



TRADITIONAL CULTIVATION OF RICE IN INDIA





Based on Akshat by Navdanya and other reports and publications of Navdanya

Rice is grown in almost all the states of India, but its cultivation is mostly concentrated in the southern states of Kerala, Tamil Nadu, Andhra Pradesh and Karnataka, but is also grown extensively in Maharashtra, Madhya Pradesh, Bihar, Orissa, West Bengal, Assam, Uttar Pradesh and Punjab. Rice has a long and deep history in the Indian subcontinent and forms a central part of almost every aspect of daily life- whether through its symbolic place in religious and ceremonial rites, its culinary importance as both a staple and gastronomic food, and its agrarian rhythms which have punctuated life in the field for millennia. This farmer and crop relationship throughout from Neolithic times to the present has developed a huge array of crop diversity, knowledge systems and cultural significance in each micro bioregion of India. As described below in these selected extracts from Navdanya's Akshat book published in 2006, each rice variety has co-evolved with its place, requiring the development of specialized knowledge systems which have guaranteed their continuity into the present. **This selection is a celebration of the work undertaken by the Navdanya organization to document, preserve and present the importance of traditional rice cultivation in India.**



Domestication and Centers of Origin:

The genus Oryza is small and consists of around 23 species. **Of all the species of Oryza, only two – O.sativa and O.glaberrima are cultivated.** The former includes the common rices cultivated all over the world, whereas, the latter is grown to a limited extent in Africa. All the other species are considered “wild rice” and are found in different parts of the world. O.sativa has been classified into two subspecies Indica and Japonica. Recent works demarcate another group, Javanica, consisting of rice exhibiting affinities of an intermediate nature between indica and japonica. These groups differ in several physiological and morphological features.

- 21 subspecies of wild rice, 2 are cultivated:
 - O. Glaberrima→ Africa
 - O. Sativa → Indica and Japonica

There are two centers of rice diversification- India and Japan

Indica:

Rice in Hindi: *Dhan*; Kannada: *Bhatta*; Tamil: *Arisi, Nellu*; Malayalam: *Nellu*; Telugu: *Odlu*; Bengali: *Dhan*; Sanskrit: *Dhanya, Vrihi, Syali*

There is a general consensus that rice was domesticated somewhere in India or Indo-china. The most significant archaeological record of rice in India is the identification of wild rice grains found at Chopani-Mando, where carbonised rice husks were found embedded in clay lumps dating back to 9000- 8000 B.C (advanced Mesolithic). Domesticated rice grains were also found at Koldihwa and Mahagara (a Neolithic archaeological site in Uttar Pradesh near the Belan river valley). The rice husks found at these two sites belong to the Neolithic era (6000-5000 B.C). All these sites are in the Central Gangetic Valley. Rice husks and spikelets have also been found at archaeological excavations in Lothal, Gujarat belonging to the Harappan civilization (2300 B.C). The presence of wild rice species (Oryza nivara, O.rufipogon, O.spontanea, O.mayeriana, O.officinalis etc), the enormous varietal diversity of cultivated rice, presence of many dominant genetic characters and the importance of rice in several religious rites of India lend support to the view of rice domestication and diversification in the Indo-China region.

Indica rice is generally adapted to the areas with a tropical monsoon climate. They are hardy, resistant to disease and tolerate unfavourable conditions, producing a fair yield, even under conditions of low management. They are usually tall, leafy, high tillering, sensitive to photoperiod and have a low response to nitrogenous fertilizers. Some traditional varieties lodge on excessive manuring. The grains are long, slender, and remain separate on cooking. **Indica rice is cultivated in the tropical monsoon regions including the Indian subcontinent, South East Asia and Philippines.**

Japonica:

Japonica rice on the other hand, have short stiff straw, are less tillering, less leafy, resistant to lodging and insensitive to photoperiod. They are less hardy, require better cultural conditions and respond readily to heavy manuring. The grains of japonica rice are short and bold and become a sticky mass on cooking. **Japonica rice is cultivated in temperate regions, exclusively in Japan, South Korea, North China, New South Wales and some parts of Europe and America.**



Preparation of land

Thorough preparation of the field is an important prerequisite to the cultivation of rice. In order to hold the water on the land, maintain it at the required depth and enable a continuous but gentle flow, bunding and leveling is essential. The land is divided by contour bunds into fields, the size and shape of which varies with the topography. In flat country, the fields may be one-fifth of an acre or more in extent. On steep hillsides, numerous terraces are cut and the fields are irregular and very small, generally smaller than one-tenth of an acre. The bunds are usually made of clay, mud and weeds with controlled openings for the outflow and inflow of water.

