



# Premium Quality Rice of Assam



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GOVERNMENT OF ASSAM





# Premium Quality Rice of Assam

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## Premium Quality Rice of Assam

Assam is one of the eight northeastern states of India, with rice being an important crop to the people of the state, both as a means of food and livelihood. The state spans across a total geographic area of 78523 sq km where rice is cultivated in approximately 24 lakh ha. Assam is endowed with a rich diversity of rice cultivars. The crop is grown in wide and diverse situations both in Brahmaputra and Barak valleys, as it is the staple food for 3.16 crore population of Assam. It is grown across the districts with different terrains; from hill slopes of Karbi Anglong to deep-water areas of Dhemaji.

The state hosts a number of premium quality rice varieties / specialty rice varieties which are region specific to Assam. Premium quality is defined on the basis of nutritional benefits (vitamin and mineral contents), softness (soft and shiny, and soft when chewed), long and slender grains, whiteness, translucency, aroma and high head rice (HR) recovery (minimal or no broken grains) in Southeast Asia (Thailand, Vietnam and Philippines), and by the physical appearance of the non-sticky texture, extra-long to long-slender grains (very fine to fine grains, uniformity, whiteness, slenderness), satiety, and aroma in South Asia (India, Bangladesh, Nepal and Sri Lanka). These trends are found to be consistent with industry perceptions and have important implications for regional and national breeding programs in terms of tailoring germplasm according to regions, and rice varieties in accordance with specific local market segments.

Assam is known for cultivating and producing the fragrant and aroma-rich variety called *Joha*. This variety is specific to the northeast region of India and is also cultivated by the farmers of Garo hills of Meghalaya.

Most of the specialty rice/ premium quality rice varieties found in Assam are traditional varieties. These specialty rice varieties of Assam can be grouped as *Bao* or red rice, *Bora* rice, *Joha* rice, *Chokuwa* rice and black rice.

Assam Agricultural University with the technical support from International Rice Research Institute (IRRI) under the World Bank funded Assam Agri-business and Rural Transformation Project (APART) has started its activities to introduce innovative methods and techniques of rice farming to promote premium quality rice varieties to ensure their sustained productivity and production in Assam.



## Joha rice

*Joha* rice is known for its unique sweet aroma, superfine kernel, good cooking qualities, with excellent palatability and taste. It contains a good quantity of phenolic compounds and flavonoids having a good source of antioxidants. The grain type of *Joha* rice generally ranges from short-slender/bold to medium-slender/bold. *Joha* rice is invariably grown by the farmers to make desserts such as *kheer* (*payas*), *pulao* and other forms of delicacies.

The global market of scented-rice is growing at 12% per annum, and India seems to have very few aromatic rice varieties to offer. The demand for medium- and short-grain scented rice is far more than that for long-grain ones. This calls for pushing non-basmati scented rice in the domestic as well as the global market. In 2007, owing to its high demand, the first consignment of 17 MT of *Joha* rice was exported to three European countries viz., Germany, UK and Switzerland.

### Varieties

***Kola Joha*:** It is one of the popular traditional *Joha* rice varieties having taller height and prone to lodging. *Kola Joha* varieties (*Kali Jeera*, *Kola Joha 1*, *Kola Joha 2*, *Kola Joha 3*) possess medium-slender grains. The cultivar is photoperiod-sensitive and requires cool temperatures for flowering. It is grown in the *Sali* season and suitable for rainfed shallow lowlands. It has medium-slender grain type, crop duration is 150-160 days and height is 145-155 cm. The average grain yield of this variety is 2-3 t/ha. It is used for making *pulao*, *kheer*, etc.

***Kon Joha*:** *Kon Joha* varieties (*Kunkuni Joha*, *Maniki Joha* and *Madhuri Joha*) grow well on medium land with clay type soil. It is of medium plant height (125-130 cm) with a duration of 170 days. The cultivar is also photoperiod-sensitive and requires cool temperature for flowering. Grain type of this variety is small and slender. The average grain yield of this variety is 2-3 t/ha. It is used both as a regular meal and special recipes on festivals.

***Kunkuni Joha*:** It is a traditional *Joha* rice variety suitable for rainfed shallow lowland and grown in *Sali* season. Crop duration is 150-160 days and plant height is 100-105 cm. The average yield of *Kunkuni Joha* variety is 1.5-2.5 t/ha and its grain type is small-slender.

***Keteki Joha* (IET – 14390):** It is an improved aromatic (scented) rice variety developed by Assam Agricultural University (AAU), and suitable for rainfed shallow lands during *Sali* season in North Bank Plain Zone (NBPZ), Upper Brahmaputra Valley Zone (UBVZ), Central Brahmaputra Valley Zone (CBVZ) and Barak Valley Zone (BVZ) of Assam. The year of notification for this variety is 1999. Its optimum sowing time is June to mid-July. The plant is 100-105 cm tall and matures in 150-160 days. The grain type of this variety is medium-slender. The average grain yield of this variety is 3.5-4.0 t/ha.





**Bokul Joha:** It is an improved aromatic (scented) rice variety developed by Assam Agricultural University (AAU), and suitable for *Sali* season. It grows well on rainfed shallow lowland areas. The variety matures in 150-160 days and plant height is 100-105 cm. The grain type of this variety is medium bold. The average grain yield of this variety is 3.5-4.0 t/ha. Its grain is used as rice, *pulao*, *kheer*, etc.



## Few aromatic rice varieties notified for Assam

### CR Sugandh Dhan 909 (CRL 74-89-2-4-1; IET 23193)

CR Dhan 909, the non-*Joha* aromatic rice variety is released by ICAR-National Rice Research Institute (NRRI). This variety is notified for Assam by Govt. of India and characterized with the parameters of being semi-dwarf in stature, strong in aroma, good in cooking quality, non-lodging, and is suitable for making rice flakes and confectionary products. The variety is moderately tolerant to leaf blast, neck blast, bacterial leaf blight, brown spot, stem borer, leaf folder, and white back planthopper. It is suitable for the *Sali/kharif* season in Assam and its year of notification for Assam and other states is 2018. It is suitable for irrigated late sown ecology. The duration of this variety is 140 days, and its grains are medium slender. The average grain yield of this variety is 5.0 t/ha.



