Step by Step Production

Pre-planting

Rice Varieties

The most suitable variety is the one that best meets the farmer and the consumer's needs. It may not always give the highest yields and may be influenced by availability of water (either from rain or irrigation), soil typeand field elevation and whether the rice would be sold or consumed at home.

Varieties should be selected based on good yield potential, resistance to disease and insect-pests, competitive ability to weeds, good eating qualities, high milling percentage and suitability to the market. When selecting a variety check the following:

Crop duration

- Long-duration varieties (more than 140 days) suitable for irrigated areas or flood-prone areas.
- Medium-duration varieties (120–140 days) suitable for both rainfed and irrigated areas.
- Short-duration varieties (less than 120 days) suitable for drought-prone areas or for double cropping.

Crop height

- Tall varieties (>1.2 m) are suitable for flood-prone and unlevelled fields, lodging may be a problem.
- Medium height varieties (1.0–1.2 m) are suitable for most of the areas and do not lodge, when fertilizer is used.
- Dwarf varieties (less than 120 days) suitable for drought-prone areas or for double cropping.

Grain quality

A premium is often paid for aromatic varieties having longer grains, but yields are normally lower. Eating quality such as softness, stickiness, colour and taste after cooking are important.

Crop Calendar

A cropping calendar is a picture of the rice growing season from the fallow period and land preparation, to crop establishment and maintenance through to harvest and storage.

The benefits of using a crop calendar are being able to:

- Plan for input purchase and use,
- Develop cash flow budget for the year,

- Determine credit need and period of requirement,
- Determine labor requirements and plan for peak usage times, and
- Organize contractors for land preparation and harvesting.

Create a crop calendar

- Determine the best date to plant. This information can be gathered from local experience, agricultural advisors and leading farmers in the district.
- Determine the time the variety takes from planting to harvest. The length of time from establishment to harvest is known for each variety. It may vary a little depending on the growing conditions especially water availability and solar radiation. Normally short duration varieties take 100−120 days, medium duration 120−140 days, and long duration 140 days or more to reach maturity.
- Most varieties take 50−55 days from panicle initiation to harvest.
- Mark on the calendar the date of planting and then when each other operation needs to be done (ploughing, weeding, fertilizing, and harvesting).
- Then determine how much labor, equipment and finance will be required at each step during the growing period.
- Pin the calendar in a prominent place to remind you when things need to be done.

Variety Ranjit

Duration	150 - 155 days
Crop calendar	Transplanting
Season	Sali
Best planting window	May 25 – June 01

Nursery Operations

1st plowing	21 - 14 DBS
2nd plowing	15 - 10 DBS
3rd plowing	7 - 5 DBS
4th plowing	2 DBS
Harrowing	2 DBS
Raised bed preparation	1 DBS
Seed soaking	4 DBS
Seed incubation	2 - 3 DBS
Sowing	DOS

Main field Operations

1st plowing	21 - 14 DBT
2nd plowing	15 - 10 DBT
3rd plowing	7 - 5 DBT

4th plowing	2 DBT
Harrowing	2 DBT
Crop protection in nursery	7 DBT
Crop protection at planting	DOT
Planting	30-35 DAS/DOT
Basal application of fertilizer	2 DBT
2nd dose of fertilizer	25 - 35 DAT
3rd dose of fertilizer	60 - 65 DAT
Post emergence herbicide application	3-5 DAT
Weeding	15 - 25 DAT
Crop protection at Tillering	25 - 45 DAT
Crop protection at PI	55 - 60 DAT
Crop protection at grain filling	95 - 100 DAT
Drain water	105 - 110 DAT
Harvesting	120 - 125 DAT
Storage	7 DAH

Seed Quality

Good quality seed reduces the required seeding rate and produces strong, healthy seedlings, resulting in a more uniform crop with higher yields.

Good seed is:

- Clean, free of stones, dirt, small soil clods and weed seed;
- Genetically pure having grains of only one variety; and
- Healthy having full big grains of the same colour with no cracks or spotting.