Temperature and humidity for Indica rice varieties

Rice demands high temperatures during its growing period ranging from 20- 38 degrees C. Weather conditions, especially air temperature and sunlight hours affect the onset of flowering. The rice crop cannot endure frost at any stage of growth, and therefore is a summer crop. Rain during the flowering stages can decrease the yield to a great extent as the pollen can be washed off and fertilization does not take place. But rain is required during the milk stage (grain setting stage) for formation of full grains. Grain yields are correlated with the amount of solar energy received, particularly during the last 45 days in the field.

Seed treatment, preparation and sprouting

Before sowing, the seed paddy is sometimes subjected to a preliminary process of selection. The seed paddy is poured into a vessel containing a common salt solution. The

floating light seeds are removed and only the heavy seeds that sink are used for sprouting. These selected heavy seeds give a better stand and an increased yield.



Soaking in water either overnight or a whole day generally affects the sprouting of the seed. The seed is put in pots, baskets, gunny bags or straw baskets and kept under water for twelve to twenty-four hours. The water is then drained, and the seeds heaped on the ground and covered with mats or leaves.

In parts of Karnataka, leaves of Castor (*Calotropis gigantea*, *Dodonia viscosa*, *Mirabilis jalapa*) and tulsi, are used. Several of these plants are known to be insecticidal and/or fungicidal.

On the third day, the leaves are removed, and water sprinkled on the heap, it is turned over and covered up again. Elsewhere, finely powdered cow dung and ashes are mixed with the seed at the time the heap is turned over. On the fourth day, the seeds are usually sprouted and ready for sowing.



The Diversity of Cultivation Systems- Dry and Wet Cultivation



Dry cultivation

Dry cultivation of paddy takes place only in regions receiving a fair amount of rainfall (at least 750 mm over a period of 3-4 months). It is also called rainfed rice or upland rice. The paddy crop cultivated in the Central Himalayas, Western Ghats and some mountainous tribal belts of Eastern Ghats are all rainfed. The paddy cultivation is done in terraced fields in the valleys of these regions. The varieties of paddy suited to this method of cultivation are usually early varieties, ready to be harvested in 80-90 days. Some of these varieties are considerably drought resistant and can withstand the vagaries of monsoon.



Farmyard manure is then spread, and the field is smoothed by a harrow to make the surface even for sowing. Seed paddy is either broadcast (seed rate 110 kg/hectare) or sown in rows using a regular 4-tyned drill (seed rate 80 kg/hectare) or through a bamboo tube, tied behind a plough and through which the seed is dropped in the plough furrow. The seed is usually harrowed in. The heavy rains usually start around this time and the rice plants grow under usual flooded conditions. In the course of around six weeks, weeding is done three or four times, and standing water is maintained in the field to the proper depth. The rest of the operations like harvesting and processing of grains is identical to wet cultivation.



Wet or puddle cultivation

This type of cultivation is done where water is abundant and guaranteed throughout the season. In some parts of India, wet cultivation methods can rely on either or a combination of irrigation and rainfall. The crop is started and continued halfway through just as a dry or rain fed crop. After the monsoon though, water is let into the fields through irrigation channels.

The cultivation of paddy by the puddle system is carried out in three different ways; in one, the seed is sown untreated, in another, the seed is sown after being sprouted, and in the third, seedlings are separately raised in a nursery and are then transplanted in the puddle field. The preparation of the field, however, is alike for all the above methods.

Preparation of the soil commences about 3 to 4 weeks before sowing or transplanting. Ploughing of the soil is undertaken after the fields are flooded and the water stands around 2-3 inches deep in the field. Four to six ploughings are given with intervals of a few days rest, during which the water stands in the field. In some places a green manure crop is grown to be ploughed in, it is then cut down and ploughed into the water, where it rots and disintegrates in the intervals between the ploughings. In some cases, cattle manure is spread over the field and ploughed with one of the later ploughings. After these repeated ploughings, the soil and water attain a proper consistency and the field is then smoothed out either by a leveling board or by people walking over.

Floating rice

This kind of rice cultivation takes place in areas prone to deep flooding like the Gangetic alluvium of Bihar, Eastern Uttar Pradesh, and West Bengal. In these areas, prolonged flooding occurs during the monsoon period, therefore, rice is cultivated under deep submerged conditions often with 2-3 meters of standing water. The varieties grown under these exceptional conditions are photosensitive, resistant to submergence and of long duration. The seed is usually broadcast by the end of March to April so that the seedlings attain the required age before flood water starts entering the fields. The crop is normally harvested from the end of October to November. Basic field preparations are the same as in other areas, but special efforts are made to control weeds.

