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STUDY ON ORIGIN RICE IN INDIAN SUBCONTINENT

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Abstract: Rice (*Oryza sativa* L.) is one of the oldest and globally most important staple crops. The tradition of rice cultivation spans several millennia, a multitude of cultures and diverse ecogeographic regions from Iran, across the Indian subcontinent, to East and Southeast Asia. Phenotypic diversity found in rice cultivar groups and traditional landraces mirrors this richness of agroecological settings and the complex population histories. The rice plant is a member of Poaceae (old Gramineae) family. The common cultivated rice plant is an annual which usually grows to a height of a half meter or two meters but there are certain varieties that grow much taller (6-9 metres). Some deep water rice varieties grow with the gradual rise of the flood water level.
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Introduction

Oryza Sativa, it is believed, is associated with wet, humid climate, though it is not a tropical plant. It is probably a descendent of wild grass that was most likely cultivated in the foothills of the far Eastern Himalayas. Another school of thought believes that the rice plant may have originated in southern India, then spread to the north of the country and then onwards to China. It then arrived in Korea, the Philippines (about 2000 B. C.) and then Japan and Indonesia (about 1000 B. C.). When Alexander the Great invaded India in 327 B. C., it is believed that he took rice back to Greece. Arab travelers took it to Egypt, Morocco and Spain and that is how it travelled all across Europe. Portugal and Netherlands took rice to their colonies in West Africa and then it travelled to America through the 'Columbian Exchange' of natural resources. But as is traditionally known, rice is a slow starter and this is also true to the fact that it took close to two centuries after the voyages of Columbus for rice to take root in the Americas. Thereafter the journey of rice continues with the Moors taking it to Spain in 700 A. D. and then the Spanish brought rice to South America at the beginning of 17th century.

The journey of rice around the world has been slow, but once it took root it stayed and became a major agriculture and economic product for the people. In the Indian subcontinent more than a quarter of the cultivated land is given to rice (20011-12). It is a very essential part of the daily meal in the southern and eastern parts of India. In the northern and central parts of the subcontinent, where wheat is frequently eaten, rice holds its own and is cooked daily as well as on festivals and special occasions.

India is an important centre of rice cultivation. The rice is cultivated on the largest areas in India. Historians believe that while the indica variety of rice was first domesticated in the area covering the foothills of the Eastern Himalayas (i.e. north-eastern India), stretching through Burma, Thailand, Laos, Vietnam and Southern China, the japonica variety was domesticated from wild rice in southern China which was introduced to India. Perennial wild rice still grow in Assam and Nepal. It seems to have appeared around 1400 BC in southern India after its domestication in the northern plains. It then spread to all the fertiled alluvial plains watered by rivers. Some says that the word rice is derived from the Tamil word arisi.

Rice is first mentioned in the Yajur Veda (c. 1500-800 BC) and then is frequently referred to in Sanskrit texts. In India there is a saying that grains of rice should be like two brothers, close but not stuck together. Rice is often directly associated with prosperity and fertility; hence there is the custom of throwing rice at newlyweds. In India, rice is always the first food offered to the babies when they start eating solids or to husband by his new bride, to ensure they will have children.

Key Points

Paddy grains found during excavation at Hastinapur (India) around 1000-750 B.C. considered as an oldest sample in the world. Southwest Himalayas has various types and varieties and indicated probable centre of origin.
De Condolle (1886) and Watt (1862) mentioned south India is the centre of rice origin.

Vavillov suggested that India and Myanmar should be regarded as the centre of origin of cultivated rice.

According to D. Chatterjee (1948), there are altogether 24 species of genus Oryza of which 21 are wild and two viz., Oryza sativa and Oryza glaberrima are cultivated. Oryza sativa is grown in all rice growing areas, but Oryza glaberrima is confined to the West Africa only.