Good quality seed can be either bought as foundation or certified seed, or the seed produced by the farmer in his own farm

Produce high-quality seed

- Select a level field with well-maintained bunds having easy access.
- Use clean, pure, true to type and healthy seed.
- Do a float test on the seed before planting and remove all seeds which float.
- Use good management practices by planting on time, applying fertilizer, weedicides, weeding before 21 days after establishment and do not let weed seeds mix with the grain seeds.
- Rogue the fields by removing all rice plants that clearly look different during the vegetative, flowering and grain filling stages.
- Harvest at full maturity when 80–85% of the grains are straw coloured or at 20–22% moisture content.
- Thresh and dry quickly after harvest.
- Store seed safely and label containers or bags with variety name and date of harvest.

Land Preparation

A well prepared and levelled field gives a uniform, healthy crop that can compete with weeds, uses less water, and gives higher yields at a lower cost.

A well prepared field has:

- Many small soil clods to give good seed-soil contact, i.e. clod size and seed size are similar.
- No weeds
- Harder layer at 10cm soil depth to stop water penetration
- Level and smooth surface after working
- Well-constructed bunds

To prepare the field

- Whenever possible, plough immediately after the previous harvest, especially if the soil is still moist.
- First or primary plowing: Use a disc or mouldboard plow to kill weeds and incorporate crop residue, preferably 2–3 weeks before planting with maximum depth of 12.5-15 cm.
- Second plowing: Plow across the field with the disc or tine harrow at least twice to make small sized clod. Second plowing should be 10-15 days before planting and the last harrowing 5-7 days before planting with a maximum depth of 5–7.5 cm.
- Repair bunds, destroy rat burrows, repair all holes and cracks, and re-compact the bunds. Bunds should be at least 0.5 m high and 1 m wide.
- Levelling the field will give better water coverage, better crop establishment, and better weed control.
- Soil puddling should be done at least 1-2 days before seeding to allow the water to clear when wet direct seeding.

Growth

Planting

Planting the crop on time will help to produce a fast-growing, uniform crop that will have higher yields and will be better able to compete with weeds and pests. The best time of planting depends on the locality, variety, water availability, labour and the last harvested time. Rice can either be transplanted from a nursery or direct-seeded in the field with dry and wet seeding methods. Transplanted crops normally take less time in the production field but 10–15 days longer for the total crop duration. In both cases, a well prepared seedbed is needed.

For transplanted crops:

- Select a nursery site that is 1/10 in size of the intended planting area.
- Prepare the nursery by ploughing at least 3-4 times and harrow at least once.
- Level the soil surface and put in drainage lines across the field.
- Pre-germination and sowing: Soak the seed for 12 hours and then drain for 24 hours in the shade. Broadcast seed in the nursery evenly, over the moist soil surface.
- Apply seed at 40-45 kg seed/ha transplanted area.
- Apply both chemical and organic fertilizer in the field before the last ploughing.
- Transplanting age: Short-medium duration varieties need 20-25 days and long-duration varieties need 30-40 days in nursery after seeding.
- Transplant in lines into puddled and water-covered fields.
- Maintain water coverage in field.

For direct seeding:

- Prepare the field by ploughing at least three to four times and harrowing once. Compare the seed size and clod size, both should be of similar size for better seed-soil contact.
- Level the soil surface.
- Sow the seed with seed-cum-fertiliser drill in non-puddled soil or through drum seeder in puddled soil.
- In dry DSR, DAP is drilled along with seeding operation in the fertilizer box of the seed-cum-fertiliser drill
- The seed rate for direct seeding is 40-45kg/ha.
- Use pre-germinated seeds for direct seeding through drum-seeder.

Apply and incorporate basal fertilizer before the last ploughing or at 10 days after establishment.