In some parts of the western coast of Southern India, special varieties of paddy are cultivated, in fields that are inundated with salt water at high tide. These varieties have become tolerant to saline conditions. This kind of rice cultivation is known as "Pokkali" in coastal Kerala. The seed is usually treated to cause germination. To keep up with the rising waters, some floating rice varieties show amazing growth rates – as much as 13 cm per day. Although yields may not be high, floating rice cultivation is worthwhile because of its negligible input costs and its adaptation to conditions of flooding.

Orissa's Beusaning and Chhattisgarh's Biyasi Cultivation Methods

In this unique system, seed is broadcast (at a higher seed rate than in transplanted rice) on lowland rice fields kept ready for sowing, just before the onset of rains in June. After the seedlings have germinated and they are a little over 5 weeks old, with the depth of water below the height of the seedlings, the fields are ploughed across. This causes displacement of the seedlings but at the same time the action of the plough serves to split some of the tillers. The action of the plough also uproots any weeds in the field and unlike the rice plants they are unable to re-establish themselves. The irregular gaps created after ploughing are filled up either by throwing clumps of seedlings in between the gaps at random, or systematically filling up the gaps by separated tillers. The latter is designated as a modified biyasi system or also known as "phalai".

The yields obtained from a phalai system of cultivation are comparable with the yields harvested from a transplanted crop. The basic principle of the phalai system and clonal propagation is the same, being the separation of the tillers. Clonal propagation, started and popularized by Dr. Richharia is a simple yet effective means of obtaining high rice production through splitting the tillers of a rice plant and planting them separately. The separated tillers (called clones) produce more tillers, each of which ultimately produces an earhead. Investigations have also revealed that the vegetatively propagated plants (clones) are superior to normal seed plants with respect to grain production, tolerance to environmental stress and drought resistance to diseases, pests, flood and salinity and have a comparatively non-lodging habit.

After sowing "when the seeds have sunk into the soft mud, the water is drawn off for a day. The next day, the water is let in again and made to stand one inch deep. This alternate watering and draining is continued for a week to ten days until the seedlings are well up and can stand heavier irrigation. Cattle manure or oilcake may be applied on one of the days when the field is drained off. After about 3 weeks from sowing, the first weeding is done and manure is added. Repeated weeding is undertaken, and more manure added if required. Fields can also be fertilized with cow urine, green manure, ash, vegetable waste and straw, as traditional rice varieties have low response rates to nitrogen fertilizer.

Water is allowed to remain up to about 4 inches tall in the field in a state of slow continuous flow, until almost up to the harvest. Shortage of water during growth results in poor development of the earheads, smaller grains and too much chaff. Water is cut off only about 10 days before harvest and just before harvesting commences, the fields are further drained by means of small furrows.

Variety Diversity and Biodiversity in the Field

From a wild aquatic grass, Indian farmers, over the centuries, selected and cultivated thousands of varieties of rice. No other cultivated crop has been developed to such an extent, to fit thousands of ecological niches all over the country, from the temperate high hills of the Himalayas to the Tropical lowland deep water and salt-water marshes of the seacoasts. The varietal diversity of cultivated rice in India can be considered to be the richest in the world with the total number of varieties estimated to be around 200 thousand, of which 10 to 15 thousand were high yielding in the past. For example, in the Jeypore tract of Orissa, the extent of diversity is evident from the fact that over 1500 morphologically distinct varieties have been found cultivated.



Hence, rice grain colour, quality and scent can have an extensive variety. Colors can include purple, black, brown, red and white. Rice length and texture can be from fine and elongated, to round oval or short rice. There is the distinction of scented aromatic rice varieties and unscented rice and glutinous rice.

Farmers' varieties have high grain yields, and high straw yields, which help to further increase soil fertility as well as its capacity for retaining moisture, as straw is either used as green manure, or as fodder for cattle, which in turn produce manure for the soil. In addition, farmers' varieties have been selected for their long-term ability to withstand several stresses and

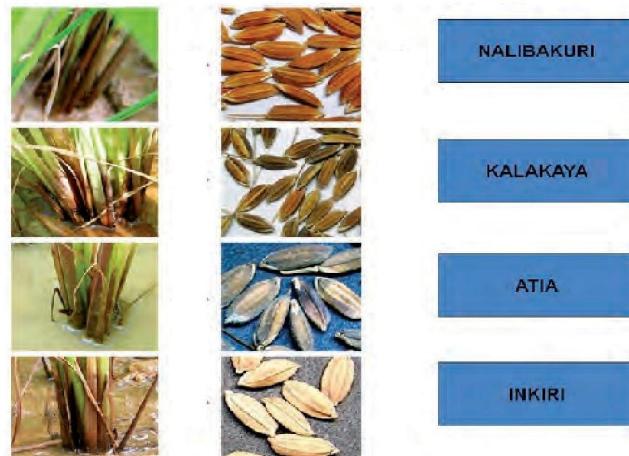
yet produce consistent yields. Thus, farmers' varieties are ecologically sound varieties as well as food security sound varieties.

