepare a well-levelled field with fine pulverized soil.
- Apply well-decomposed FYM and thoroughly mix with the soil. About 3 kg of FYM will be enough for a seedbed of 1 m x 3 m.
- Make raised beds 10 -13 cm high, 1 m wide, and any convenient length.
- Broadcast un-soaked or dry seeds uniformly on the seedbeds. About 1kg seed will be sufficient for an area 6 m^2.
- Cover the seeds using a thin layer of fine soil mixed with well-decomposed FYM.
- Irrigate the bed immediately after sowing. The beds should be just soaked. Never flood.
- Check the moisture of the seedbed and irrigate when necessary.
- The seedlings will be ready to transplant 30-35 days after sowing.

1.2.2 Wet Bed Method

Wet bed nursery is recommended for places with assured irrigation facilities. This method is advantageous for controlling of weeds in the nursery and produces healthy seedlings in a short span of time. Follow these steps:

- Plough, puddle and level a conveniently located plot. Apply enough FYM before puddling. Make slightly raised beds, 10-13 cm high, 1 m wide and any convenient length.
- Soak the seeds in clean water for 12 hours. Then rinse the seeds, drain and incubate them for 24 hours. During incubation keep them moist and warm in half-filled, loosely-tied sacks. After every 12 hours, drench the sacks and turn them upside down to even out the temperature.

- Broadcast the pre-germinated seeds uniformly on the beds. One kg of seeds will be enough for a seed bed of 10 m^2.
- Maintain just enough water to continuously saturate the beds for the first week. Thereafter, gradually increase the water level as the seedlings grow. Never let the beds dry out.
- The seedlings will be ready to transplant 20-25 days after sowing depending on the temperature.

1.2.3 Tray method

Tray method is recommended for mechanized transplanting or when a rice transplanter is to be used. This method is laborious and requires additional materials like tray. Follow these procedures:

- Fill a bucket with fresh and clean water.
- Put common salt and stir the water to dissolve the salt.
- Stop adding more salt and stirring when a fresh egg floats on the water.
- Put the seeds in the solution of water and salt and stir gently.
- All seeds that will sink are healthy and mature and can be used for sowing.
- All seeds that will float are empty or half filled and may not germinate or produce weak plants. Throw away the floating seeds.
- Wash the healthy seeds in running water.
- Soak the seeds in clean water for 12 hours. Then rinse the seeds, drain and incubate them for 24 hours.

- To prepare trays, use acid soil or red soil from uncultivated areas (virgin soil) to prevent weed seeds. The soil should be sieved in a mesh of 4-5 mm.
- Cover the tray with newspaper to clog the roots before putting soil.

- The virgin and sieved soil is put into the tray on which the sprouted seeds are sown very carefully to avoid breakage of the seeds.
- The seeds are evenly distributed in the tray which is then covered again by the virgin soil.
- After covering the seeds with soil, dip the tray in water and drain completely.
- Heap the trays and keep away from direct sun or rain.
- After seeds have germinated to about 1 cm, transfer the trays to a shaded house with levelled ground. Water the seedlings as needed.
- After 20-25 days nursery will be ready for transplanting.

1.2.4 Dapog Method

This method is good when there is time constraint and seedling needs to be raised quickly. Seedlings will be ready for transplanting within 12-14 days. Dapog method can be established in any flat areas. Follow these steps:

- Construct seed beds the same way as in wet-bed method, but cover the bed with banana leaves or plastic sheets. This will prevent seedling roots from getting into contact with soil and facilitate separation of seedlings during transplanting.
- Surround the seedbed with banana stems held in place on the edge by bamboo sticks. Remove the midribs of banana leaves and spread them with the underside up. Overlap leaves to prevent holes or breakage.
- Aside from the field, one can also use concrete floors for dapog.
- Sow seeds uniformly at the rate of one kg per sqm. One ha of land will require 60 kg seeds.
- Water the seedlings continuously, occasionally pressing them with hand or a small board. This will ensure even germination.
- Water the seeds 4-5 times a day to prevent from drying. Use a sprinkler or broom so that the water will not displace seeds.
- Seedlings will be ready for transplanting 10-14 days after sowing. Roll the seedlings like a mat with the leaves turned inward and the root outward. Cut the roll into convenient sizes.

RICE VARIETIES

2.1 Local Varieties

Farmers in the low altitude belt grow several local varieties. Based on various surveys, at least 33 local varieties are grown by farmers in Samtse and Sarpang (Table 1).

Table 1. Cultivated landraces and their characteristics based on farmers' perceptions in Samtse and Sarpang.

Varieties	Yield stability	Taste/scent	Pericarp color	Maturity days	DP	Thresh-ability
Achamay	-	Poor	White	145-160	s	Easy
Attey	Stable	Good	White	90-120	-	Very easy
Aumusli/ Musli	-	-	White	100-120	s	Easy
Babu Jasuwa	Stable	-	White	-	-	Easy
Bakhri-kotay	Unstable	Good	White	-	-	-
Balingpa	Unstable	Good	Red		s	-
Baudhan	Unstable	Good	White	-	-	Easy
Bayarni Dhan	-	Good	White	145-160	-	Hard
Champa-suri	Stable	Good	White	-	-	Easy
Chettri Mansara	Stable	Medium	White	145-160	-	Very easy
Chotakati	-	Good	White	-	-	Easy
Choti Masino	Unstable	Good	White	90-120	s	Easy
Dutkalam	-	Good	White	-	-	-
Gauria	-	Good	White	-	s	-
Jadu	-	Poor	White	145-160	-	Easy
Japaki	Unstable	-	White	-	s	-
Jasuwa	Stable	-	White	-	-	Easy
Juwadhan	Unstable	Medium	White	-	-	-
Kalo Noonia	Stable	Good & scented	White	145-160	s	Hard
Katiksali	Unstable	Medium	White	150-160	R	-
Khatkiri	Stable	Poor	White	100-130	-	Easy
Krishna Bhog	Unstable	Good & scented	White	-	s	Hard
Malinginy	-	-	White	-	-	Easy
Malsira	Stable	Good	White + red	100-120	-	Easy
Mama	Stable	Good	White	110-120	-	Very easy
Mauli	Unstable	Good	White	145-160	s	Very easy
Morangay	Unstable	Medium	White	-	-	Easy
Pakha Dhan	-	Good	White	-	-	-
Ranigajal	-	Good & scented	White	145-160	s	-
Rato Mansara	Stable	Poor	White	-	-	Hard
Timburay	Stable	Medium	White	150-170	-	Easy
Tsirangzam	-	-	White	-	-	Easy
Wangdakam	-	-	White	-	-	Easy