## Best management practices

### Seed Selection:

The seed cleaning should be done in salt solution (200g salt/litre of water). To check the concentration of the solution, an egg or a potato is to be immersed, until it floats. Thereafter, seed should be poured into the solution for cleaning. The light or diseased seeds, which float on the prepared solution, are to be removed. The seeds settled at the bottom are then collected and washed 3 times with plain/normal water to remove any traces of salt from the seed.

### Seed treatment:

Since this class of rice is susceptible to diseases, it is advisable to adopt seed treatment with recommended fungicide(s). The cleaned seed should be kept in water for 12-24 hours before fungicidal treatment. The seed is to be treated with Carboxin @ 2.5 g/kg of seed. The treated seed is thereafter to be incubated for 48-72 hours.

Alternatively, the seed can be treated with bio-control agent *Trichoderma* species @ 10 g/kg of seed. For this, first soak the seed in water for 12 hours, then decant and thoroughly mix the seed with a bio-control agent, and store as a heap covered with moist gunny bags for 6-12 hours before sowing.

**Safety precaution:** Plastic gloves should be used while handling chemicals to avoid any negative effect on health.

## Nursery raising

**Time of sowing:** Mid-May is the most appropriate time for raising a nursery. Keep in mind that 30-35-day seedlings are transplanted and well established in the main field before occurrence of flood.

**Seed rate:** 40 kg per hectare for both dry and wet raised bed nursery.

**Nursery size:** For one hectare of main field, the nursery bed size should vary between 750 and 1000 m<sup>2</sup>, and not more than 1/10<sup>th</sup> of the main field size. Land should be thoroughly puddled, and seedbeds of 10 m length and 1.25 m breadth are to be prepared with a 60 cm gap in between the beds. The length of the beds may vary according to convenience and availability of the space.

**Irrigation:** Irrigate to maintain saturated condition in the surface soil of the nursery bed. Maintain 2-3 cm standing water 2-3 days prior to uprooting.

**Plant protection:** Adopt plant protection measures in the standing nursery as a standard package of practices.

**Seedling root dip.** Before transplanting, first seedling roots should be washed and then dipped into the solution of systemic insecticide, or *Trichoderma* or *Pseudomonas* species for better seedling growth and protection against soil- and seed-borne diseases.

**Nursery fertilizer:** Use 3-1-2 g N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O + 2000 g manure per m<sup>2</sup> i.e., equivalent to 3-1-2 kg N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O + 2 tons manure in 1000 m<sup>2</sup> nursery area for one-hectare main field.

When?	What?	How much? (g/m <sup>2</sup> )		How much? (kg/1000 m <sup>2</sup> )		Application method
		Through DAP	Through SSP	Through DAP	Through SSP	
Basal (Same day as sowing)	Manure	2000	2000	2000	2000	Soil incorporation
	Urea	5.6	6.5	5.6	6.5	
	DAP	2.2	-	2.2	-	
	SSP	-	6.3	-	6.3	
	MOP	3.3	3.3	3.3	3.3	

## Main field preparation

**Preparation of main field:** For preparation of the main plot, the following points should be kept in mind:

- Field should be prepared thoroughly by ploughing with *desi* (traditional) plough 4 times, followed by harrowing and laddering.
- Ploughing should be started at least 2-3 weeks ahead of transplanting so that weeds are dried up/decayed.
- Alternatively, one pass of mould board plough followed by one or two passes of modified helical blade puddler are sufficient for obtaining good quality puddled soil.
- The ploughing intervals should be spaced such that the weeds germinated after the first round of ploughing are knocked down in the next round.
- If available, compost or manure should be applied uniformly prior to field preparation and should be mixed well with soil.

- Bunds are to be repaired to reduce water losses from the field during the cropping season.
- Level the fields, best by maintaining a shallow water layer in the field.
- The basal fertilizer dose is to be applied to the field (see fertilizer section below).

## Transplanting

**Seedling age:** 30-35 days for long duration, and 20-25 days for medium duration rice varieties for transplanting in the main field.

**Spacing:** 20-25 cm x 15cm (8-10 inches x 6 inches)

**Seedling density:** 2-3 seedlings per hill.

**Depth of seedling:** 4-5 cm

## Nutrient management

For transplanted aromatic rice, fertilizer recommendation per hectare is 40-20-20-5: N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O-Zn. The nitrogen is applied into 3 equal splits i.e., 1/3<sup>rd</sup> as basal, 1/3<sup>rd</sup> at tillering, and 1/3<sup>rd</sup> at panicle initiation (PI).

Stage of fertilizer application	Name of fertilizers	Fertilizer application (kg/ha)		Fertilizer application (kg/bigha)		Application method
		Through DAP	Through SSP	Through DAP	Through SSP	
Basal	Urea	19	27	2.5	3.6	Broadcast & incorporate in soil at the time of field preparation
	DAP	43	-	5.7	-	
	SSP	--	125	--	16.7	
	MOP	33		4.4		
	ZnSO <sub>4</sub>	25		3.3		
Tillering after 1 <sup>st</sup> weeding	Urea	30		4.0		Broadcast
PI after 2 <sup>nd</sup> weeding	Urea	30		4.0		Broadcast

PI = Panicle initiation

### Note:

- Do not apply urea at or after booting, as it is too late and will not increase yields.
- Stop urea broadcast, in case bacterial blight symptoms appear.
- Apply ZnSO<sub>4</sub> in soil deficient in Zinc, once in three years.
- As far as practicable, drain out standing water before fertilizer application.

In field where the *Joha* rice is grown organically the following organic components are recommended:

Components	Recommended dose	When to apply
Biofertilizer consortium ( <i>Azospirillum</i> , <i>Azotobacter</i> , Phosphate solubilizing bacteria)	4 kg/ha	Root dip treatment for 4-6 hours before transplanting
Green manure (GM) crops i.e Dhaincha ( <i>Sesbania rostrata</i> ), Sunn hemp ( <i>Crotalaria juncea</i> ), Pillipesara, Cluster bean is arid legume and unable to tolerate water stagnation, high rainfall, that too on heavy soils.	2.5 t/ha	Application of green manure and vermicompost on the main field, before one month of transplanting
Vermicompost (VM)	2.5 t/ha	
Azolla	20 kg/ha	Application of Azolla after 7 days of transplanting
Rock phosphate	17 kg/ha	One-day before transplanting

## Weeding:

Keep the field weed-free, especially early in the season. Weeds do most damage in the early crop stage, but later control is also important to prevent seed setting of weeds.