The resilience and wide adaptability of farmers' varieties is clear from the fact that while commercial and public sector varieties of salinity resistant rice failed to rehabilitate agriculture in Ersama, Orissa in the aftermath of the super cyclone and floods of 1999, a farmers' variety from the Navdanya Project in West Bengal proved extremely successful and is today in high demand. Farmers have developed and have been using these varieties for over hundreds of years. (Navdanya, Seed Freedom, pg. 65-66) Several wild rice species and many indigenous rice varieties have also been found to possess pest resistant characteristics. And in Nepal, for instance, two farming communities in the same valley developed new rice varieties for high-altitude areas.

Drought Resistance

Rice displays tremendous variations in the two traits that allow it to survive drought conditions. The first, which is dependent upon the root, its extent, thickness, depth, branching, regrowth capacity, and penetration capacity, which all contribute to drought avoidance. The second, which determines true drought tolerance, is due to osmotic adjustment, wherein osmosis begins quickly with the onset of moisture stress.

PPBSA - NAVDANYA, ORISSA ACCESSION AND
CONSERVATION OF DROUGHT TOLERANT RICE VARIETIES



Navdanya seed banks in India have conserved 55 drought tolerant varieties in Uttarakhand; 69 in West Bengal; 4 in Orissa that can withstand drought for a month; 39 in Kerala; 8 in Karnataka.

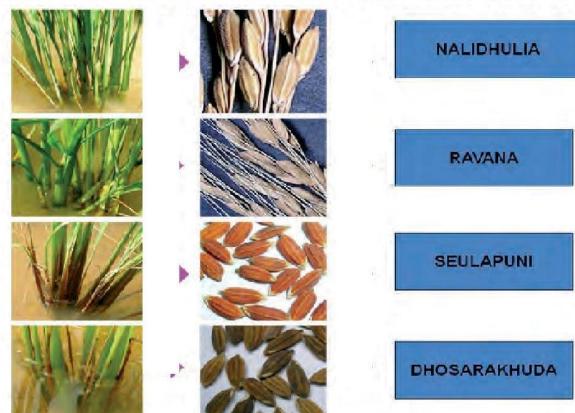
Flood Resistance

The first type of resistance is the ability to withstand submergence. The second is exhibited by rice varieties that grow exceptionally tall and fast, and thus keep their leaf canopy above the rising water level.

Submergence Tolerance

Submergence for more than 2-3 days can kill ordinary rice varieties. There are however, some traditional cultivars that can survive complete submergence for 12-14 days, and some varieties that can withstand it for even longer periods. Tolerant varieties accumulate more starch and at a more rapid rate than other varieties, and these reserves are used by the plant to produce energy and stay alive during submergence.

PPBSA - NAVDANYA, ORISSA ACCESSION AND
CONSERVATION OF FLOOD TOLERANT RICE VARIETIES



Stagnant Deepwater Tolerance

These varieties survive submergence by internal elongation of the leaf sheath, leaf blade, and internodes so the leaf canopy is always kept above the water. Deepwater rice varieties, like submergence resistant varieties, also accumulate starch before the flooding occurs. However, unlike the other submergence tolerant varieties, they utilize this starch for rapid growth when they're submerged. For example, some floating rice varieties elongate by as much as 15 cm per day while submerged.

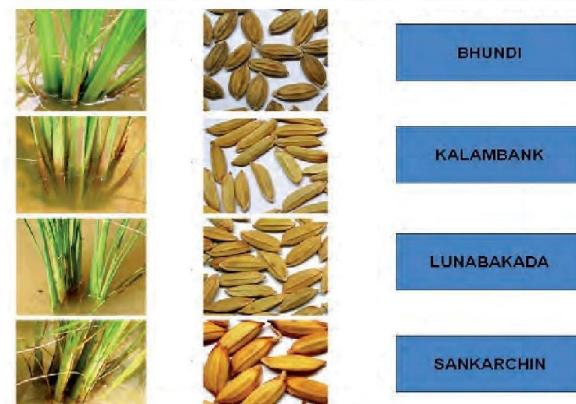
The yield of these elongating rice depends primarily on the maximum water depth and ranges from about 10 qt/ha in very deep areas to about 30 qt/ha in shallow (50-100 cm) areas. In very deep areas where floating rice is grown, good stand establishment and control of pests, weeds and stem borers in particular, contribute to increasing yield.