Fertilizer Management

Most soils provide only limited amount of nutrients to the crops, therefore fertilizers need to be applied to compensate the crop nutrient requirement and for increasing the increase grain yield. In some cases, fertilizers are also added to improve the soil's physical condition specially, the organic fertilisers. The amount and type of fertilizer applied are determined on the assumption that 1 ton of grain will remove 15 kg nitrogen (N), 2–3 kg phosphorus (P), and 15–20 kg potassium (K). These base rates need to be modified according to the soil type, the cropping season, the variety, ecology, the crop condition and prevailing weather conditions, and efficiency of nutrient application. Steps for efficient fertilizer-use are:

- Use organic fertilizers (manure, compost, straw, husk, plant leaves) wherever possible, especially in nurseries.
- Apply fertilizer according to soil type and expected yield. As a guide, apply complete recommended dose of phosphorus and potassium as basal and nitrogen in 2-3 splits. In sandy soils apply K in two splits, with additional 10–15 kg K per ha.
- All quantity of P and K and 1/3rd of N must be incorporated evenly just before seeding or transplanting. For direct-seeded broadcast crop, it is better to apply 10-14 days after crop establishment when there is water in the fields.
- Apply remaining N (urea) in 2 equal splits as top dressing at 25-35 days after transplanting and at panicle initiation.
- Use leaf colour chart (LCC) - a tool that can assess leaf N status and the crop's need for N.
- In established crops, apply chemical fertilizer only in standing water and evenly across the whole field.
- Do not apply high rates of fertilizer in traditional tall varieties, it may lead to lodging.

- Inorganic fertilizers must be stored under dry and shaded conditions

Pests and Diseases

The majorinsect pests of rice crop include rice hispa, yellow stem borer, rice bug, brown plant hopper, leaf folders, caseworm, rice gundhi bug, gall midge and thrips. Rice hispa is abundant during Sali and Ahu seasons than in Boro. The incidence of brown plant hopper is relatively greater in the Boroseason. The rice bug is a major problem in ahu season, particularly in the early ahu crop. Caseworm is a localised pest and occurs more in the Sali season.

Many diseases infest rice plants in Assam, but the most important ones are sheath blight, bacterial blight and blast in Sali, blast and sheath rot in Ahu, and sheath rot and sheath blight in Boro. It is assumed that 15-20 % yield losses may occur in pest infested fields of rice. Although several cultural, mechanical,chemical and biological management practices are available for controlling insect pests and diseases, it is not known what percentage of the farmers use these technologies. One of the sustainable approaches to manage pest and diseases in the fields is to use the Integrated Pest management (IPM) approach. IPM integrates preventive and corrective measures to keep pests at a level from causing significant damage, with minimum risk or hazard to human and desirable components of the environment. IPM programs have proven track record of significantly reducing the risks related to pesticides, while improving quality, health & welfare of environment with increased productivity and reduced pest damage.

To limit pest and disease incidences in a rice crop, the following recommendations can be adopted.

- Practice proper cleaning of equipment
- Clean the field between seasons by managing stubbles and ratoons, and by maintaining and repairing bunds
- Use clean seeds and resistant varieties
    - Certified seed is recommended. If certified seed is not available, use clean seed having no discoloured seeds, weed seeds or other rice varieties mixed in.
    - Use short-duration and resistant cultivars to decrease insect-pest populations
- Plant at the same time as your neighbours (or within a 2-week window) to minimize insect, disease, bird and rat pressure on individual fields.
- Do not over-apply fertilizer. Following specific fertilizer recommendations is important because high nitrogen can increase susceptibility to certain pests and diseases
- Encourage natural pest enemies
    - Overuse of pesticide is common among farmers, and can actually lead to pest outbreaks
    - Natural enemies of rice pests are killed when pesticides are applied which can lead to a pest outbreak
- Do not apply pesticide within 40 days of planting
    - Rice crops can recover from early damage without affecting yield
    - Get appropriate information on specific diseases that require early management
- When deciding to use a chemical for pest and disease control, it is important to:
    - Use well-maintained spray equipment that has been properly calibrated;
    - Apply the dosage recommended by the manufacturer; and
    - Follow the safety precautions for mixing and spray applications.

Water Management

- Rice is typically grown in bunded fields that are continuously flooded up to 7-10 days before crop harvest.
- Continuous flooding helps ensure sufficient water and control weeds.
- Lowland rice requires a lot of water.