### Hand weeding/mechanical weeding

For environmental safety, it is advised to prefer manual / mechanized weeding to control the weeds.

- 1<sup>st</sup> weeding with paddy weeder or hoe, 3 weeks after transplanting
- 2<sup>nd</sup> weeding with paddy weeder or hoe, 6 weeks after transplanting

## Herbicide application

- **Equipment** - Given their superior effectiveness, herbicides should only be applied using boom fitted with multiple flat-fan nozzles.
- **Pre-emergence (PE) herbicides** - Most PE herbicides require moisture at the soil surface at the time of application. Without sufficient moisture, the PE herbicide will not be as effective. Pre-emergence herbicides can be used by a splash method in 3-5 cm standing water in the field, preferably within 0-3 Days After Transplanting (DAT).

Pre-emergence herbicides supplemented with one hand weeding may be more effective to take care of the germinating weeds as well as those weeds emerging later in the season.

- **Post-emergence (PoE) herbicides** - PoE application, if required, should be done 15-25 DAT or done between 15-25 days of trasplanting when weeds attain 2-4 leaf stage. Ensure that there is no standing water in the field, however, the field should have moisture at the time of PoE application.
- **Spray volume** - Use spray volume of 300 liters/ha in all herbicide applications.

## Herbicide safety

- ✓ Read the label prior to use to understand both the toxicity level and the safety measures required.
- ✓ Plastic gloves, goggles or face shield, and full clothing should be worn by the person while mixing and during application of the herbicides.
- ✓ Post-application, all clothes need to be washed separately from the common family-laundry.

Select suitable and need-based herbicide(s) from the table given below:

When does it kill weeds	Chemical Name	Dose (ai, g/ha)	Type of weeds it kills		When to apply	Commercial dose (g or ml/ha)	Commercial dose (g or ml/ <i>bigha</i> )
Pre-Emergence	Pretilachlor 50% EC	750	Narrow leaf	Some broad leaf	0-3 DAT	1500 ml	200 ml
	Pyrazosulfuron Ethyl 10% WP	18.8	Narrow leaf (sedges)	Some broad leaf	0-3 DAT	187.5 ml	25 ml
	Oxadiargyl 80% WP	100	Narrow leaf	Some broad leaf	0-3 DAT	125 g	16.6 g
Post-Emergence	Bispyribac-sodium 10% EC	25	Narrow leaf (grasses + sedges)	Some broad leaf	15-25 DAT	250 g	33 g
	Chlorimuron ethyl 10%WP + Metsulfuron methyl 10% WP	4 (2+2)	Broad leaf	Some sedges	15-25 DAT	20 g	3 g
	Pyrazosulfuron Ethyl 10% WP	25	Narrow leaf (sedges)	Some broad leaf	15-25 DAT	250 g	33 g

DAT= Days after transplanting

Given below are some of the recommended herbicide-combinations. Depending on weed-flora, follow the application timing and doses as per above table:

- Pretilachlor (PE) *fb*\* Bispyribac-Sodium (PoE)
  - Pretilachlor (PE) *fb*\* Bispyribac-sodium + Pyrazosulfuron (PoE)
  - Pretilachlor (PE) *fb*\* Bispyribac-sodium + Pyrazosulfuron (PoE) *fb*\* Spot hand weeding
- fb*\*: followed by

## Irrigation

During the *Sali* season, in the absence of rain, application of 5 cm irrigation water 3 days after disappearance of ponding water is recommended in medium and heavy soils.

### Plant protection measure:

The insect-pests and diseases prevalent in different districts of Assam include stem borer, leaf folder, swarming caterpillar, *gundhi* bug, blast, brown spot, false smut, bacterial blight, etc. The details of management practices including cultural, mechanical, biological and chemical are presented below. Chemical use is advised only when the pest population exceeds the Economic Threshold Level (ETL), and the environment seems conducive for the explosion of the pest population.