Principal among these varieties are the Assam 'Aman' paddy varieties which have the capacity to grow as fast as the water rises – sometimes as much as 20 to 23 cm overnight, if the water rises suddenly. The plant is able to support these quick growth spurts due to its ability to take in the nutrients present in the flood waters with the help of nodal roots, while at the same time, drawing up food supplies from the soil. These paddies thus give good yields, regardless of the stressful conditions. Of the various varieties of Aman paddy, the most popular is Prasad Bhog (offering to the gods).

Salinity Resistance

India has a wide variety of rice that exhibit salinity resistance, particularly in the coastal regions of Kerala and Karnataka (rice varieties in this region are both flood and salt tolerant); as well as in the mangroves of Bengal where varieties such as Matla, Getu and Hamilton can tolerate up to 14% salinity and need little attention until harvest. These conditions can be found in areas such as the Kole lands in Thrissur-Malappuram; Kuttanad, Uttara Kannada, and the Karnataka coast as well as the North Kerala Kannur, and Kasargod districts where the "Kaipad Cultivation" method is practiced.

PPBSA - NAVDANYA, ORISSA ACCESSION AND CONSERVATION OF SALT TOLERANT RICE VARIETIES



There are four types of salinity 1) coastal salinity, 2) inland salinity-alkalinity by interflow, 3) groundwater salinity - alkalinity, and 4) surface water salinity-alkalinity.

Rice in the first two types is usually rainfed. Salinity in the last two cases is primarily due to water-intensive, chemical-based rice monocultures of the green revolution which create soil alkalinity and salinity due to the killing of the soil biome and absence of soil carbon. The salinity exhibited in coastal regions and the kind caused by interflow is usually lower than salinity found in irrigated soils, as the former are usually inundated periodically. In cases of salinity caused by irrigation, the constant drawing up of groundwater to the surface, puddling of transplanted rice and the use of chemical fertilizers leads to constant increase in salinity of the soil.



Aromatic rice

Aromatic rice in India has long been prized for its scent, quality and auspiciousness and has historically enjoyed high regard from Indian high society. Basmati being the most famous.

The diversity of aromatic rice carries a diversity of aromas, with some smelling like fried green gram and others like cumin seed.

The difference between basmati and non basmati aromatic rice-

India grows 650,000 tonnes of Basmati annually. Basmati covers 10-15 percent of the total land area under rice cultivation in India with exportation going to more than eighty countries around the world.

Basmati has a long slender grain with moderate to strong aroma. It is typically grown in Uttar Pradesh, Uttarakhand, Himachal Pradesh, Kashmir, Haryana and Punjab.

Non Basmati has some of the basmati characteristics but not all. Most commonly have small or medium kernel length instead of the characteristic long slender grain.



Traditional Significations and Medicinal Uses of Rice:

In India, each traditional rice variety has its own cultural significance in its place of origin. But since ancient times there have been several ancient Indian texts and scriptures that have mentioned the different varieties of rice, the use of different rice preparations as offerings in rituals and the medicinal and recuperative properties of the crop. During the later Vedic period, the rice crop was established enough to be identified with "Prana" or breath and prosperity. In the Jakas and the Sutras there is also mention of rice being used as a form of remuneration for both domestic and agricultural workers and that it was paid as tax to the king.

Religious significance

In religious contexts rice is also associated with birth, marriage and funeral ceremonies of several communities in India. While several festivals of India are directly related to the different aspects of agricultural life in the village communities, which celebrate the occasion of sowing (Akshya tritiya) and transplanting of paddy, arrival of the monsoon (Adi-perukku) and harvesting. Examples of these festivals include: Pongal in Tamil Nadu; Onam in Kerala; and the Akti festival in Chhattisgarh. In the South, rice grains mixed with turmeric and kumkum are considered auspicious. It is called "Akshata" and used as a symbol of blessing in various ceremonies.

Medicinal Properties in some varieties are listed in the Jatakas, Puranas and ancient medical literature of Charaka and Susruta, with a few being considered therapeutic, as well

having the tissue rejuvenating potentialities as required in traditional Indian medication. The 'Kolpi' variety is recommended to be eaten by the elderly due to being easy to digest. Several rice preparations are used as a diet for dysentery, urinary infections, respiratory tract infections and other diseases.

In Pondicherry, a rice variety – Chengalpattu Sirumani (Samba) – is noted for its nutritional value and has been fed to women immediately after delivery from ancient times. It is also said to increase milk production in lactating mothers.

In Kerala, the variety Navara is believed to have medicinal properties and is used to rejuvenate the nerves in paralytic conditions. Oridine, an alkaloid present in rice, has some anti-neurotic properties when impure.