Thus it indicates that there might have been two centres of origin of our cultivated rice; South-eastern Asia (India, Myanmar and Thailand) and West Africa

Importance of Rice

Rice has shaped the culture, diets and economic of thousand of millions of peoples. For more than half of the humanity " rice is life". Considering its importance position, the United Nation designated year 2004 as the "International Year of rice. Importance of rice are as follows:

a. Rice is an important staple food crop for more than 60 per cent of the world people. In 2008, more than 430 million metric tons of rice were consumed worldwide, according to the USDA.

b. Ready to eat products eg. popped and puffed rice, instant or rice flakes, canned rice and fermented products are produced

c. Rice straw is used as cattle feed, used for thatching roof and in cottage industry for preparation of hats, mats, ropes, sound absorbing , straw board and used as litter material.

d. Rice husk is used as animal feed, for paper making and as fuel source.

e. Rice bran is used in cattle and poultry feed, defatted bran, which is rich in protein, can be used in the preparation of biscuits and as cattle feed.

f. Rice bran oil is used in soap industry. Refined oil can be used as a cooling medium like cotton seed oil / corn oil. Rice bran wax, a byproduct of rice bran oil is used in industries.

Scientific Name:

The two major rice varieties grown world wide today are Oryza sativa indica and Oryza sativa japonica. The two cultivated rice species, Oryza sativa L. and O. glaberrima Steud., belong to a species group called Oryza sativa complex together with the five wild taxa, O. rufipogon (sensu lato), O. longistaminata Chev. et Roehr., O. barthii A. Chev., O. glumaepatula Steud., and O. meridionalis Ng. Among these taxa, only O. rufipogon produces fertile F1 hybrids with O. sativa and therefore these two species are considered to belong to a single biological species. Together with all circumstantial evidence, this suggests that O. rufipogon is the ancestor of O. sativa. Similarly, it leaves no doubt that O. barthii is the ancestor of African rice O. glaberrima.

Rice Growing Region in India

Rice is grown under so diverse soil and climatic conditions that it is said that there is hardly any type of soil in which it cannot be grown including alkaline and acidic soils. Rice crop has also got wide physical adaptability. Therefore, it is grown from below sea-level (Kuttanad area of Kerala) upto an elevation of 2000 metres in Jammu & Kashmir, hills of Uttaranchal, Himachal Pradesh and North-Eastern Hills (NEH) areas. The rice growing areas in the country can be broadly grouped into five regions as discussed below:

i. North-Eastern Region:This region comprises of Assam and North eastern states. In Assam rice is grown in the basin of Brahmnaputra river. This region receives very heavy rainfall and rice is grown under rain fed condition.

ii. Eastern Region This region comprises of Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Orissa, Eastern Uttar Pradesh and West Bengal. In this region rice is grown in the basins of Ganga and Mahanadi rivers and has the highest intensity of rice cultivation in the country. This region receives heavy rainfall and rice is grown mainly under rain fed conditions.

iii. Northern Region: This region comprises of Haryana, Punjab, Western Uttar Pradesh, Uttrakhand, Himachal Pradesh and Jammu & Kashmir. The region experiences low winter temperature and single crop of rice from May-July to September-December is grown.

iv. Western Region: This region comprises of Gujarat, Maharashtra and Rajasthan. Rice is largely grown under rain fed condition during June-August to October - December.

v. Southern Region: This region comprises of Andhra Pradesh, Karnataka, Kerala and Tamil Nadu. Rice is mainly grown in deltaic tracts of Godavari, Krishna and Cauvery rivers and the non-deltaic rain fed area of Tamil Nadu and Andhra Pradesh. Rice is grown under irrigated condition in deltaic tracts.

Rice (Oriza sativa L.)

Rice (Oryza sativa) is the major food crop in the world. Nearly 40% of the world population consumes rice as the major staple food. Most of the people, who depend on rice as primary food, live in the less developed countries. Archeological evidence on rice in India dates back to 1500-1000 B.C. Since the dawn of civilization, rice has served humans as a life-giving cereal in the humid regions of Asia and, to a lesser extent, in West Africa. Introduction of rice into Europe and the America has led to its increased use in human diets. There are 42 rice producing countries throughout the world but China and India are major

rice production centers. Rice is grown in wide range of agro-climatic conditions ranging from mountainous (Jammu) lands to low land delta areas (Sundarban), spanning an area from 53° latitude north to 35° south of the world but about 90% of the crop is grown and consumed in Asia. Rice provides fully 60% of the food intake in Southeast Asia and about 35% in East Asia and South Asia. The highest level of per capita rice consumption (130-180 kg per year, 55-80% of total caloric source) takes place in Bangladesh, Cambodia, Indonesia, Laos, Myanmar (Burma), Thailand, and Vietnam (Kenneth and Kriemhild, 2000). In many cultures of the world rice is the central part of people's life and culture. Rice is an excellent food and is an excellent source of carbohydrates and energy.