Legend: DP = Disease and pest resistance where s is susceptible and R is resistant
Source: Javier, 2007

Generally, the local varieties have the following traits:

- Good grain characteristics such as high palatability, aroma and grain size. Small and bold grains, similar to the premium rice of Sri Lanka called *Samba* type, are preferred because of very high milling recovery.
- Ease of threshing: Easy to thresh, which is a labor-saving trait.
- Stability of performance: A variety that could consistently produce grains, even if the yield is low, regardless of rainfall regimes provides a feeling of food security.
- Growth duration: Cultivated local varieties could fall into two maturity groups – early maturing (90-130 days) and late (145-170) maturing. This variation in growth duration could distribute the labor requirement and food supply over time.

2.2 Improved Varieties

Among improved rice varieties, there are two varieties recommended for the low altitude zone. These are BR 153 and BW 293. The mean yield of BR 153, from a farmers survey recently, was 3,019 kg/ha, whereas the average yield of local varieties was 2,099 kg/ha. Thus the yield advantage of BR 153 is close to 1 t/ha. The most widely grown modern variety is BR 153 which has been selected for low altitude environments. Its higher yield potential and stability, shorter growth duration and better resistance to pest diseases than the local varieties are the major attributes for its adoption. Its negative traits are poor taste, not so easy to thresh, low milling recovery with many broken grains, and short straw. IR 64, Bajo Kaap 1 and Bajo Kaap 2 are not adapted in the unfavorable areas of the southern belt since they have been selected for mid altitude zones.

2.2.1 Characteristics of improved rice varieties

BR 153

- BR 153 is a high yielding, tropical semi-dwarf variety which originally came from Bangladesh.
- It is 100 -110 cm tall and matures in 140 -150 days.

- It has shown good resistance to diseases and pests and is somewhat tolerant of poor soil.
- It has slender white grains.
- It has become susceptible to brown spot and blast diseases.

BW 293

- BW 293 is a tropical, high yielding variety developed in Sri Lanka.
- It is 75 - 85 cm tall and matures in 140 -150 days from sowing
- It has slender white grains with intermediate to high amylose content.
- However, it is not popularly grown due to its non-uniform morphological growth characteristics.
- It is also susceptible to diseases.

KARJAT-3: A New Promising Variety

The research sub-centre at Bhur has identified a new and promising new rice variety, originally called Karjat-3 from India, for the low altitude belt. This variety is in the process of being officially released.

Karjat-3 matures in 135 days, 9 days early than BR 153. It is also tolerant to blast and yield higher than the local varieties and BR 153. Plant height and taste are acceptable to the farmers. It will contribute to enhancement of rice yield and also add to the existing improved rice genetic diversity in the sub-tropical belt.

LAND PREPARATION

Land preparation is important for crop establishment, to reduce clod size, manage soil water, incorporate manure and fertilizer, control weeds, destroy insect eggs/breeding places and also to avoid erosion of water/soil. Follow these steps to achieve good land preparation:

3.1 Steps

- Pre-irrigate the field, if it is dry, before ploughing.
- Plough the field 20-25 cm deep using bullock-drawn implements, power tiller or tractor depending on land terrain and available farm resources.
- Dig the corners of the field manually where the plough may not have reached. Also, get rid of the weeds and grasses from the bunds and walls which may later harbour rodents. Bunds should also be repaired for impounding water in the field.
- Keep the field flooded for few days which will help in decomposition of crop and weed residues.

- Drain the water slightly and puddle the field using a rotovater or other implements as needed to break clods and ensure a fine soil tilth. Ideally, puddling should be done about two weeks before the date of transplanting.
- Repair and maintenance of bunds and the incorporation of chemical fertilizers, if any, should be done before the final puddling.
- Level the field prior to transplanting using a mechanical leveller or wooden leveller which improves water management, weed control, crop establishment, nutrient use efficiency, crop uniformity/maturation, drainage and rice yields.

MANURES AND FERTILIZERS

Soil fertility management is one of the biggest challenges for increasing rice production in the country. Traditional management practices such as the sole reliance on farmyard manure or animal manure from tethering are not adequate to exploit the yield potential of rice varieties, especially the HYVs. In the southern foothills, soils are generally poor with low organic matter due to leaching of nutrients and insufficient use of FYM or any other nutrient source. Hence proper nutrient management is necessary to increase rice production.

Rice requires a balanced supply of nutrients, water, air and sunlight to grow well. Nutrients can come from either organic or inorganic sources. Organic sources include biological nitrogen fixation sources such as green manures and blue green algae, compost and animal manures. Nutrient composition varies with the sources. Green manures such as *Sesbania aculeata* can accumulate 80–100 kg N/ha in 45–60 days of growth. The advantage of organic sources of nutrients is that they can provide a wide range of nutrients, whereas inorganic fertilizers only produce a single or few nutrients. Organic sources also provide "bulk" matter that are important in the sustenance of soil organic matter. Inorganic fertilizers are easy to use and save labour.

Soil fertility status is subject to change from one location to another and from one cropping season to the next. Ideally, analysis of soil would determine the nutrient requirements of a specific field but may not be possible all the time. For sustainable rice production, follow proper nutrient and crop management practices as outline below.

- Make efficient use of all available sources of nutrients, including organic manure, crop residues, as well as inorganic fertilizers according to availability and affordability. It has been found that supplementing the basal use of FYM with Urea topdressing at tillering or panicle initiation stage increases rice yield.
- Follow plant need-based Nitrogen management strategies such as the use of Leaf Colour Chart (see details in the following section).
- Use balanced fertilizers supplying with macro-nutrients (NPK) as well as micro-nutrients such as zinc, iron, boron etc. Farmers tend to use only N which is not a wise practice in the long run.
- Replace nutrients, particularly P and K, that are removed with grain and straw to avoid nutrient mining.
- Follow other proper crop management practices such as the use of quality seeds, optimum plant density, IPM, water management etc to fully realize the benefit of soil management.