On average, it takes 1,432 litres of water to produce 1 kg of rice in an irrigated lowland production system. Total seasonal water input to rice fields varies from as little as 400 mm in heavy clay soils with shallow groundwater tables to more than 2000 mm in coarse-textured (sandy or loamy) soils with deep groundwater tables.

Around 1300-1500 mm is a typical amount of water needed for irrigated rice in Asia. Irrigated rice receives an estimated 34–43% of the total world's irrigation water, or about 24–30% of the entire world's developed fresh water resources.

Worldwide, water for agriculture is becoming increasingly scarce. Due to its semi-aquatic ancestry, rice is extremely sensitive to water shortages.

To effectively and efficiently use water and maximize rice yields, the following good water management practices can be followed:

For transplanted crops:

- Construct field channels to control the flow of water to and from ricefield.
- The construction of separate channels to move water to and from each field greatly improves the control of water by individual farmers.
- Field channels allow water to be delivered to the individual seed beds separately and the main field does not need to be irrigated until it's time to plant in the main field.
- In addition, the ability to control water to ricefield is important when you need to retain water (especially after applying fertilizer so nutrients are not lost) or when you need to drain the field for harvest.
- Construction of individual field channels is the recommended practice in any type of irrigation system.
- Prepare the land to minimize water loss and create a hard pan
- Till the soil to fill cracks
- Perform shallow tillage operations before land soaking. This fills in the cracks and can greatly reduce the amount of water used in land preparation.

Puddle the field to reduce water loss

- For clayey soils that form cracks during the fallow period, puddling results in a good compacted hard pan
- For coarse sandy soils, puddling may not be effective
- For heavy clay soils, puddling may not be necessary to reduce water losses because of the low infiltration rate of such soils; however, puddling may still be necessary if the soil was cracked prior to primary tillage, if weeds are present prior to transplanting, or if the soil is too hard or cloddy for transplanting after soaking
- Despite reducing water loss, the action of puddling itself consumes water. There is a trade-off between the amount of water used for puddling and the amount of water "saved" during the crop growth period because of a compact hard pan.
- Wet land preparation can consume up to a third of the total water required for growing rice in an irrigated production system.

- If water cost or availability at the time of crop establishment is a concern, consider dry land preparation which uses considerably less water than wet land preparation.

Minimize time between operations to reduce water use

In some canal irrigation systems, the period of time between land soaking for land preparation and planting can be up to 40 days. To minimize time between operations:

- Install field channels
- Use common/community seed beds
- Plant nearby fields at the same time, or
- Practice direct wet seeding

Level the field

- A well-levelled field is crucial to good water management. An unlevelled field requires an extra 80−100 mm of water to give complete water coverage. This is nearly an extra 10% of the total water requirement to grow the crop.
- Most fields need to be ploughed twice before you can level. In wet land preparation, the second ploughing should be done with standing water in the field to define high and low areas

Construct bunds and repair any cracks or holes

- Good bunds are a prerequisite to limit water losses. Bunds should be well compacted and cracks or rat holes should be plastered with mud at the beginning of the crop season to limit water loss.
- Bunds should be high enough (at least 20 cm) to avoid overflowing during heavy rainfall.
- Lower levees of 5-10 cm height in the bunds can be used to keep the ponded water depth at that height. These levees can be heightened with soil when more stored water is needed.

Different crop establishment methods require different water management practices

For continuous flooding

- Continuous flooding of water generally provides the best growth environment for rice.
- After transplanting, water levels should be around 3 cm initially, and gradually increase to 5-10 cm (with increasing plant height) and remain there until the field is drained 7-10 days before harvest.
- For direct wet seeded rice, field should be flooded only once the plants are large enough to withstand shallow flooding (3-4 leaf stage).

Safe Alternate Wetting and Drying

Transplanting

Alternate Wetting and Drying (AWD) can be started a few weeks (1-2) after transplanting. Irrigate and then allow the water depth to drop to 15 cm below the surface using a field water tube (pictured to the right) to monitor the water level depth. Once the water level has dropped to 15 cm below the surface, re-flood the field to a depth of 5 cm above the surface and repeat. From one

week before to one week after flowering, the field should remain flooded. After flowering, during grain filling and ripening, the water level can drop to 15 cm below the surface before re-flooding.