The major insect-pests/diseases and their control is presented below –

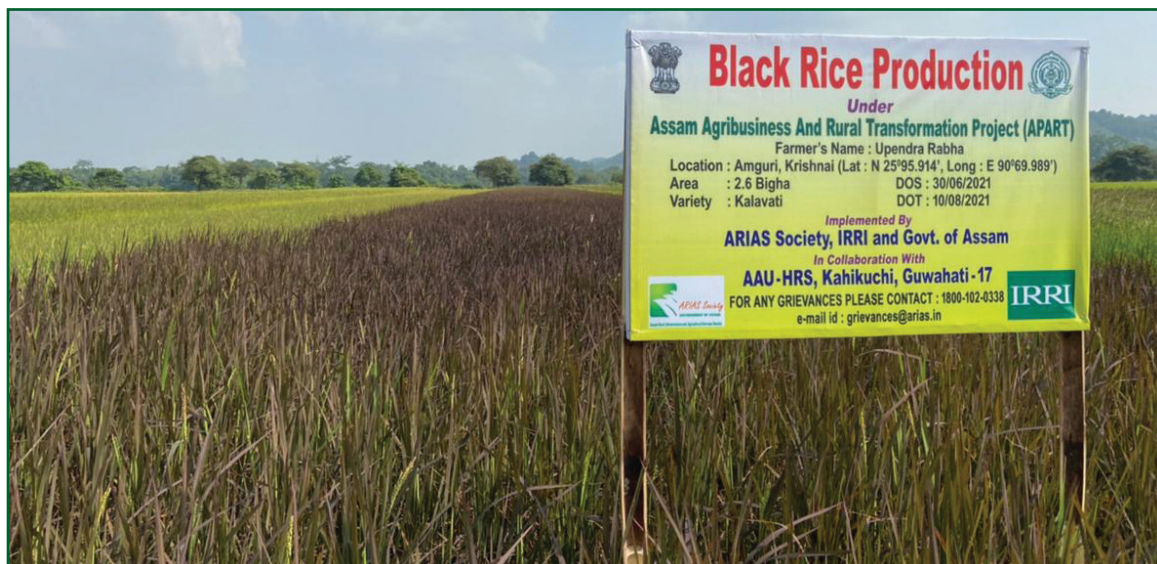
S. No.	Insect-pest/disease	Treatment/control
1.	Stem borer	<ul style="list-style-type: none"> <li>Clipping of the seedling leaf tips before transplanting, harvesting close to ground and flooding fields after harvest of the crop.</li> <li>Installation of light traps and pheromone traps @ 1 trap per bigha for monitoring the pest.</li> <li>Installation of bird perches @ 3 no. per bigha and removal before ripening of the crop.</li> <li>Biological control – Tricho cards having <i>Trichogramma japonicum</i> should be installed @ 7000 eggs/bigha 5 to 6 times at weekly intervals starting from 30 days after transplanting.</li> <li>Spray Chlorantraniliprole 0.4% G @ 10 kg/ha or Flubendiamide 20% WG @ 0.25 g/L of water or Cartap hydrochloride 50% SP @ 2 g/L of water.</li> </ul>
2.	Leaf folder	<ul style="list-style-type: none"> <li>Elimination of alternate grassy weed hosts.</li> <li>Avoid use of excessive nitrogenous fertilizer.</li> <li>Drawing of a kerosene-soaked rope across fields to dislodge/kill the larvae.</li> <li>Field release of <i>Trichogramma chilonis</i> @ 7000/bigha starting from 35 days after transplantation with 3 repetitions at fortnightly interval.</li> <li>Spray Chlorantraniliprole 0.4% G @ 10 kg/ha or Flubendiamide 20% WG @ 0.25 g/L of water or Cartap hydrochloride 50% SP @ 2 g/L of water.</li> </ul>
3.	Rice gundhi bug	<ul style="list-style-type: none"> <li>Hanging some foul-smelling dead frog or dead poultry in the field which attracts the gundhi bug towards the foul smell and then it can be easily destroyed.</li> <li>Spraying of NSKE 1500 ppm @ 3-5 ml/L of water, Neemazal 1% @ 2-3 ml/L of water.</li> </ul>
4.	Swarming caterpillar	<ul style="list-style-type: none"> <li>Digging of trenches around fields to check the spread of the caterpillars.</li> <li>Flooding of the field to expose the hiding larvae to the surface.</li> <li>Installation of bird perches @ 3 no. per bigha.</li> <li>Release of ducks into the field to feed on the larvae.</li> <li>Spray Chlorantraniliprole 0.4% G @ 10 kg/ha or Flubendiamide 20% WG @ 0.25 g/L of water. Spraying is advocated only during evening hours.</li> </ul>
5.	Caseworm	<ul style="list-style-type: none"> <li>Practice alternate wetting and drying method of irrigation to kill the larvae.</li> <li>Spray Chlorantraniliprole 0.4% G @ 10 kg/ha or Flubendiamide 20% WG @ 0.25 g/L of water.</li> </ul>
6.	Brown spot	<ul style="list-style-type: none"> <li>Proper fertilization and correction of nutrient deficiencies in soil.</li> <li>Spray Propineb 70% WP @ 3-4 g/L or Chlorothalonil 75% WP @ 2 g/L of water, and the spray may be repeated after 10 days.</li> </ul>
7.	Blast	<ul style="list-style-type: none"> <li>Seed treatment with Chlorothalonil 75% WP or Tricyclazole @ 2 g/kg of seed or with biocontrol agents, <i>Trichoderma harzianum</i> or <i>T. viridae</i> @ 10 g/kg of seed or <i>Pseudomonas fluorescens</i> @ 10 g/kg of seed.</li> <li>Reduced application of nitrogenous fertilizers with more number of splits.</li> <li>Field should not be drained in case of disease incidence.</li> <li>Spray Tricyclazole 75% WP @ 0.6 g/L or Isoprothiolane 40% EC @ 1.5 ml/ L of water.</li> </ul>

S. No.	Insect-pest/disease	Treatment/control
8.	Bacterial Leaf Blight (BLB)	<ul style="list-style-type: none"> <li>Seed treatment by mixing 0.025% solution of Agrimycin-100 + 0.05% wetttable Ceresan, and then transferring the seed to hot water at 52-55°C for 30 minutes.</li> <li>When the disease is noticed, stop or reduce the further application of nitrogenous fertilizers.</li> <li>Spray a ready-mix combination of Streptomycin sulphate 90% + Tetracycline hydrochloride 10% SP @ 100-150 ppm.</li> <li><b>Indigenous Technical Knowledge (ITK):</b> For controlling bacterial blight in rice, prepare a slurry of 20 kg cowdung in 200 liters of water, and filter it through a gunny bag. Dilute the filtrate with 50 liters of water and allow it to settle. The filtered water is then decanted, strained &amp; sprayed on healthy plants to check the spread of disease.</li> </ul>
9.	False smut	<ul style="list-style-type: none"> <li>Use of good quality and disease free seeds.</li> <li>Spray Chlorothalonil 75 WP @ 2 g/L or Azoxystrobin 23% SC @ 1ml/L or Tebuconazole 25.9% EC @ 1 ml/L of water.</li> </ul>
10.	Sheath blight	<ul style="list-style-type: none"> <li>Seed treatment with <i>Trichoderma harzianum</i>/ <i>T. viridae</i> @10g/kg of seed.</li> <li>Spray Hexaconazole 5% @ 2ml/L.</li> <li>Spray Validamycin 3% L @ 3-4ml/L of water.</li> </ul>

## Harvest and post-harvest

- Harvest when 80-85% of the grains attain physiological maturity i.e. visually straw-colored.
- Minimize the time during which the harvested plants remain in the field, and avoid field drying. Make sure that the panicles stay dry.
- Thresh and dry within two days after harvesting. Sun drying is best on a mat or plastic sheet, keeping the thickness of the grain layer at 3 to 5 cm.
- Clean thoroughly by winnowing. Store the rice in a cool, dry, and clean area. Grain should be dried to 12-14% moisture before storing hermetically to avoid re-entering moisture in the grain. While storing, jute bags should not be stacked more than 4-meter high and plastic bags 3-meter high. A one-meter gap should be kept between two stacks. For seed purpose; dry to a moisture level of <12% and <9% to store for up to 1 year and >1 year, respectively, using a super bag or Grain safe (Cocoon). If the grain is stored for 3 months, then use a gunny bag, but it will be good if the super bag is used. If the gunny bag is used for storage, then check the moisture content before milling, and dry it if required.
- Milling should be done as and when there is demand for rice. Rice milling should be done 3 months after harvesting to ensure good quality traits like amylose content. Milling should be done in a rubber roller type rice-mill for better head rice recovery. To reduce the broken percentage in milling; above mentioned practices of harvesting, threshing and drying should be followed.