During last 50 years, world rice area has increased by 1.37 times from 115.50 to 159 m ha but production has increased three times from 216 to 685 mt and productivity has increased 2.3 times from 1.87 t/ha to 4.30 t/ha . China is the world's leading rice producer with nearly 125 million tones production. India possess largest rice area (45 m ha) producing nearly a quarter of Asia's production occupying second position after China (Moya et al., 2004). In India, Rice production and productivity showed a steady increase from the first five year plan to the tenth five year plan. Rice production has been increased during last six decades by nearly 481% or 4.8 times from 20.58 mt in 1950-51 to nearly 99.15 mt during 2008-09, whereas the average rice productivity has been increased 3.3 folds from 668 kg/ha in 1950-51 to 2186 kg/ha in 2008-09.

To feed the estimated world population of 9.1 billion by 2050 the overall food production has to be increased by 70% of the existing. The annual cereal production will have to grow by almost a billion tonnes. Crop yields will grow but at a slower rate than in the past. Although rice commands a higher price than wheat on the international market, less than 5% of the world's rice enters that market, contrasted with about 16% of the wheat. On the basis of mean grain yield, rice crops produce more food energy and protein supply per hectare than wheat and maize. Hence, rice can support more people per unit of land than the two other staples (Lu and Chang, 1980). It is, therefore, not surprising to find a close relationship in human history between an expansion in rice cultivation and a rapid rise in population growth (Chang, 1987).

As a human food, rice continues to gain popularity in many parts of the world where other coarse cereals, such as maize, sorghum and millet, or tubers and roots like potatoes, yams, and cassava have traditionally dominated. For example, of all the world's regions, Africa has had the sharpest rise in rice consumption during the last few decades. Rice is unquestionably a superior source of energy among the cereals. The protein quality of rice (66%) ranks only below that of oats (68%) and surpasses that of whole wheat (53%) and of corn (49%). Milling of brown rice into white rice results in a nearly 50% loss of the vitamin-B-complex and iron and washing milled rice prior to cooking further reduces the water-soluble vitamin content. However, the amino acids, especially lysine, are less affected by the milling process (Kik, 1957; Mickus and Luh 1980; Juliano 1985a.

Rice, which is low in sodium and fat and is free of cholesterol, serves as an aid in preventing hypertension. It is also free from allergens and now widely used in baby foods (James and McCaskill, 1983). Because rice flour is nearly pure starch and free from allergens, it is the main component of face powders and infant formulas. Its low fibre content has led to an increased use of rice powder in polishing camera lenses and expensive jeweler. Rice starch can also serve as a substitute for glucose in oral rehydration solution for infants suffering from diarrhoea (Juliano, 1985b). The coarse and silica-rich rice hull is finding new use in construction materials. Rice straw is used less in rope and paper making industries than before, but except for modern varieties, it still serves as an important cattle feed throughout Asia. In industrial usage, rice is also gaining importance in the making of infant foods, snack foods, breakfast cereals, beer, fermented products, and rice bran oil, and rice wine remains a major alcoholic beverage in East Asia.

On the research front, rewards can be gained by breaking the yield ceiling, making pest resistance more durable, and improving the tolerance to environmental stresses. Biotechnology will serve as a powerful force in broadening the use of exotic germplasm in Oryza and related genera (Chang and Vaughan, 1991). We also need the inspired and concerted teamwork of those various sectors of society that, during the 1960s and 1970s, made the "Green Revolution" an unprecedented event in the history of agriculture.