4.1 Fertilizer recommendations

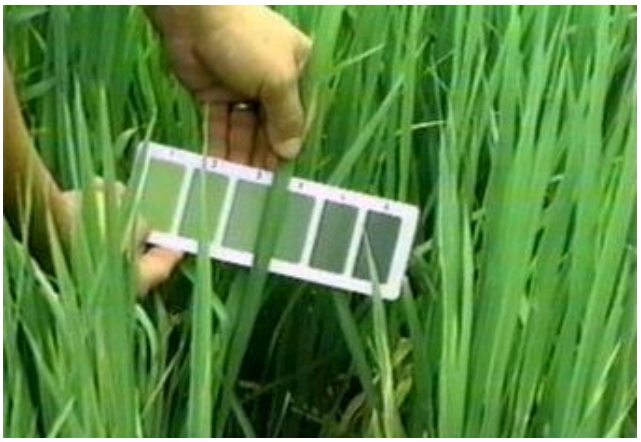
Based on the field experiments done by NSSC and present knowledge, the following fertilizer recommendations for rice are made for the low altitude southern foothills:

- For local rice varieties, the general recommended rate is 32-20-8 kg NPK per acre for high resource farmers. Where resources are limited, a rate of 20-16-8 NPK per acre is recommended.
- For improved rice varieties, the general recommended rate is 32-20-12 kg NPK per acre for high resource farmers. Where resources are limited, a rate of 30-12-8 NPK per acre is recommended.
- Apply the entire dose of P and K as basal dressing during land preparation. If half the N is applied basally, topdress the remaining half at active tillering stage (20-35 days after transplanting) or after first hand weeding. Further splitting of N into equal doses at tillering and PI stage can improve rice yields.
- To improve soil structure and water retention capacity, use FYM or compost prior to or during land preparation. Generally, 2-3 tons of FYM per acre is recommended. Supplementing with N topdressing @ 14 kg per acre after 30-40 days of transplanting can lead to higher yields.

- Wherever possible, use green manures like *Sesbania aculeate* (Dhaincha) as a pre-rice manure. Sow dhaincha in April-May @ 20-25 kg/acre and incorporate in the soil after 6-8 weeks. Transplant rice after about 2 weeks of incorporation.

4.2 Leaf Color Chart (LCC)

Farmers generally use leaf color as a visual and subjective indicator of the rice crop's nitrogen status (N) and need for N fertilizer application. The leaf color chart (LCC) reinforces the farmer's knowledge and provides a simple, easy-to-use, and inexpensive tool for efficient N management in rice. The LCC contains six gradients of green color from yellowish green (No. 1) to dark green (No. 6) and can guide nitrogen top-dressing in rice crops. The color chart is an ideal tool to optimize N use in rice cropping, irrespective of the source of nitrogen applied - inorganic, organic, and/or biofertilizers. The successful adaptation and use of the color chart will promote timely and efficient use of N fertilizer in rice.



Guidelines for using the leaf color chart

Take LCC readings once every 7 to 10 days, starting from 14 days after transplanting (DAT) for transplanted rice. The last reading is taken when the crop

just starts flowering (first flowering). Choose the topmost fully expanded leaf (Y leaf) for leaf color measurement because it reflects the N status of rice plants. The color of a single leaf is measured by placing the middle part of the leaf in front of the chart and comparing the leaf's color with the standard color chart. If the color of a rice leaf is judged to fall between two color grades/shades, the mean of the two values is taken as the LCC reading. For example, if the leaf color lies between the chart values No. 3 and No. 4, it is noted as 3.5.

During measurement, always shade the leaf being measured with your body, because leaf color reading is affected by sun's angle and sunlight intensity. If possible, the same person should take LCC readings at the same time of the day. Take readings of ten leaves at randomly chosen hills in a field. If six or more leaves show color grades below the established critical values, apply N fertilizer without delay. The amount of N to be applied at different growth stages for semi-dwarf indica varieties are as follows:

Transplanted rice	**Dry season**	**Wet season (cloudy)**
Early growth stage (14-28 DAT)	30 kg N/ha	20 kg N/ha
Rapid growth stage (29-48 DAT)	45 kg N/ha	30 kg N/ha
Late growth stage (49 DAT-flowering)	30 kg N/ha	20 kg N/ha

NB. To get optimum response to N fertilizer, other nutrients (P, K, S, Zn) must not be limiting. Therefore, adequate levels of other nutrients should be applied based on soil test or local recommendations. (***Source of information: IRRI, Philippines).***

4.3 Nutrient deficiency symptoms

Nutrient balance is an important factor in cases of deficiency symptoms because deficiencies may also be caused by an excess of one element rather than a shortage of another. Nutrient deficiency can cause stress symptoms in young leaves. Nutrient deficiency symptoms of NPK are described below.

Nitrogen (N)

Nitrogen is an essential plant nutrient being a component for plant growth which helps tillering, leaf area development grain formation, grain filling, protein synthesis and ultimately improves grain yield. Nitrogen deficiency occurs in coarse textured acid soils with low organic matter content (less than 0.5% organic C). The symptoms are stunted plants with small yellowish green leaves and fewer tillers. In younger leaves, the whole plant can be


Leaves are smaller in N-deficient plant.

yellow. In older plants, yellowing is more pronounced in older leaves.

Phosphorus (P)

Phosphorous is important for root development, tillering, early flowering, and ripening. Phosphorus deficiency occurs in sandy soils with low organic matter content. The symptoms are stunted dark green plants with erect leaves, reduced tillering, thin and spindly stems and delayed maturity. A purplish color at the leaf tips may develop.

Potassium (K)

Potassium is an essential plant nutrient that improves root growth, plant vigor, prevent lodging and enhances crop resistance to pests and diseases. Potassium deficiency symptoms occurs in coarse-textured/sandy, acid, upland soils and degraded lowland soils soils. The symptoms of K deficiency are stunted dark green plants with yellowish brown leaf margins and/or older leaves with necrotic tips and margins.

RICE ESTABLISHMENT METHODS

There are two methods of crop establishment, direct seeding and transplanting. Direct seeding greatly reduces labour cost in establishing a crop of rice, because it avoids seedbed preparation, pulling of seedlings and transplanting. Under ideal conditions, similar high yields can be obtained with direct seeded as transplanted crops. A direct seeded crop of rice also matures about a week earlier than transplanted. However, the general requirements for successful direct seeding are good rice variety, good land preparation, good weed control, and good water supply and management. Weed control is a major issue in direct seeding.