## Black rice



Black rice has been grown since 140 BC and owing to its novel and highly beneficial attributes, it is now taking a large share on the world stage as a superfood. This rice with a thin layer of black bran, is gaining popularity for its high levels of antioxidants and superior nutritional value. Black rice, also called 'Forbidden rice' or 'Emperor's rice', earned its name because it was once reserved for the Chinese emperor to ensure his health and longevity, and forbidden to anyone else. It is known to prolong life, thus, is also called '**Long-life rice**'. Research shows that black rice is considered as the twenty-first century '**Superfood**' that provides a wide range of health benefits along with inherent calorie and nutritive value.

Black rice comes in several forms - short grain, long grain and glutinous varieties similar to brown rice with a slightly nutty flavour, smooth and firm texture, and quite sticky. The pericarp (outer covering) of this rice is black due to the presence of a high amount of anthocyanin that acts as antioxidant in the body.

When cooked, the colour lightens into a deep purple/violet colour hence, it is also known as "purple rice". This unusual colour makes it popular for dessert.

### Nutritional quality

Nutritive value of black rice is superior to any other rice. This rice is free of gluten, cholesterol, and low in sugar, salt, and fat. It is a whole grain, super nutritious type of rice that is high in antioxidants, vitamin B-complex and E, iron, manganese, magnesium, molybdenum, phosphorus and a good source of protein, fiber and complex carbohydrates. It is estimated that 50 g of black rice provides 35% of RDA (Recommended Dietary Allowances) of selenium, copper, zinc and magnesium per day. Quality and quantity of protein in black rice is higher than any other rice varieties. Being a naturally good source of iron, it is excellent for those who are concerned about getting enough iron on a plant-based diet.

### Health benefits

Black rice is a useful therapeutic agent for the treatment and prevention of diseases associated with chronic inflammation, obesity (weight management), prevention of cardiovascular disease, cancer and diabetes, reducing allergies, prevention of constipation and anemia, betterment of liver health, skin-, eye- and hair-care, and immunity build up.



## Varieties

Black rice is grown in the *Sali* season. Manipuri black rice variety was first brought under cultivation by one of the farmers from lower Assam - Mr. Upendra Rabha. Some people in lower Assam recognize this variety of black rice by his name (*Upendra rice*). The grain-type of black rice is either medium-bold or long-bold. The yield potential is between 3.0 and 4 tons per hectare.



**Manipuri black rice:** It is a traditional rice variety having its origin in Manipur. This variety is 130-140 cm tall and matures in 140-150 days. The grain type is medium-bold and black in colour. Plants of this variety possess purple-coloured leaves. The average grain yield of this variety is 3.0 - 4.0 t/ha and head rice recovery is 55%. The colour of this rice remains black after cooking. This variety possesses a high amount of antioxidants, zinc, iron and calcium. No severe disease or pest attack is observed in this variety.

**Kalavati:** It is a traditional rice variety of Odisha. The plant is 120-145 cm tall and matures in 140-150 days. The grain type of Kalavati is medium-bold and the colour is black. Plants of this variety possess purple-coloured leaves. The average grain yield of this variety is 2.0 - 3.0 t/ha and head rice recovery is 50%. The colour of this rice remains black after cooking. This variety possesses high antioxidants, iron and calcium.



**Kalamalifula:** It is a traditional rice variety of Odisha. The plant is 110-130 cm tall and matures in 120-130 days. The grain type of Kalamalifula is medium-bold. Plants of this variety possess black colour only in nodes. The average grain yield of this variety is 2.0 - 3.0 t/ha and head rice recovery is 55%. The colour of this rice after cooking remains black. This variety possesses high amounts of antioxidants, iron and calcium.

## Management practices

Black rice is low water consuming, labor-intensive, and traditionally grown organically, using young seedlings singly spaced and typically hand-weeded with special tools.

Traditionally, black rice is cultivated under rainfed condition by direct seeding in the months of June-July and harvested in October-November. In general, the black rice landraces possess higher stress tolerance. Farmers do not apply chemical fertilizers in black rice fields because such applications enhance vegetative growth and cause lodging which increases the number of chaffy grains. In general, black rice cultivation needs less ploughing, weeding and care compared to other rice varieties. No severe disease or pest attack has ever been observed on all the landraces of black rice, whereas other rice varieties are susceptible to insect-pests and diseases such as rice bug, stem borer, thrips, green caterpillar, rots, leaf blight, and false smut. This could be attributed to high phenolic and anthocyanin contents in black rice landraces.

## Bora rice



*Bora* rice or sticky rice or waxy rice or glutinous rice is grown in *Sali* season. It has <5% amylose content. The grain of the sticky rice or waxy rice or glutinous rice is opaque and cooked sticky due to its chemical constituent known as amylopectin, a component of the starch 'Boka'. Traditionally, many items including *pithas* (biscuit-like confectionaries) *chira* (flaked rice), *hurum* (expanded waxy rice), *Sunga chaol* (roasted rice inside bamboo internode), *Sandohguri* (fried rice powder) and rice beer are made from this rice. The grain type of sticky rice is medium-bold to medium-slender. The yield potential of *Bora* rice is 2 - 4.5 tons per hectare. *Ronga Bora*, *Bokul Bora*, *Jenguni Bora*, *Aki Bora*, *Mou Bora*, *Moina Bora*, and *Goria Bora* are the indigenous waxy rice varieties. *Aghoni Bora* and *Bhogali Bora* are high yielding varieties of glutinous rice.