When the quantity of weeds is more, AWD should be postponed for 2-3 weeks to assist suppression of weeds by ponded water, and to improve the efficacy of herbicide.

Direct seeded rice

- Keep the soil moist but not saturated from sowing till emergence, to avoid seeds from rotting in the soil.
- After sowing, apply a flush irrigation to wet the soil, if there is no rainfall.
- Saturate the soil when plants have developed three leaves, and then follow the safe Alternate Wetting and Drying practices as described above.
- Lowland rice is extremely sensitive to water shortage (below saturation) at the flowering stage. Drought at flowering results in yield loss from increased spikelet sterility, thus fewer grains.
- Keep the water level in the fields at 5 cm at all times from heading to the end of flowering.
- In case of water scarcity, apply water-saving technologies such as Alternate Wetting and Drying (AWD) and consider changing planting method from puddled transplanting to non-puddled transplanting or dry-direct seeding.

Weed Management

Weeds compete directly with the rice plants and reduce rice yield. Presence of each 1 kg dry matter of weeds is equivalent to 1 kg grain loss. Weeds cause maximum yield loss within the first 20-50 days after crop establishment. Weeding after panicle initiation may also be important to prevent shedding of weed seeds for future crops.

Manual and mechanical weeding

Direct control of weeds can be done through (1) manual weeding by hand and (2) mechanical weeding using implements such as push weeder and inter-row cultivation weeders.

Manual

Manual weeding by hand is an efficient method for weed control. However, this is labour-intensive and is not practical for large areas.

When to hand weed:

- When weeding annual weeds and certain perennial weeds that usually do not regenerate from underground parts
- When removing weeds within rows and hills where a cultivating implement, such as a push weeder, cannot be used

Handweeding of young weeds at the two-leaf to three-leaf growth stages is extremely difficult. To effectively hand weed:

- Delay weeding for at least 2 weeks or until weeds are large enough to be grasped easily.
- Ensure that there is enough soil moisture for easy pull.
- Remove the weeds from the field to stop them from regenerating.

Mechanical

Mechanical weeding is most appropriate for crops transplanted in straight rows. This method requires less time and laboras compared to manual weeding.

- Ensure that there is enough soil moisture before weeding. It could be difficult to use a weeder when the soil is too dry.
- Pass the weeder in between rows. This buries the weeds after cutting their root system, so weeds die before they can re-establish. Improper use of weeders can damage the rice crops.

Effective weed management

- Ploughing and harrowing in fallow fields should be undertaken at least 7-10-dayinterval during field preparation.
- Good land levelling reduces weed growth because most weeds have trouble germinating under water.
- Select varieties which have early vigour.
- Use clean rice seed which is free of weed-seeds.
- Apply permanent water during early crop stage, as weeds cannot germinate under water.
- First weeding begins within 2–3 weeks after establishment and the second in another 2–3 weeks. Weeding should be before fertilizer application.
- Use herbicides after correct identification of weeds and use the appropriate rate of application as recommended on the label.
- Apply pre-emergence herbicides after planting, prior to weed-emergence.
- Apply post-emergence herbicides 15-25 days after sowing/days after transplanting at 2-4-leaf stage of weeds.
- Herbicides are poisonous; if they are not used properly, they can cause health and environment problems. Label them clearly and keep them out of children's reach.
- Always use protective clothing when spraying.
- Do not wear raincoat when spraying as this increases sweating.
- Avoid eating, drinking, smoking and tobacco chewing while spraying.

Post Production

Harvesting

Harvesting the crop on time is very important to maximize yields and grain quality. Crops harvested too early will have many unfilled and immature grains. Immature grains break easily when milled and will not germinate when used as seed. If crops are harvested late, heavy losses occur through shattering and bird attack. Quality also decreases due to grain weathering, resulting in breakage and downgrading due to undesirable grain colour.