Transplanting enables to obtain good and uniform plant stand, crop and water management is easier, controls weeds and other pests. Major disadvantage of transplanting is increased labour input.

5.1 Direct Seeding

Depending on the cropping season and varieties, direct seeding should be done 15-20 days prior to the recommended transplanting time. Any short-statured, tolerant of lodging and early to medium maturing varieties are suitable for direct seeding. Generally the recommended improved varieties such as BR 153 can be successfully direct seeded. Local varieties, notably the tall ones like Masino is not suitable as they severely lodge at maturity.

Wet seeding on puddled fields is a common method of direct seeding. Direct seeding can be done manually or using a seed drill. Follow these steps:

- Prepare the land as for any transplanted rice crop. However, field should be properly levelled for efficient drainage.
- After final land preparation, allow the mud to settle overnight to avoid sinking of seed. Keep water level to the minimum.
- Broadcast pre-germinated seeds (soaked for 24 hours) @ 32-40 kg/ac evenly. Walk backwards while seeding and avoid making too many mud depressions that collect water and rot the seeds.
- Keep the water level as minimum as possible till the seedlings are established (2-5 days but may take longer if temperature is low). Then, increase the water level gradually as seedlings grow in height.

5.2 Transplanting

Transplanting can be done manually or using a mechanical rice transplanter from in July.

- Rice can be transplanted at random or in a straight rows or lines. In our country, random transplanting is the most common method, which requires less labour compared to planting in lines.
- Traditional or random method of transplanting can be adopted if the weed pressure is expected to be low and herbicide such as Butachlor is intended to be used for weed control.
- Avoid wide spacing in random transplanting. A plant density of 25-35 hills per square meter is optimum.
- Line planting is recommended where the aim is to control weeds using a rotary weeder. Line planting also enhances the attainment of an optimum plant population and facilitates weeding and other operations.
- In line planting, use ropes, guides or markers to attain straight rows. Plant seedlings on spots indicated by ropes or markers.
- Maintain plant spacing of 20 X15 or 15 x15cm. Transplant 2-3 seedlings per hill at a depth of 2-3 cm.
- There is no single spacing recommended for all varieties – it will depend on the variety, soil fertility and planting season.
- Increase the number of seedlings per hill if transplanting is delayed or if the seedlings are old to compensate for reduced tillering.
- If a rice transplanter is used, allow the mud to settle for a day before transplanting to avoid sinking of seedlings. Land preparation has to be thorough and seedlings need to be raised in trays.

WATER MANAGEMENT

6.1 Importance

Water is a major constraint in wet subtropical belt especially during land preparation, puddling and transplanting. Rice consumes about 4000-5000 liters of water to produce 1 kg of grain. Although rice is a water loving crop, most critical stages for water requirement are panicle initiation, flowering, and grain filling stages.

Water is a critical input for rice production. However, it is becoming increasingly scarce and expensive and it is important to find methods to reduce water consumption without compromising yields. Unlike the conventional thinking of our farmers, it is not necessary to keep the rice fields flooded all the time for higher yields. Recent research has shown that water use can be greatly reduced without affecting grain yield. Keeping rice fields moist or in field capacity saturation without standing water saves water. However, if the soil drops below field capacity saturation, yield potential can be reduced and weeds can compete more freely.

6.2 Irrigation methods

- There are generally three types of irrigation and water management practices commonly followed, depending on water availability:
    - Continuous flooding with standing water: there is continuous water in the field at varying depths of 3-8 cm. It is practised where there is abundant and assured irrigation water.
    - Intermittent irrigation: involves applying water rapidly in sufficient quantities to the field from 4-7 days. This is then stopped and water is completely depleted until the next irrigation period. It is common in water scarce areas where rotational water sharing is practised by farmers. Intermittent irrigation helps to reduce *shochum* pressure.
    - Rainfed water management: involves impounding rainwater in the field for irrigation, either directly or through a network of channels. This practice is influenced by the onset and withdrawal of monsoon and the amount of rainfall in the season.

- Water is most critical during land preparation, vegetative, reproductive and ripening stages of the rice crop. Land preparation requires a large amount of water.
- After transplanting keep the water level as minimum as possible for about 3-6

days until the seedlings recover.

- If drought occurs after the root establishment stage, rice plants can withstand the stress and resume normal growth as irrigation water is reapplied.
- Water level should be gradually increased as the crop grows ensuring adequate soil moisture from panicle initiation to dough stage. Flowering is the most critical stage when moisture stress should be avoided.
- It is beneficial to drain water at maximum tillering stage so that tiller formation is not hampered.
- Drain water from the field 10-15 days before harvest. This will ensure dry field conditions during harvesting and other operations.
- Integrate sound water management with other recommended cultural practices for more effective pest management and fertilizer use efficiency.

WEEDS AND THEIR MANAGEMENT

Weeds are the worst competitors of rice plant. They compete for water, nutrients, sunlight and other growth requirements for rice hence reducing grain yields.

7.1 Recommendations

- Where weed pressure is expected to be low or moderate, 2 hand weedings at 20 and 40 days after transplanting are sufficient. It needs to be stressed that if hand weeding is to be done, plants should be close spaced and the first weeding performed not later that 30 days after transplanting.

- Concentrate on the use of line planting and rotary weeding where weed pressure is expected to be high. Two rotary weedings 20 and 40 days after planting are recommended.

- Where grass and sedge weeds are expected to be severe, Butachlor will be very effective. It should be applied at the rate of 10 -16 kg of 5% granule "Punch" per acre 3-6 days after transplanting.

- Indirect or complementary weed control methods like good land preparation, proper water management, use of weed-free seedbeds and seeds etc. should be emphasised.

7.2 Important weed species of rice

Echinochloa crusgalli

It is an annual, tall and often weedy grass in rice fields. Locally it is known as Jam (Dz) and Sama (Lhot). It resembles rice plants and is undistinguishable during early vegetative growth. Plants are erect, 80-100 cm tall and highly propagative. A single plant produces 15-20 tillers and 2,000 to 3,000 seeds per season. It also poses a problem in the rice nursery and often gets transplanted along with rice seedlings. The plant has leaves without ligules.