Origin and Classification

The primary centre of origin of the cultivated rice according to archeological and historical evidence is South-east Asia for O. sativa and Africa for O. glaberrima. The common ancestor to all rice is considered to be O. perennis and O. sativa is derived from perennial O. rufipogan and annual O. nivira, whereas O. glaberrima is derived from perennial O. longistaminata and annual O. barthii.

The cultivated species O. sativa has evolved into three geographical subspecies due to adaptation under diverse climatic conditions for a long period, they are i) O. sativa sub sp. indica, ii) O. sativa sub sp. japonica and iii) O. sativa sub sp. javanica. Marked sterility

barrier occur between these three sub-species. It ranges up to 80% in indica × japonica but to a less extent between indica and javanica cross.

The japonica subspecies are characterized by short, erect plant with compact panicles, pubescent spikelets and oval to round grains. These varieties are found mainly in Japan. The javanica subspecies are characterized by very tall, erect plants with long panicles and awned spikelets and are mainly grown in Indonesia. The indica sub species contains tall, spreading plant types with lot of variation in the morphological characters and are cultivated all over the tropical and sub-tropical Asia.

Rice belongs to the genus Oryza, family: Poaceae (Gramineae), tribe: Oryzeae. The genus Oryza is distributed throughout the tropics and subtropics of the world. It has 25 species out of which 23 species are wild and only two species viz. Oryza sativa and Oryza glaberrima are cultivated species. Oryza sativa is mainly cultivated in the Asiatic region where as O. glaberrima in Africa. The genus contains both diploid (2n = 24) as well as tetraploid (2n = 48) species. Based on genome analysis all the 25 species were grouped into nine distinct genomes, viz. A, B, C, D, E, F, G, H and J.

Morphology

Cultivated rice is an annual crop but some of its wild relatives are perennial in nature. The rice plant, typically a grass, consists of root, stem (culm), tillers, leaves and panicles at the terminal part of productive tillers. The plant height varies by variety and environmental conditions, ranging from 0.4 m in dwarf varieties to 5 m in some deep water floating rice.

Root

All the members of graminae family are monocots with adventitious root system. The primary root which results due to the prolongation of the radical is in turn supported by several adventitious roots. Generally taller varieties have a greater penetration of roots than shorter varieties. Similarly varieties with good tillering habit have well developed root system. The direct seeded crop develops deeper but poorly developed root system, whereas the transplanted crop has a shallow but well developed root system. In case of deep water rice varieties the nodal roots develop even on higher nodes as the plant elongates.

Stem

The Oryzae species stem like other grass plants consists of both underground rhizome and aerial pseudostem. This condition is more visible in the wild rice with perennial habit. Where as in the cultivated species there is no well differentiated rhizome. The stem above the ground level consists of solid nodes and hollow internodes and is commonly called as culm (Fig. 4.4). Based upon the habitat and species the elongation of internodes varies. The rapid elongation is observed mostly after the emergence of panicle from the flag leaf. The lowermost buds on the crowded nodes just at the ground level or below that develop into tillers. The tillering habit depends on varieties, spacing, fertilizers, and cultural operations. Tillering starts at 10 days after transplanting and reaches maximum between 40 and 50 days after transplanting (Arunachalam, 1984).

Leaf

The leaves arise from the nodes on the culm in two ranks. Each leaf is composed of a leaf sheath and lamina (Fig. 3.4). The junction of leaf sheath and lamina is called as junctura/collar, which is a triangular structure. At the base of the juncture a membraneous ligule and a pair of sickle shaped auricles are present on each side of the lamina. The ligule is oblong or blunt and 1-5 mm long in most species. The swollen base of the sheath, above the point of insertion on the culm, is called pulvinus. The main culm bears large number of leaves compared to tillers. The number of leaves on tillers decreases with the rise in tillering order. The last leaf on the culm is called flag leaf/ boot leaf and its lamina is shorter and wider than that of other leaves the angle of flag leaf is oriented more vertically than the preceding leaves. The tillers arise from auxillary buds and are enclosed by special leaves called prophyllus.