Clean water used to rinse rice (initial rinses) has been used for gargling to soothe mouth ulcers.

In China, for example, black rice is believed to have a body-strengthening value. Thus, it is known as "blood strengthening rice", "drug rice" or "(con) tributed rice". Black rice, which has a pigment level of 1 mg per 100 g rice, has 3 mg vitamin C and 0.2 mg riboflavin per 100 g and has more iron, calcium and phosphorus than non-pigmented rice.



Pests & Disease Control with Biodiversity



The major pests of the rice crop are the stem borer (*Heiroglyphus banian*), the gundhi bug (*Leptocoris acuta*), brown plant hopper – BPH (*Nilaparvata lugens*) and the swarming caterpillar/armyworm (*Spodoptera mauritia*), gallfly (*Orseolia oryzae*), the rice caseworm (*Nymphula depunctalis*), the green beetle pest (*Leptisma pygmaea*) and the rice hispa (*Hispa armigera*).

Beneficial insects, such as spiders, dragonflies, damselflies, robber flies, ladybugs, wasps and water striders, control almost 95% of insect pests. A “chemical-free” rice field in the tropics supports 800 species of these “friendly insects”. In some places young ducklings are herded into the rice fields and have been found to reduce pest populations by 65 to 75%. Ducks also eliminate damage causing snails. Bacterial control of insect pests (at the caterpillar stage) using such species like *Bacillus thuringiensis* has also been found to be quite effective.

During the milky stage, birds and rats also feed on grains. In this case, perches can be made for predatory birds, or sound boxes rattled from perches to scare off birds. Crabs which can damage bunds can be controlled by luring them with oil cake into a pot stuck into the ground to where they can then no longer get out. Crabs then can also become an additional food source.

Many types of botanical pesticides can also be used, as well as in Tamil Nadu technique of planting a rice variety highly susceptible to stem boar in between the rice fields so all the pests feed only on that one.

Disease control

Fungal diseases can include blast, brown spot, narrow brown leaf spot, foot root disease, and false smut. Viral diseases can include grassy stunt and tungro virus transmitted by the brown planthopper.

The Warlis tribe put leaves of catechu (*Acacia catechu*) at the inlet of paddy fields to cure brown spot. Leaf extracts of tulsi, betel vine (*piper betel*) and parijatak (*Nyctanthes arbortristis*) and lemon have been found to be potent fungicides to cure blast, brown spot and sheath blight diseases, respectively, in rice. Extracts of the fruit rind of pomegranate at a concentration of 10 grams per litre and other tannin bearing plants show positive inhibition against *Piricularia oryzae*. The smoke from mahua (*Madhuca indica*) oil cake was used in the Central Himalayas to control blight on rice. Green manuring with prickly sesban (dhaincha – *Sesbania cannabina*) or sann (*Crotalaria juncea*) has been seen to reduce sheath blight. Spraying of cow dung slurry (2kg to 10 liters of water) can minimize disease development and the spread of bacterial blight. Neem leaf extract controls BPH that is then unable to transmit the grassy and ragged stunt viral diseases of rice.



Mixed cropping

In Garhwal, fields are rain-fed and pink and green-eared barnyard millet (*Echinochloa colona*) is sown on bunds. For example, in the Chamoli district, "Kauni" (foxtail millet) and "Jhangora" (barnyard millet) are sown as bordering the rainfed rice fields. In the case of transplanted rice fields, "Urad Dal" (black gram) is sown along with the paddy seeds. In both rainfed and terraced fields, Ragi (mustard) and the traditional variety of soybean, referred to as bhat, are sown sparsely on the bunds.

In Tamil Nadu, moth beans (*Vigna aconitifolia*) and pearl millet (*Pennisetum typhoides*) are sewn together along with the rice.

In the dry tracts of Karnataka, rice is grown in mixtures with dry crops like pigeonpea or cotton.

In Madhya Pradesh, as well as in Chhattisgarh, a unique double cropping system is practiced. Seeds of rabi (spring) pulses like urad, masoor, pea, gram and linseed are broadcasted among standing rice crops just before or after water is finally drained out from the field, sometime in mid-October. The young seedlings grow in the shade provided by the rice plants and are protected from the harsh October sun. After the rice is reaped in November the plants are strong enough to make their own way. This second crop after rice is known as "Utera".