It is propagated through seed which often is shed in the field before harvest of the rice crop. These seeds remain dormant in the field during winter and start germinating when water is available.

Flooding reduces the incidence of this weed. It is readily controlled by hand weeding or by using herbicides such as Butachlor.

Cyperus iria

This is an annual weed found in rice fields and nurseries. It is an erect sedge that is often mistakenly identified as a grass or as one of the perennial sedges. It is locally known as guchen, ochumani, chow (Dzo) and mothey (Lho). The stem is triangular at the top. Leaves are linear and somewhat shorter than the stem. Inflorescence is a compound umbel varying greatly in size subtended by 3-5 brackets.

It is propagated through seed. Seedlings are shiny without hairs and distinctly ridged and tougher than most grass seedlings.

This weed can be controlled through good flooding, hand weeding or applying Butachlor.

Schoenoplectus juncoides

It is an erect, strongly tillering and slender annual or perennial weed. It has 2-3 membranous leaves truncated at top sheath often with a small rudimentary blade. Inflorescence has 2-5 spikelets, ovoid to oblong in shape, 1 cm or less long and greenish brown or straw coloured to brownish in colour. Locally it is known as inchodum, chocksen, shesem, manitsau (Dzo) and suirey (Lho).

It is propagated through seed. In Bhutan it is a major weed of flooded rice present almost everywhere and often a dominant component of the weed flora.

It is readily removed by hand weeding when immature and can be controlled by Butachlor.

Cyperus difformis

This is a common weed in rice fields and nurseries. It is an annual sedge which is fibrous with reddish roots up to 20-100 cm tall. It is locally known as guchen, ochumani, chow (Dzo.) and mothey (Lho). The stem is usually solitary and erect. Leaves are linear and somewhat shorter than the stem. Inflorescence is an umbel subtended by two leaf-like bracts.

It is propagated through seed. It is readily controlled by normal manual weeding and mechanical weeding in row planted rice plants and by applying Butachlor.

Paspalum distichum

This is a perennial weed with long creeping rhizomes and stolons. Leaves are stiff and narrow and about 15 cm long. It is locally known as jagarampa (Dzo) and Chittrey or Janai ghaas (Lho).



It is a common weed of wet places at lower altitudes and up to 2000 m in all districts. It is most commonly seen around the edges of paddies, freshwater wetlands and drainage channels but sometimes it is troublesome in rice paddies and in dry land crops.

It is propagated through seed and rhizomes. The grass spreads mainly vegetatively. Pieces of stolons easily root and form new plants. Seeds remain viable in water for some time and are carried by streams across long distances to start new infestation.

It can be controlled by hand weeding and use of Butachlor.

Fimbristylis dichotoma

It is an annual sedge up to 50 cm high or occasionally apparently biennial with extremely flattened stem and leaf bases. Inflorescences are small with many obtuse spikelets. It frequents rice fields, swampy cultivated areas and pastures. It is propagated through seed. It is eaten by cattle and the seeds pass through their digestive tracts mostly undigested and germinate near droppings.


It is readily controlled by hand weeding and applying Butachlor.

Monochoria vaginalis

It is usually found in freshwater pools, stagnant backwaters, mudflats, swampy places, ditches, along canals banks and in rice fields. Locally it is know as damperu (Dz) and piraley (Lho). It is propagated by whole plants or through spreading stolon or seeds. In Bhutan, it is a common weed of flooded conditions found at a wide range of altitudes from 200 to 2400 m, probably in all districts.

It can be controlled by manual removal but needs persistence to remove prolonged flushes of germination. It is usually controlled by applying Butachlor but requires a full dose of the herbicide.

RICE DISEASES AND MANAGEMENT

Integrated management is recommended to manage pest and diseases which will minimize crop losses. The management should start from nursery till crop harvest. Constant field monitoring and surveillance is important for disease and pest management which will also help to determine the requirement of control measures. Integrated management includes good cultural practice and use of resistant varieties.

Disease pathogens are mostly viruses, bacteria and fungi that are parasitic and live in or on rice plants which limit yield and affect grain quality. Their development depends on environmental factors such as temperature, humidity and light. Diseases common in the wet sub tropical belt are described below.

8.1 Rice Blast (Pyricularia oryzae or Magnaporthe grisea)

Blast is one of the most important diseases of rice and it attacks all aboveground parts of the rice plant at any growth stages. In Bhutan leaf, node, neck and panicle blast are common. *Echinochloa* species are alternate host for blast.

(a) *(b)* *(c)* *(d)* *(e)*

Symptoms

- Leaf blast - the lesions are elliptical or spindle shaped with brown borders and white centres which enlarge and eventually kill the leaves [Pic (a) and (b)]**.**
- Collar blast - pathogen infects the collar that can kill the entire leaf blade [Pic (c)]
- Node blast -node turns blackish and breaks easily [Pic (d)]**.**
- Blast on the neck of the panicle - greyish brown lesion on the neck and the panicles break when severe [Pic (e)].
- No grain formation if disease occurs during flowering stage
- Brown lesions - on the branches of panicles and on the spikelets.

Favourable Factors

- Cloudy and overcast skies, frequent rain, and drizzles favor the development of rice blast.

- Relative humidity of 90% or higher and long duration of leaf wetness favours development of blast disease.
- The optimum temperature required for spores to germinate is 25-28°C.
- Excess amount of nitrogen fertilizer is conducive for blast development.

Cultural management

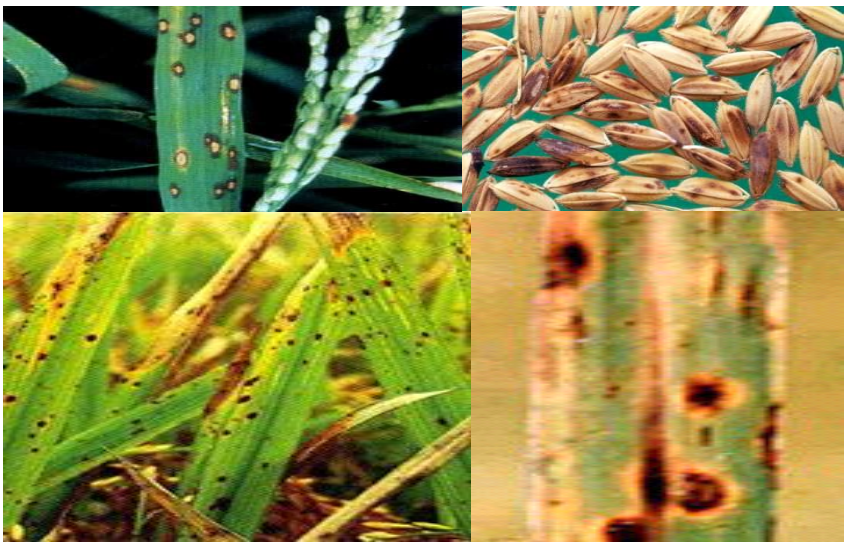
- Planting resistant varieties
- Proper management and sanitation of the field
- Proper crop residue management after the harvest
- Do not apply over dose of nitrogen fertilizer as it enhances the development of blast disease
- Apply balance dose of fertilizer
- Soak seeds in hot water at 55^0C for 1 hour.