### Varieties

**Aghoni Bora:** It is an improved *Bora* rice variety. It is suitable for the *kharif/Sali* season in Assam. The grain yield of this rice variety is 2.5-3.0 t/ha and it matures in 155-165 days. It is developed by Regional Agricultural Research Station, Titabar, Jorhat. This variety with average plant height (100-105 cm) has long-slender grains.

**Bhogali Bora:** It is an improved rice variety suitable for the *kharif/Sali* season in Assam. The grain yield of this rice variety is 2.5-3.0 t/ha and it matures in 155-165 days. It is developed by Regional Agricultural Research Station, Titabar, Jorhat. This variety is 100-105 cm in height and has long slender grains.

Management practices is similar to best management practices of *Joha* rice varieties.

## Bao rice (Deep-water Rice)



Red rice is popularly known as deep-water rice or *bao* rice, as it is cultivated on low, swampy lands and flood-prone areas. This variety of paddy has a unique tolerance to stress, which is not possible for any other paddy variety. The seedlings can withstand drought-like conditions. During May-September, which is the rainy season (flood season in Assam), this paddy shows the unique ability to grow rapidly with the rising water level. It was Prof Handique's research team who for the first time studied and reported the presence of anthocyanin in 'red rice' from Assam as early as 2008. The study, published in Indian Journal of Plant Physiology, was widely acclaimed by the scientific community associated with rice research. While most varieties exhibit a white pericarp, local farmers traditionally grow rice varieties with a red pericarp, which are preferred over white rice because of their supposed higher nutritional value and market potential. Red rice contains higher amounts of iron, fiber, zinc, protein, magnesium, phosphorus, selenium, thiamine, niacin, manganese and other micronutrients.

Assam has approximately 100,000 ha area under deep-water rice (DWR) cultivation (Rohilla *et al.* 2019). It is cultivated primarily in the Brahmaputra valley of Assam. Substantial *bao* or red rice growing areas are Dhemaji, Lakhimpur, Sivasagar and Majuli districts. The deep-water and floating rice are grown in some low lying areas of Kamrup, Nalbari, Barpeta, Goalpara and Morigaon districts.

### Varieties

*Bao* rice is grown in April/May and harvested in Nov/Dec. The grain type is medium-bold. The yield potential is 1.5 to 2.0 tons per hectare. Some indigenous red rice varieties are as follows:

Varieties	Agro-climatic zones
Amona	Upper Brahmaputra Valley Zone
Dholabadal	Barak Valley Zone
Kakua	Central & Lower Brahmaputra Valley Zone
Maguri	North Bank Plains, Upper & Lower Brahmaputra Valley Zones

Varieties	Agro-climatic zones
Negheri	Upper, Central & Lower Brahmaputra Valley Zones
Padmanath	North Bank Plains Zone
Padmapani	North Bank Plain Zone
Panikekua	North Bank Plain & Upper Brahmaputra Valley Zones
Salibadal	North Bank Plain Zone

Additionally, some of the improved deep-water rice varieties are as follows:

**LPR 106 (Panchanan):** It is an improved rice variety suitable for well adapted flood-prone, semi-deep water (50-100 cm). This variety was recommended for cultivation in Assam in 2015. The duration of this variety is 240 days when direct-seeded and 186 days when transplanted. The average grain yield of this variety is 3.0 t/ha. This rice variety possesses red kernels and medium-slender grain, and is prone to lodging, resistance to shattering, responsive to fertilizer application, suitable for normal/late sown condition, and tolerant to flood, submergence and intermittent drought.

**KDML 105 (Padumani):** Low lying areas having higher land submergence because of recurrent flood, suitable for growing normal *Sali* rice where water level goes up to 1.0 meter are suitable for growing this rice variety. It is also an improved rice variety and recommended for semi-deep-water in flood-prone areas (50-100 cm water depth) of Assam in 2015. The duration of this variety ranges from 230-240 days when direct-seeded through broadcasting in a lowland area and from 180-200 days when transplanted in a medium lowland area. This variety is non-lodging, resistant to shattering, responsive to fertilizer application, suitable for normal sown condition. It is aromatic, possesses medium slender grain, and tolerant to submergence. The average grain yield of this variety is 2.6 t/ha.

**Basudev:** It is semi-deep-water (50-100 cm) rice with red kernels and medium slender grain tolerant to *ufra* nematode infestation. The duration of this rice variety is 240 days when direct-seeded through broadcasting in a lowland area and 186 days when transplanted in a medium lowland area. The average grain yield of this variety is 3.0 t/ha. This variety is prone to lodging, resistance to shattering, responsive to fertilizer application, suitable for normal/late sown condition and tolerant to flood, submergence and intermittent drought.

**Panindra:** It is suitable for semi-deep-water (50-100 cm) situations in flood-prone areas of Assam. It possesses white kernels and medium-slender grains. The duration of this variety is 240 days when direct-seeded through broadcasting in a lowland area and 186 days when transplanted in a medium lowland area. The average grain yield of this variety is 3.0 t/ha. The variety is prone to lodging, resistance to shattering, responsive to fertilizer application, suitable for normal/late sown condition, and tolerant to flood, submergence and intermittent drought.

## Best management practices

### Land preparation:

- i) Stubbles of the previous crops should be thoroughly burnt to minimize nematode and pest infestation.
- ii) Adequate ploughing / cross-ploughing should be done.

**Seed selection:** The seed cleaning should be done in salt solution (200g salt/litre of water). To check the concentration of the solution, put an egg or a potato till it floats. After that, seed should be poured into the solution for cleaning. The light or diseased seeds, which float on the prepared solution, are removed. The seeds settled at the bottom are collected and washed 3 times with plain/normal water to remove any remnant salt from the seed.

## Seed treatment

**Wet method:** After selection, seed should be soaked for 24 hours directly in fungicidal suspension using Carboxin @ 2.5 g/litre of water for treating 1 kg seed, and thereafter incubated for 48 hours before they are soaked for final germination.

**Dry method:** Put seed in container and add Carboxin @ 2.5 g/kg seed. Mix fungicide thoroughly with seed by agitating them for five minutes.