Inflorescence

The inflorescence in rice is a terminal panicle (Fig. 4.5). The stalk of the panicle is called peduncle and it is the last internode of the culm. The junction of the peduncle with the main axis of panicle is marked by a ciliate ring. In rice the exposure of portion of peduncle from the juncture of boot/flag leaf to ciliate ring is called panicleexertion and the degree of exertion varies between varieties. The main axis of the panicle called primary axis bears a number of secondary rachii. The secondary rachis further branches into tertiary rachii. The tertiary rachis in turn produces alternately arranged rachillae, which bears spikelets on their tips. The primary rachis contains hollow internodes but secondary and tertiary rachii are not hollow. The shape of the inflorescence in most rice species is oblong or fusiform.

Flower

The spikelet consists of two empty glumes (sterile glumes) and two fertile glumes, outer lemma and inner palea. Two transparent, fleshy structures situated at the base of spikelet are called lodicules,

which represents the reduced perianth. Inside lemma and palea, six stamens of 2.0-2.5 mm long, arranged in two whorls of three each and a purple shaded pistil containing single ovule with short slender style and bifurcated, plumose stigma are present. The empty glumes are generally single nerved where as lemma consists of five veins and palea.

Grain

The rice grain is typically a fruit called caryopsis and is oblong in shape. The outside hull consisting of lemma and palea encloses the caryopsis (brown rice). Brown rice consists of mainly outer pericarp followed by seed coat, nucellus, a small embryo towards ventral side and a large endosperm. In indica rice lemma, palea and rachilla constitute the hull where as in japonica rice the hull is made up of mainly rudimentary glumes and sometimes a portion of pedicel. A single grain weighs about 10-40 mg. The hull constitutes nearly 20% of the total grain weight. The grain length and width varies among varieties.

Grain Quality

Grain quality is mainly a varietal character but also depends to some extent on environment, processing and handling systems. The removal of hull covering the caryopsis (brown rice) is called dehusking. The percentage of dehusked kernel to that of paddy is called hulling percentage. The removal of outer bran from the brown rice using polisher is called milling. Rice bran includes outer pericarp, seed coat, nucellus and aleurone layer of endosperm of brown rice. Percentage of polished grain to that of paddy is called milling percentage. Thus for a given sample of paddy about 70% of milled rice is obtained after the removal of hull (20%) and bran (8-10%). Even though bran consists of valuable nutrients its removal is necessary for longer storage of grain since the fat in the bran develops rancidity up on storage. The percentage of 3/4th to whole polished grains to that of paddy is called head rice recovery. Although head rice recovery is a inherited trait it is also dependent on temperature and humidity during ripening, grain size, shape, hardness, abdominal white, storage conditions etc. Varieties possessing medium slender, long slender and translucent grains give high head rice yields. Parboiling increases the milling percentage. Varieties with high protein content and high gelatinization temperature types are less prone to cracking.

Factors Affecting Broken in Rice

Imbalanced nutrient application/untimely application leads to improper grain filling resulting in increased broken.

Avoid application of nitrogen at flowering/ boot leaf stage which increases the endosperm protein causing more broken during milling.

The produce from the saline soils may contain shriveled and ill-filled Water stress during reproductive phase (panicle initiation to grains resulting in poor milling recovery.

Ensure effective control of BPH especially after flowering to reduce physiological maturity) may lead to increased broken.

Protect the crop from diseases such as Sheath Blight, Sheath rot and broken in milling.

Harvest the crop at right stage to ensure grain quality (i.e. when 80% RTV as the produce from the affected crop will be of inferior quality of the panicles turned yellow and 90% of the panicles turned straw colour).

The grains at the base of the panicles should be at hard dough Allow the sheaves to dry in the field for 2 or 3 days to reduce the Over ripened and under ripened produce also leads to breakage. stage.

Whenever feasible harvest, thresh and clean the produce moisture content Avoid varietal admixtures to overcome poor milling recovery and to simultaneously using combine harvesters to get good produce. realize quality rice.

The appearance of milled rice is important to the consumer, which in turn is important to producer and miller. Thus, grain size and shape are the first criteria for breeding the quality rice for commercial purpose (Adair et al., 1966). The International Rice Research Institute, Philippines, has given a classification for size and shape based on brown rice length and length-width ratio respectively.

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