Chemical

- Treat seed with solution of *Tricyclazole* @ 3g/1kg seed
- Spray *Tricyclazole* @ 1gm/1lit of water 1-2 times depending on the environmental condition. Use stickers like mustard oil or sandovit to prevent washing away of the chemicals due to rainfall.

8.2 Brown spot (Helminthosporium oryzae)

Brown spot is one of the common diseases of rice in poorer soils. Disease occurs both in the nursery and transplanted field. Infected seeds lower the grain quality and cause yield loss.



Symptom

- Fungus produces small, circular to oval, dark brown or purplish brown lesions about the size and shape of sesame seed. Sometimes the symptoms are similar to blast lesions in certain rice varieties
- Fully developed spots are brown with gray or whitish centers surrounded by a reddish brown margin

- Infected seedlings are stunted or killed
- Infected panicles are with brown spots
- It can infect roots and causes a black discoloration
- It may infect the glumes and grain causing dark brown to black oval spots causing a black discoloration**.**

Favourable Factors

- High relative humidity (86-100%), cloudy weather, and continuous temperature of 16-36°C
- Use of infected seeds, volunteer rice and rice debris
- The disease is common in nutrient-deficient soils and water stressed soil but rare on rice grown on fertile soils.

Cultural management

- Presoak seed before planting in cold water for 8 hours
- Hot water seed treatment (53-54°C) for 10-12 minutes is effective before sowing
- Proper management of straw and rice debris by burning or removing from the field
- Use resistant varieties
- Proper management of fertilizer by using silicon fertilizers (use e.g.- calcium silicate slag).

Chemical

- Seed treatment with captan, thiram, carbendazim, or mancozeb
- If severe, spraying of mancozeb and tricyclazole at tillering and late booting stages.

8.3 Sheath blight (Rhizoctonia solani)

Symptom

- Irregular large spots on leaf sheath
- Small ovoid, water-soaked greenish-gray lesion near the water line

- Older lesions - elliptical or ovoid with a grayish white center and light brown to dark brown margin
- Severely infected plants produce poorly filled or empty grains, especially those on the lower portion of the panicles
- Rotting on the leaf sheath enclosing the young panicles.
- In cases of severe infection, the panicle may fail to emerge completely
- Panicles rot, and florets turn red-brown to dark brown and grains become sterile, shriveled, partially or unfilled and discolored
- Whitish powdery growth may be found inside affected sheaths.

Favourable Factors

- High Relative humidity and temperature (28-32°C) with high leaf wetness favours development of the disease.
- High nitrogen fertilizer
- Disease is soil borne and the pathogen can be spread through irrigation water along with soil and infected crop residues.

Cultural management

- Optimized Seeding rate or plant spacing to avoid closer plant spacing or dense crop growth
- Maintaining field sanitation by removing weeds, infected stubbles or crop residues

Chemical

- When severe, spray fungicides such as Carbendazim @ 0.5 gm/ 1lit of water.

8.4 Sheath rot (Sarocladium oryzae)

Sheath rot is a common disease worldwide and there are no resistant varieties for Bhutan. Alternate hosts are maize, sorghum and weedy rice.

Symptom

- Infection starts with uppermost leaf sheath enclosing the young panicles at late booting stage

- Oblong or somewhat irregular spots or lesions, 0.5-1.5 cm long, with dark reddish brown margins and gray center
- Severe infection causes entire or parts of young panicles to remain within the sheath
- Visible abundant whitish powdery growth inside the affected sheaths and young panicles
- Infected panicles are discolored, sterile, shriveled, or panicle partially emerged/filled.

Favourable Factors

- Insect injury serves as entry point
- High amount of nitrogen
- High relative humidity
- High plant density.

Cultural management

- Optimum plant spacing
- Managing crop residue by burning straw and stubble or any crop residue after harvest
- Application of potash at tillering stage is recommended.

Chemical

- Seed treatment carbendazim or mancozeb
- When severe, spray fungicides such as Carbendazim @ 0.5 gm/ 1lit of water or copper oxychloride WP @ 0.5 gm/ 1lit of water.

8.5 False smut (Ustilaginoidea virens)

False smut occurs only at grain maturity stage leads to loss of grain quality. Farmers usually associate false smut with bountiful harvest.

Symptom

- Rice grain transformed into a mass of velvety spores or yellow fruiting bodies which encloses floral parts
- Mature spores are orange and turn yellowish green or greenish black
- Few grains in a panicle are usually infected (orange or yellow) and the rest are normal.

Favourable Factors

- presence of rain and high humidity
- presence of soils with high nitrogen content
- presence of wind for dissemination of the spores from plant to plant

Cultural management

- Removal and destruction of infected stubbles after harvest and optimum plant spacing
- Apply balance nitrogen fertilizer

8.6 Bacterial Blight (Xanthomonas oryzae pv)

Bacterial leaf blight is caused by bacteria. When disease occurs at maximum tillering and booting stages, it does not affect yield but will result in poor quality and high proportion of broken grains.

Symptom

- Water-soaked yellowish stripes on leaf blades with a wavy margin
- Lesions turn yellow to white as the disease advances
- Seedling wilt or kresek
- Severely infected leaves tend to dry quickly.

Favourable Factors

- Warm temperature (25-30° C), high humidity, rain and deep water
- Excess use of fertilizer
- Handling of seedlings at transplanting (cutting of leaf tip before transplanting) will enhance the disease development.