Crop Rotations

In areas where water is available in more than one season and the soil is suitable for dry season cultivation, **rice is rotated with crops like wheat, ragi, sugar cane, vegetables, barley and mustard**. In some other cases the land is left fallow after the main crop of rice is reaped. In another rotation method practiced, rice is grown once in the course of 3, 4 or even 5 years, during the latter period of which either single crops like plantains or betel leaves or a series of crops like turmeric, chillies, tobacco, irrigated cotton, groundnut, irrigated ragi, sorghum and so on occupy the land, creating longer cycle of crop rotations. While in parts of India where irrigation is assured and the climate is suitable, rice is grown continuously throughout the year without any rotation.

In most regions of North and Central India, wheat, barley, sugarcane, sesame and pulses follow the kharif (summer) crop of rice. One traditional system uses rice, rabi, sunn or Indian hemp (*Crotalaria juncea*) in the first year and rice and any other leguminous crop other than sunn in the second year. For example, in Bihar maize or millets are also grown in rotation. In Uttar Pradesh and the Central Himalayas after the kharif crop harvest, radish, mustard or wheat is usually sown. In Bengal, pulses, jute, sugarcane, oilseeds, potatoes or winter vegetables, are among the crops grown. In jute growing lands, paddy, pulses, oilseeds and sugar cane are rotated on a three-year basis.

In drier regions such as Karnataka, for example the Dharwad district, sugarcane is grown once every third year. Leguminous crops like moong, lab lab beans, cluster bean and chickpea are also grown after rice.

In the wetlands of Andhra Pradesh rice is rotated with fodder crops like sunn hemp or legumes like blackgram and green gram.

In Tamil Nadu rice is grown as the kharif crop followed by ragi or jalo (sorghum) as the monsoon crop or rice is grown during the monsoon followed by sugarcane. In the above rotation, a vegetable crop is grown between the sugarcane and the rice crop.

In Kerala sesame is grown after the principal rice crop has been harvested in October – November.

Along coastal Regions of Kerala the traditional crop rotation system of "**Pokkali**" or "**Chemmeen Kettu**" is practiced where shrimp cultivation is undertaken in the same field after the rice crop is harvested (around October – November). The fields are inundated with water from the river channels, which bring in the prawn larvae. After they are fully grown, the prawns are harvested. The water inflow and outflow is controlled by a sophisticated system of sluice gates. This unique farming system requires no inputs and only certain specific traditional varieties of rice (eg. Pokkali) are suited to the waterlogged and saline conditions. Fish are also allowed to grow in these fields and this supplements the diet of the coastal communities.

Harvest, Storage and Uses



The grain is ripe about 30 – 40 days after flowering. Early varieties are harvested after one month, late varieties are harvested at around six weeks. The ready rice crop is harvested traditionally with a hand-sickle and piled up in a circular pattern with pinnacles toward the center to provoke the ripening of immature grains. This circular stacking also facilitates the dropping of grains during the threshing process. Threshing is usually done over a hard surface, by either rubbing the stalk with feet or being trampled by cattle. Grains are then winnowed to separate extra chaff. After winnowing, grains are then dried further and set aside for storage. When needed the grains are taken to the rice mill for dehusking or pounded at home for consumption.

Ratoon Crops:

To make the harvest easier, and to achieve an equal degree of ripening, water is drained off 2 -3 weeks before the harvest date. **Growth of the plant can be restimulated after the harvest** if there is enough humidity and warmth. If the rice straw is cut just above the surface of the ground, new tillering takes place and this second crop is called a "**ratoon crop**". With careful cultivation, the first ratoon ripens 10 -20 days faster than newly planted rice and gives a 20 – 30% better yield. The utilization of water is also about 100% improved in the ratoon.

Yields

The minimum yield required for a rice variety to qualify as "high yielding", as fixed by Dr. Richharia is 14.82 quintal/acre or 37.05 quintal/hectare (equivalent 725.4 kg/ acre or 1813.6 kg/ hectare) . Traditional varieties are often termed as low yielding and deemed as unsuitable to meet the food requirement of the growing population. But, several surveys have indicated that there are many traditional varieties which can give as high yields and even more than those of Green Revolution HYVs. For example, Richaria's highest yield was 54 quintals per acre or 13.6 tons per hectare achieved in Salem and the lowest yield was 24 quintals per acre or 6 tons per hectare achieved in West Bengal from his indigenous improved rice varieties.