**Sowing time:** March- April

## Method of sowing

**For *Ahu* area:** *Ahu* + *bao* mixtures in the ratio of 4:1 (60 kg *Ahu* + 15 kg *bao* seed/ha)

**For *bao* area:** Monocrop *bao* is recommended.

**Seed rate:** 75 kg/ha for both situations (mixture and monoculture) when manually broadcast. To attain a uniform crop-stand and save seed-cost, it is recommended to go for mechanized direct seeding of rice (MDSR) with drum seeder using a seed rate of 40 kg/ha.

**Spacing:** 25 cm x 25 cm.

## Fertilizer

Application of neem-coated urea at 30 kg N/ha in two equal splits as basal and at maximum tillering stage is recommended.

## Insect-pests and management:

The major insect-pests of *bao* paddy are stem borer, *gundhi* bug and rice hispa.

To control rice pests, erect 50 'T'- perches per ha 2 ft (60 cm) above crop canopy as roosting site for insectivorous birds, which are to be removed before flowering in order to prevent activity of granivorous birds.

## Diseases and management:

The common diseases of *ahu* rice are blast, sheath blight, bacterial leaf blight, brown spot and bakanae disease.

**Field rats:** Apply dry poison baits in bait stations (broken earthen pot, coconut shell, bamboo cylinder, etc.). Before application of poison baits, pre-baiting is essential to attract the rats. Pre-bait can be prepared using 1 kg cereal + 20 g vegetable oil + 10 g dried fish and may be applied at 10 g per live burrow for 3 days prior to actual poison baiting.

### Bait formula:

1.	Flour ( <i>Atta</i> ) or wheat bran or maize crush	80 g
2.	Jaggery ( <i>Gur</i> )	10 g
3.	Fried or dried fish	5 g
4.	Bromellion	5 g

## Nematode

For control of plant parasitic nematodes in endemic areas, Cartap hydrochloride (30 kg/ha) should be applied 5-7 days after sowing.

### *Ufra* disease control

1. Burning of stubbles and straw followed by several ploughing just after harvest.
2. Delay sowing up to mid-April.
3. Use early maturing *bao* varieties like Padmapani’.



*IRRI, AAU Scientists, Department of Agriculture officials with Bao rice farmers*

## Chokuwa rice

*Chokuwa* rice, also known as soft rice or *Boka* rice or magic rice, is a unique type of rice variety which can be consumed without cooking, i.e. it's a zero-fuel rice. The rice simply needs to be soaked in water for 20-30 minutes before consumption. It is versatile and can be consumed with milk, curd, jaggery, coconut, sugar or molasses, salts, oils, pickles, vegetables, etc. It is grown in the *Sali* season. The amylose content of *Chokuwa* rice is 10-15%. *Komal chaol* is prepared from this class of rice in Assam.



Soft rice

### Varieties

*Saru Chokuwa, Bor Chokuwa, Bora Chokuwa, Boga Chokuwa, Boka Chokuwa-1, Boka Chokuwa-2, Chokuwa-6, Haru Chokuwa, Kagoli Chokuwa, Kalomdani Chokuwa, Lahi Chokuwa, Maju Chokuwa-1, Maju Chokuwa-2, Malbhog Chokuwa, Nepali Chokuwa, Sam Chokuwa, Pozo Chokuwa, Kagoli Chokuwa and Paro Chokuwa* are traditional *chokuwa* rice.

The grain type of *Chokuwa* rice is medium-bold to medium-slender. The yield potential of *Chokuwa* rice is 2 - 2.5 tons per hectare and it matures in 160 days. The average plant height of these rice varieties is 158 cm.

Management practices are similar to management practices of *Joha* rice varieties.

## Biofortified or Nutrient-rich rice

Humans have been modifying crops for favorable traits since agriculture was invented thousands of years ago. But conventional breeding takes multiple generations and cannot be used to improve only one specific trait. Genetic engineering and genome editing are precise technologies that can streamline the breeding process and introduce rice traits that cannot be significantly improved through conventional breeding.

Biofortification is the process of improving the nutritional quality of food crops. This can be achieved through agronomic practices, conventional breeding or biotechnology-based approaches like genetic engineering and genome editing. Biofortification of staple crops such as rice is intended as a sustainable, cost-effective and food-based means of delivering target micronutrients to populations who do not have access to or cannot afford diverse diets and other existing interventions such as fortified foods and supplementation.

### Few biofortified rice varieties

**DRR Dhan 45:** It is the first high zinc variety notified at national level. It is rich in zinc (22.6 ppm) in polished grains in comparison to 12.0-16.0 ppm in popular varieties. The grain yield of this rice variety is 5.0 t/ha and it matures in 125-130 days. It is suitable for irrigated conditions in *kharif/Sali* season.

It was developed by ICAR-Indian Institute of Rice Research, Hyderabad and released in 2016 for Karnataka, Tamil Nadu, Andhra Pradesh and Telangana. It has long slender grains and good cooking quality with amylose content 20.7%. It is moderately tolerant to blast, sheath-rot and rice tungro virus. The plants of this variety are 100-105 cm tall and tolerant to lodging.

**DRR Dhan 49:** It is rich in zinc (25.2 ppm) in polished grains in comparison to 12.0-16.0 ppm in popular varieties. The grain yield of this rice variety is 5.0 t/ha and it matures in 130 days. It is suitable for irrigated conditions in *kharif/Sali* and *Rabi/Boro/early Ahu* season. It was developed by ICAR-Indian Institute of Rice Research, Hyderabad and released in 2018 for Gujarat, Maharashtra and Kerala. The grain type of this variety is medium slender. With very high culm strength, this variety is tolerant to lodging.

**Zinco Rice MS (R-RHZ-L1-23; IET 25477):** It is rich in zinc (27.4 ppm) in polished grains in comparison to 12.0-16.0 ppm in popular varieties. It is moderately tolerant to leaf blast, brown spot, sheath rot and rice tungro virus disease. The grain yield of this rice variety is 5.0 t/ha and it matures in 135 days. The variety has long slender grains. The plant height of this rice variety is 100-105 cm. This variety is resistant to lodging and shattering. It is suitable for early and timely sowings under rainfed and irrigated conditions in *kharif/Sali* season.