Cultural management

- Field sanitation (removing weed hosts, rice straws, volunteer seedlings)
- Maintain proper planting spacing (avoid overcrowding)
- Use of resistant varieties
- Balance and split application of nitrogen fertilizer.

Chemical

- There are no effective chemicals for this disease.

INSECT PESTS AND MANAGEMENT

In Bhutan pre-harvest loss due to pest is estimated between 20-30% and post harvest losses due to storage pest is about 10-20%. Ecological condition of low subtropical belts encourages development of pest incidences. Important insect pest are stem borer, leaf folder, case worm, rice bug and army worm.

9.1 Stem Borer (Scirpophaga incertula)

There are different types of stem borer such as white, yellow, purple, striped and dark-headed. These insects attack rice plants at tillering and ripening stages causing dead-hearts and white heads respectively.

Damage symptoms

- Cutting and drying of the central tiller during the vegetative stage (dead heart)
- Bore into the stem at reproductive stage leading to unfilled panicles (white head) which can be easily pulled from the base.

Favourable Factors

- High nitrogen favours population build-up of the stem borers
- Infested stubbles that remain in the field act as source of infestation.

Cultural management

- Early planting avoids infestation
- Ploughing and flooding the field will control eggs, larvae and pupae from developing
- Harvest crop at ground level to remove the larva in stubble
- Grasshoppers, ants, birds and toads feed on the pest
- Pheromone traps will, attract the stem borer which can be collected and destroyed to reduce the population in next season.

Chemical

- When severe (10% hills affected or 1 panicle/hill) or (4 egg masses/hill) spray insecticide such as Dimethoate 30 EC @ 1ml/ 1lit of water.

9.2 Rice Case worm (Nymphula depunctalis)

Rice case worm is found in irrigated and rainfed rice with standing water. The larvae are semi-aquatic which stay inside the case built from cutting of rice leaves. During severe cases it causes patches of defoliation resulting in stunted growth and death of plant.

Damage Symptoms

- Cutting off leaf tips to make leaf cases
- Field looks whitish due to leaves scrapping
- Leaves look as if cut with a pair of scissors
- Older larvae are enclosed within the case and feed by scraping leaf tissues or biting through leaf sheaths
- Leaf cases can be found floating on water.

Favourable Factors

- rice field with standing water
- transplanting young seedlings also favours pest infestation

Cultural management

- Avoid overcrowding and maintain wider spacing during transplanting
- Maintain proper drainage
- Cases can be destroyed by moving a rope or long stick on crop and collecting and destroying the larvae
- Spiders, dragonflies, and birds eat the adults.

Chemical

- When severe (>25% leaves damaged or 10 leaves/hill) spray insecticides such as Chlorpyrifos 20 EC @ 4ml/ 1lit of water.

9.3 Rice Leaf Folder (Cnaphalocrocis medinalis)

Leaf folders are common in the wet sub-tropical rice ecozone. There are three species of leaf folders. It infests at early crop stages and their damage does not cause significant yield loss. Crop generally recovers from this damage.

Damage symptoms

- Folds the leaves and stitch the leaves sides ways
- Translucent larvae remain inside the leaf fold and feed on green matter
- Distortion and whitening/yellowing of margins of young leaves
- Faecal matter present.

Favourable Factors

- heavily fertilized fields
- high humidity and shady areas
- presence of grassy weeds from rice fields and surrounding borders.

Cultural management

- Drain and dry field
- Flood and plough field after harvesting if possible
- Remove grassy weeds from fields and borders
- Reduce density of planting
- Use balanced fertilizer.

Chemical

- When severe (>25% leaves damaged or 10 leaves/hill) spra insecticide such as Chlorpyrifos 20 EC @ 4ml/ 1lit of water.

9.4 Army Worm (Mythimna separata)

Army worms occur mainly in the southern belt. Out breaks depend on periods of long dry spells during the rainy seasons. They can damage crops from seedling to grain ripening stages.

Damage Symptoms

- cutting off leaf tips, leaf margins, leaves and even the plants at the base
- cutting off rice panicles from the base.

Favourable Factors

- periods of drought followed by heavy rains.

Cultural management

- Do not allow the field to be dry
- Grasshoppers, ants, birds and toads feed on the pest.

Chemical

- When severe (two damaged leaves/ m2) spray insecticide such as Malathion 50EC @ 2ml/ 1lit of water.

9.5 Rice Bug (Leptocorisa acuta)

Rice bugs infestation occurs during reproductive stages of plant development. It is one of the major pests in Bhutan. Slender and brown-green nymphs and adults feed on endosperm of rice grains during milky stage which causes empty grains.

Damage symptoms

- Feeding causes deformed or spotty grains at the soft or hard dough stage
- An odour is often emitted indicating their presence
- Feeding causes empty or small grains during the milking stage
- Grains become dark, deformed or spotty
- Empty grains and erect panicles.

Favourable Factors

- warm weather, overcast skies, and frequent drizzles presence of alternate hosts
- weeds in and near the field.

Cultural management

- Grasshoppers, ants, birds and toads feed on the pest.
- Dried twig of *Artemisia vulgaris* (“khempa shing”) is burned to repel the insect
- Attract rice bugs to traps, baited with spoiled fish, decaying meat, or chicken manure.

Chemical

- When severe (> 2 bug or nymph/ hill) spray insecticide such as Malathion 50EC @ 2ml/ 1lit of water
- Spray with Cypermethrin 10 EC @0.5 ml/ 1lit of water

SEED PRODUCTION

Farmers avail seeds through two main supply systems - formal and informal. Formal seed system consists of government (research, extension, projects) and private and semi-private agencies (Druk Seed Corporation, Alpine Seeds) who normally supply certified seeds to farmers. However, the supply of seed in rural communities is normally met by the informal seed supply systems whereby the farmer saves part of the harvest or exchanges and/or trades seeds with farmers in the community. This section focuses in improving the existing farmers' seed practices through simple and doable technical modifications.

10. Steps in seed production

Step 1: Selecting the Site

- It is important to allocate a separate piece of land for seed production purpose.
- Select a portion of rice field as seed production plot, which is fertile and accessible to irrigation.
- Such a plot should be located in the centre of the field, at least 2m away from the field borders.
- Determine the size of the plot to produce enough seeds of the chosen variety for the following crop season.
- Place bamboo sticks or other markers to identify the seed plot.