Some of these high yielding indigenous varieties of Madhya Pradesh are listed below

Rice Variety	Yield in Kg / Ha	Yield in Kg / Acre
Amar Jyoti	3750	1500
Rani Kajar	5625 – 6562	2250-2625
Chattri	3750	1500
Dubraj	3750-4687	1500-1875
Luchai	5625-6562	2250-2625
Mokdo	3700-4700	1480-1880

(Survey done by Dr. Richharia in 1973-74)

Storage and other uses

Storage of rice grains greatly improves the cooking quality of rice. Fresh and new rice is difficult to cook since it turns pasty. Whereas rice from paddy stored for about 6 months cooks easily. Old rice swells to about four times its volume whereas fresh rice does not yield even half as much when cooked. For milling rice must be par-boiled before milling for up to three days and then steamed at low pressure. Then it is dried and milled and hand pounded. This results in less breakage during milling and higher retention of nutrients, allowing for

better storage. During this method of parboiling, part of the layer between the husk and the rice kernel passes into the body of the kernel.

Husked and hulled rice is usually called brown rice and is known to have a higher nutritional value. Whereas polished white rice is rice where the outer layers of the germ and the bran have been removed also causing the removal of much of the protein, fat, vitamins and minerals (especially Vitamin B1). From the grain, parched rice, rice flakes and puffed rice are also made.

Other parts beside the rice grain hold many daily uses and rarely go to waste. Rice straw is commonly used as fodder, fuel, cattle bedding, for thatched roofs, basket weaving, cushions, sandals, necklaces and personal adornments. If the straw comes out too coarse, it is used as fuel or for manuring fields. Rice husk is also used as fuel for parboiling, as a binder in mud plaster and mortar for construction and insulation, and can make a colored yellow-brown dye. Rice husk or straw ash is used in fields for insect control, for cleaning and is even used as an industrial ingredient for grease absorption as it is rich in silica. Leftover rice bran used for animal feed, and to produce oil, soaps, and wax.

The Example of Chhattisgarh

From: Women, Seed and Food Sovereignty from Chhattisgarh by Illina Sen, Rupantar, Navdanya's Seed Freedom Report

Chhattisgarh has traditionally been known as the rice bowl of India and has had an amazing variety of food production systems. It is one of the last places on the earth to have a remembered history of an enormous diversity of food resources. These include indigenous rice varieties capable of giving the equivalent of, or even higher yields than the Green Revolution varieties.

These varieties are adapted to various micro ecological conditions: some have maturity periods which range from 55 days to more than 180 days; while some can be drought resistant, and have water tolerance capacity. There are low rainfall area varieties and deep water ones, short rice varieties of a height of 50 cm, to tall varieties that can reach more than 150 cm.

The grain size also varies from short fine to long fine; long bold to short bold and round; oval ones, beaked and awned ones; awned with various colours, sizes and shapes. The kernel may be coloured white, dull white, red opaque and the grain can be of one of many possible colours. The grain may be scented or unscented. The world's longest rice "Dokra-Dokri" is found in Chhattisgarh.

Rupantar's own collection and accession of seed varieties exceeds 2000 in number, and each type is adapted to a different eco-climatic region, just as each has its own demand for production related protocol and knowledge systems. **This is because the diversity in crops is matched by the diversity in production techniques.**

For example, "Laichopi" is a production system in which the seeds were germinated in a controlled environment and then sown. This technique is very useful in areas or years where

the rains came early, and the fields did not retain enough warmth for in situ seed germination.

To cover seed shortage, farmers practice the technique of *chaalna*, in which broken earheads were replanted in the soil using the method of clonal propagation.

Wild Foods Found in Rice Fields

There is a large range of leaves from trees, creepers , bushes and shrubs that are eaten. Some of these like the tinpania and chanori bhajis grow naturally in the many rice fields after the rice harvest. As a matter of fact, the distinction between what is a bhaji and what is a weed is a product of the philosophy of agricultural monoculture that is in complete contradiction to the culture of biodiversity prevalent in Chhattisgarh

Seed Conservation

In traditional Chhattisgarh, the crop to be harvested as seed is identified in the field of standing crop, and women always took special care while reaping these. A wide variety of seed storage structures were used in subsequent stages, and the exact storage structure used for seed depends on the length of time the seed was needed to be stored away, the moisture content, and other factors. Some seeds like rice are even today stored in bamboo dholgi (or dhongis), thatched and sealed with cow dung, and kept away. These can last for up to three years.

Community systems in tandem with biodiverse systems

The amazingly complex production system of this region is also accompanied by a distribution system that is equally as comprehensive. The Charjaniha (literally meaning belonging to several people) is a community based grain bank, found in several areas of the southern hills, with variants seen among the different tribal groups of the area. Procurement is through voluntary contributions, and/ or preferential collection from the more affluent families, or those wishing in any given year to donate to a public fund. Community collections through the Cherchera rituals or through groups of women dancing the Relo, also go to build up the collection. The Charjaniha resources can be held in paddy, in the minor millets, and even in an NTFP product like Mahua, and are used for community functions, as well as for distribution to individual households during drought years.

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RICE DIVERSITY