Crops should be harvested when:

- Grain moisture is between 20–25%, which is normally about 30 days after flowering or 80–85% of the grains are straw-coloured.
- Grains in the lower part of the panicle are hard, not soft, and
- Grains are firm but not easily broken when squeezed between the teeth.

After cutting, maximize grain quality by:

- Minimizing time the harvested panicles remain in large bundles in the field — thresh within 24 hours of cutting.
- Avoid direct contact of panicles with soil for better quality.
- Drying the grains as soon as possible after threshing.
- Turning or stirring the grains at least once every 30 minutes to achieve uniform drying.
- Sun-drying on tarpaulins or clean drying pads.
- Keeping the thickness of the grain layer at 3–5 cm.
- Covering the grain during mid-day on hot days to prevent over-heating and covering immediately, if it starts raining.
- Cleaning the grain by repeated winnowing after drying; and
- Storing the rice in a cool, dry and clean area preferably in hermetic / sealed containers for seed.

Storage

Rice is best stored as paddy because the husk provides some protection against insects and prevent grain quality deterioration. A safe or hermetic storage system prevents the grain from getting wet after drying and also gives protection from insects, rodents, and birds.

Rice can be stored for longer periods if:

- Moisture content is maintained at less than 14% for grain and 12% for seed;
- Grain is protected from insects, rodents, and birds; and
- Grain is protected from re-entering of moisture by rain or from the surrounding air.

A rule of thumb for seed is that the life of the seed is halved for every 1% increase in moisture content or a 5°C increase in storage temperature above recommended levels.

Rice storage systems

Bag storage system

- Bags should not be stacked higher than 4 meters.
- Bags should be stacked under a roof, in a shed or under water-proof tarpaulins.
- A one-meter gap should be kept between and around stacks.
- Bags should be stacked on pallets above ground.
- Bags should be stacked so that fumigation can be undertaken, if necessary.

Bulk storage

Hermetic or sealed storage

Market Intelligence

The value of milled rice in the market is determined by a number of physical and chemical characteristics and the consumers preference, which varies within a country and between the countries.

Physical characteristics

Milling degree or colour: The degree of milling or amount of the brown rice removed, affects the colour of white rice, and often the price. Under-milled rice absorbs water poorly, does not cook well, and is normally cheaper.

Head rice or broken percentage: Milled rice, having 75-80 % head rice (whole kernels), also includes broken kernels. High head rice yield is one of the most important criteria for measuring milled rice quality. High-quality rice normally has less than 5% broken grains.

Whiteness or translucency: This characteristic is a combination of varietal physical characteristics and the degree of milling. During milling, the whitening and polishing process greatly affects the whiteness of the grain and its transparency.

Chalkiness: Grain appearance is affected by the amount of chalkiness or white belly. Chalkiness is caused by interruption in the final grain-filling. Though chalkiness disappears upon cooking (and has no direct effect on cooking and eating qualities), excessive chalkiness often downgrades the quality and reduces milling recovery.

Chemical characteristics

Gelatinization temperature or cooking time: Environmental conditions such as temperature during ripening influence gelatinization temperature. There is normally a preference for rice with intermediate gelatinization temperature.

Amylose content or stickiness: The amylose content of rice usually ranges from 15–35%. High-amylose rice has high volume-expansion, the grains cook dry, are less tender, and become hard upon cooling. Low-amylose rice cooks moist and sticky. Intermediate-amylose rice (21–24%) is preferred in most rice-growing areas of the world.

Gel consistency: Gel consistency measures the tendency of the cooked rice to harden on cooling. Varieties with a softer gel consistency are preferred if rice is to be consumed after cooling, or if cooked rice with higher degree of tenderness is desired.

Drying

Importance of drying the paddy correctly

Rice is usually harvested at grain moisture content (MC) between 20 and 25% (wet basis). Any delay in drying, incomplete drying or uneven drying results in qualitative and quantitative losses, such as:

- Yellowing or discoloration caused by mold development and heat build-up from respiration.