Step 2: Transplanting and Cultural Practices

- Transplant one seedling per hill at a spacing of about 20 x 20 cm.
- Transplanting single seedling per hill makes it easier to identify and remove off-types, besides allowing full genetic expression of the seed.
- Follow other normal practices of fertilizer, water, weeds and insect pests and disease management.

Step 3: Roguing or Removing Off-Types

- Off-types are plants of rice varieties other than the one grown for seed.
- Such plants can be recognized by their different growth habits and morphological traits.
- The most easily distinguishable traits are stem/culm colour, plant height, tillering, plant vigour, maturity, grain size and colour.
- Observe plants for these characteristics:
    - *Plant vigour*: Plants vigorous than normal could be off-types (different variety or wild/weedy types)
    - *Plant height*: A pure variety has uniform plant height. Plants either very tall or short would normally be off-types.
    - *Leaf sheath and stem colour*: A pure variety will have a distinct colour of its sheath and stem, either green (with light or dark shades) or purple (light purple lines or blotches). Remove plants with varying colours other than the one planted for seeds.
    - *Presence or absence of awns*: Awns (thorn-like extension from grain tip) are easy to detect in the field at ripening stage. If the original

variety is awnless, remove all plants that have awns. If the variety planted has awns, then all other plants without awns are off-types.
    - *Flagleaf angle*: examine plants to find out if they have erect, horizontal or drooping flagleaf (first leaf at the base of a panicle). If the planted variety has erect flagleaf, then remove plants having horizontal or drooping flagleaves, or *vice versa*.
- Remove off-types by hand pulling or cutting them out. This process is technically called roguing.
- The best time for roguing is at heading or flowering time. However, remove off-types immediately when you identify them in the field.

Step 4: Selection at Harvest
- Selection should be done on a standing crop prior to harvest.
- Select individual panicles that have uniform and filled grains, disease-free and conform to the true characteristics of the variety grown.
- The number of panicles to be harvested depends on the amount of seed required in the following season. Usually 100-200 panicles would be adequate.

Step 5: Harvesting and Threshing
- Harvest the seed plot when over 80% of the grains turn golden yellow and are ripe.
- It is advisable to harvest seed plot ahead of the general production plots.
- After the panicles have been selected, harvest the remaining crop and thrash after drying. Use these harvested seeds for general production in the following year.
- Use the panicles for planting and selection again in the ensuing year.

Step 6: Storage
- Tie the panicles together into a bundle after drying properly.
- Hang the bundles in a secure place with good ventilation.
- The attic or ceiling is normally a good place to hang, however, ensure protection from birds and rats.
- Store the seeds in airtight containers, safe from insects and rodents.

Step 7: Selection Cycle and Seed Replacement
- In a situation where seed selection is not practiced, start with the selection of individual panicles at harvest.
- Sow seeds of the individual panicles separately in lines.
- Transplant single seedlings in a hill.
- Select and harvest panicles for another cycle of selection.
- Harvest remaining crop and use as seeds for planting.
- Following such a cycle would ensure genetic purity of seeds.

It is advisable to replace seed stock after about 3-5 years. Pure seeds of improved rice varieties can be availed from the commission agent, extension centre or research centre.

HARVEST AND POST HARVEST MANAGEMENT

Post-production includes all operations starting from harvesting: cutting, field drying, stacking or piling, hauling or transporting, threshing, cleaning, drying, storage, milling, and grading. The key to post-production is correct timing of operations to manage grain moisture content or MC. Target MC for key post production operations are shown in the table below.

Operation	Desired Moisture Content (%)	Primary Cause of Losses
Harvesting	20-25	Shattering if grain is too dry
Threshing	20-25 for mechanical threshing (varies slightly with variety) <20 % for manual threshing	Incomplete threshing, grain damage and cracking/breakage
Drying	Final moisture content is 14% or lower	Spoilage, fungal damage, discoloration, smell
Storing	<14% for grain storage <13% for seed storage <9% for long term seed preservation	Fungal, insect & rat damage, smell
Milling	14%	Grain cracking and breakage

Timely harvest and post harvest operations should be done to avoid field losses due to shattering and also to maintain the grain quality of rice. Immediate threshing will reduce losses from birds, insects and rodents. Crop piling (2-4 days) after the harvest, will lead to grain discoloration, germination and spoilage due to mould development.

11.1 Harvesting and threshing

Harvest the crop when at least 85% of the upper portion of the panicles turns golden yellow or straw coloured. The moisture content at harvest should at least be 20-25%. Some leaves and stems may still be green at maturity particularly of improved varieties.

- Do not delay harvesting as grain shattering leads to yield loss and also affects milling quality.
- After harvesting, dry the crop for 3-4 days depending on weather condition.
- Threshing can be done using pedal thresher, machine or manually.

11.2 Drying and milling

- Generally, the moisture content of the freshly harvested rice varies from 20-24%, which needs to be brought down to a standard of 14% after drying for safe storage. The grains usually crack when you bite at this moisture level.
- Size and shape of rice vary from variety to variety and mixing different varieties may result more breakage while milling. Therefore, do not mix grains of different varieties to avoid breakage during milling.

RICE DOUBLE CROPPING

In the low altitude areas, growing two crops of rice in a year is possible where there are assured irrigation facilities. Major problems for double cropping include labour shortage, scarcity of irrigation water, yield loss due to birds and rodents and rigidity in the rice-rice cropping pattern.

12.1 First Crop

Varieties

- IR20913 is recommended due to its early maturity.

Time of nursery sowing

- Feb -March under normal conditions
- Use a seed rate of 20-25 kg/acre.

Time of transplanting

- The first crop is recommended to be transplanted in March - April.
- The method of transplanting, either in line or at random, should be decided depending upon the weed control method to be adopted and labour availability.
- First crop of rice can be established also by direct seeding which reduces labour cost and the crop matures a week earlier.
- Other activities like field preparation, manures and fertilizers, weed control etc. are similar to a normal crop of rice.

12.2 Second Crop

Varieties

- BR 153 or any other local variety can be used for second crop.

Time of nursery sowing

- June
- Use a seed rate of 25-30 kg/acre.
- Seedlings could be raised either by wetbed or semi-drybed methods.

Time of transplanting

- It is recommended to transplant the second crop in July.
- Other practices are similar as for a normal rice crop.