It was developed by IGKV, Raipur under ICAR-All India Coordinated Research Project on Rice, and notified in 2019 for Chhattisgarh, West Bengal and Odisha.

**CR Dhan 310 (CR 2829-PLN-37; IET 24780):** It is a protein-rich rice variety. It contains 10.5% protein in polished grain. It is moderately resistant to leaf blast, brown spot, sheath rot, stem borer, leaf folder and gall midge biotype 1. Parentage of this rice variety is HP-2 / Naveen. The average grain yield of this rice variety is 5.0 t/ha and it matures in 125 days. The grains of this variety are medium slender. It is suitable for irrigated conditions in *kharif/Sali* season.

It was developed by ICAR-National Rice Research Institute, Cuttack and released in 2015 for Odisha, Madhya Pradesh and Uttar Pradesh. The plants of this variety are 110 cm tall.

**CR Dhan 311 (Mukul, CR 2829-PLN-100; IET24772):** It is rich in protein (10.1 %) and zinc (20.1 ppm) in polished grains in comparison to 7.0-8.0 % protein and 12.0-16.0 ppm zinc in popular varieties. The grain yield of this rice variety is 5.54 t/ha and it matures in 120-126 days. This variety has long bold grains. It is suitable for irrigated ecologies and also for rainfed shallow lowland during *kharif/Sali* season. This variety is tolerant to blast, brown spot, rice tungro virus, bacterial leaf blight, moderately resistant to gall midge and sheath blight.

It was developed by ICAR-National Rice Research Institute, Cuttack and released in 2018 for Odisha. It is tolerant to blast, *gundhi* bug, brown spot, rice tungro virus and bacterial leaf blight. It is moderately tolerant to gall midge and stem borer. The plants of this variety are 115 cm tall.

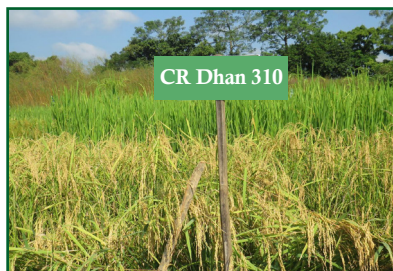
**CR Dhan 315:** It is rich in zinc (24.9 ppm) in polished grains in comparison to 12.0-16.0 ppm zinc in popular varieties. The grain yield of this rice variety is 5.0 t/ha and it matures in 130 days. It is suitable for irrigated conditions in *kharif/Sali* season. It is developed by ICAR-National Rice Research Institute, Cuttack and released in 2020 for Maharashtra and Gujarat. It is tolerant to leaf folder. It is moderately tolerant to leaf blast, neck blast, brown and stem borer.

**RNR 15048:** It is also called Telangana Sona and has good cooking quality, this variety is resistant to blast, and suitable for both *Sali/kharif* and *Boro/rabi* seasons. This variety has low Glycemic index (GI) of 51 and has 5% more protein compared to the normal Sona Masoori having GI of 72, which is also useful for both diabetic and obesity patients. The grain yield of this rice variety is 6.0-7.0 t/ha and it matures in 150-155 days in Assam.

It is developed by Rice section, Agricultural Research Institute, Professor Jayashankar, Telangana State Agricultural University (PJTSAU), Rajendranagar, Telangana and released in 2015. This variety has short-slender grains and the plants are 105-110 cm in height.



Zinco Rice MS





## Knowledge Management Committee

Sl. No	Name	Designation	Department
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4	Dr. Debanand Das	Principal Scientist and Alternate Nodal officer	Directorate of Research (Agri.), AAU, Jorhat
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27	Dr. Rahul Priyadarshi	Specialist - Agriculture Research & Development	
<b>Assam Rural Infrastructure and Agricultural Services (ARIAS) Society</b>			
28	Mr. Baljeet Singh	Market Analyst cum Operations Specialist	
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<b>Department of Agriculture, Govt. Of Assam</b>			
30	Mr. Madhuram Patiri	Nodal Officer, APART, DoA	



*Round table meeting to improve rice value chain in Assam*



*Launching of rice value added products*



*Rice varietal cafeteria*

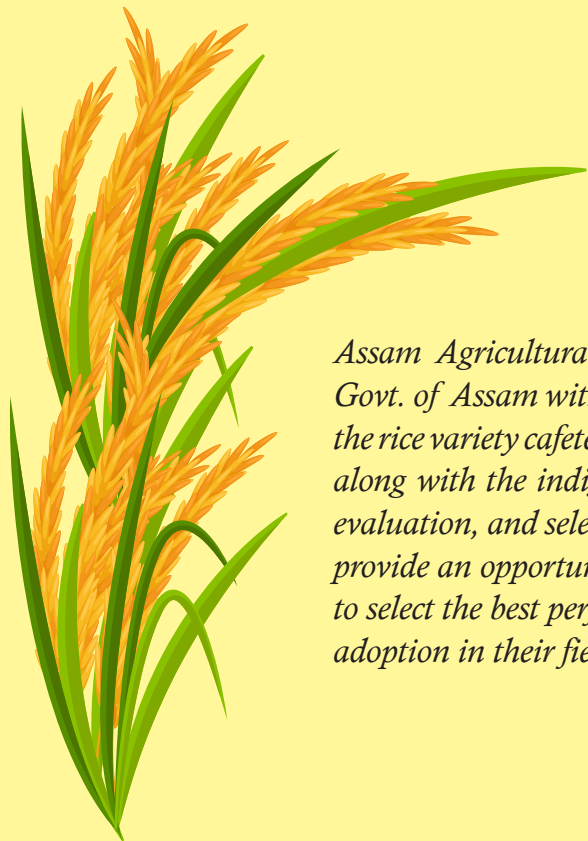


*Black rice products*





*Lunching of Black Rice varieties - Kalamalifula, Kalavati and Manipuri black rice in Assam*



*Assam Agricultural University and Department of Agriculture Govt. of Assam with the technical support of IRRI has introduced the rice variety cafeteria of the premium quality rice (PQR) varieties along with the indigenous rice varieties for comparative analysis, evaluation, and selection. The purpose of rice variety cafeteria is to provide an opportunity to the farmers and extension functionaries to select the best performing varieties of their preference for further adoption in their fields.*