- Reduced milling yields caused by high temperatures and re-wetting of grains.
- Loss of germination and vigour from grain respiration, mold and insect activities or exposure of grains to higher temperatures.
- Damage caused by insects which are more active at higher MC levels.

Some recommendations on drying the paddy

- Clean the grains before drying to avoid uneven drying and wet spots.
- Dry the paddy immediately after harvest; dry to 17% MC if the paddy is tobe stored for a maximum of two weeks and to be sold at the MSP.
- When drying for milling, target 14% MC so the grain weight and milling yield won't decrease.

  When storing grains for 8-12 months, dry the grains up to 13% MC or less.

- For long-term storage (1 year or more), dry to 9%.
- Do not mix grains maintained at different MCs to avoid cracking.
- Always monitor the grain temperature and MC to prevent the grains from being exposed to excess temperatures and overdrying.

Solar Bubble Dryer

The Solar Bubble Dryer (SBD) is the latest low-cost drying technology developed by IRRI, Hohenheim University and GrainPro. The SBD is mobile and is completely independent from fuel or the power grid, and therefore has very low operating cost. It comes in different sizes, with current models having 0.5 and 1.0 ton batch capacity.

How does it work?

The SBD uses energy from the Sun in two ways. First, the drying tunnel serves as a solar collector to convert the energy contained in the sunrays entering the transparent top of the drying tunnel to heat, which increases the temperature of the drying air for faster drying. Second, it is equipped with a photovoltaic system consisting of a solar panel, a deep cycle rechargeable battery and a controller to generate electricity that drives a small blower to move air through the drying tunnel, inflate the tunnel, and remove the water evaporated from the grains placed inside the tunnel. A simple roller dragged on ropes attached to the ends underneath the tunnel is used for mixing the grains without the need to open the tunnel. A rake for internal mixing is also available.

How does it compare to other traditionaldrying method?

The SBD improves the traditional sun-drying process, in which farmers spread the paddy in the open under the sun, by protecting it from animals, insects, contamination and rain. The drying tunnel also provides a buffer for the temperature and protects the grains from overheating, as it is common during sun-drying at noon.

Milling and Processing

Milling rice paddy removes the husk and bran layer to produce white rice. Rice is best milled at 13–15% moisture content. Best results are attained when the process is completed in a number of stages. Grain temperatures should not exceed 45°C during the process. An efficient mill removes the husk (20%), the bran or meal (8–10%), and leaves 70% as white rice. Rice grown in irrigated systems should attain 60% white rice as head rice (unbroken, white kernels), and in rainfed systems, 40–50% as head rice. Rice is milled in several ways

- Hand pounding using a mortar with a pestle results in very high numbers of broken rice and leaves brown rice (meal layer still attached). Cleaning of the husk is done by winnowing.
- A one-step milling process (steel rollers are available in Assam) where the husk and the bran are removed in one pass and white rice is produced directly from the paddy. The single-pass rice mill is an adaptation of the Engleberg coffee huller. This process results in many broken kernels, low white rice recovery (50–55%), and head rice yields less than 30%. The fine broken grains are often mixed in with the bran and the ground rice husk. This happens due to steel roller. Nowadays single pass rubber roller machines are available which can be a better option.
- A two-step milling process wherein the husk and the bran are removed separately. These mills are often called compact rice mills, and in many countries, have superseded the Engleberg mill. The two-stage mill has separate hulling and polishing processes. Rubber rollers remove the husk and the brown rice is polished with a steel friction whitener. These mills have a capacity of 0.5–1 t/hour paddy input and are often used for custom milling in rural areas. The milling performance of the compact rice mill is superior to the single-pass huller with milling recoveries normally above 60%.
- A multi-stage milling process wherein rice passes through a number of different operations. The milling process in larger commercial mills combines a number of operations and produces higher quality and higher yields of white rice from paddy. The process involves:
    - Pre-cleaning the paddy prior to milling
    - Removing the husk or outer layer from the paddy
    - Polishing the brown rice to remove the bran layer
    - Separating the broken grains from the whole kernels
    - Bagging the milled rice, and
    - Managing the by-products