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An Overview of Rice Productive Cultivation and Variety in India

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Abstract - *In many nations, rice is one of the most dominant crops and an integral part of the world economy. A substantial part of the world's population consumes rice and the trade of rice plays a major role in countries' trade. The origin of rice and its development is very widespread. There are a lot of rice varieties that are grown all over the world. Across the countries a demand for multiple varieties of rice has been created, rice trade has grown significantly in many countries. During the food shortage, the importance of rice has been recognized multiple times. The whole study focuses on the global rice production scenarios, trade and other economic significance. Throughout all these years, rice production in India and all over Asia has increased substantially. The paper demonstrates the growth of India's rice industry, and agriculture as well as trade, and production across India in recent years. It also analyses the global state of the food crisis and the economic perspective of the rice trade. Trade policies and deals proposed between countries that provide mutual benefits have a direct or indirect impact on the production and supply of rice. It is difficult to compare a huge amount of production and trade data from farming, and economic point of view, this paper tries to give an overall view of the sectors.*

***Key Words*: Oryza sativa, Origin of rice, Types, Texture, Climatic condition, Rice Production, State wise Production, West Bengal, Basmati Rice, Export, Trade Policy.**

1. INTRODUCTION

Rice is one of the most important crops consumed in India. India is the second-largest producer of rice in the world in accordance to the year 2018-19 after China with 148.5 million metric tons of milled rice production. In 2018-19 India's total milled rice production was about 116.42 million metric tons, and West Bengal being the largest rice-producing state. India also holds the record for the world's major exporter of Basmati rice, with 4.4 million tons in the same year 2018-19 [1]. Oryza sativa is commonly known as rice, a widely cultivated cereal grain, and the grass plant that produces it. About one-half of the total population, and nearly all of East, and Southeast Asia, relies primarily on rice as a major staple food, and humans consume almost 95% of the total of the world's rice harvest [2,3]. Rice is one of the main grains of India. Significant shares are for rice are during the Kharif season [4]. In addition, India has the largest rice-growing region, since it is one of the major food crops. It is indeed the country's dominant crop [5]. This high-calorie starchy grain is usually low-cost, making it affordable to everyone and a crucial base for several diets. Each nation displays a rice specialty that meet local tastes and food habits [6].

2. ORIGIN OF RICE

There are many theories and much debate regarding the origin of rice. Around 3,000 years ago, in Africa, the now less popular *Oryza glaberrima* rice was separately cultivated [7]. Southeast Asian archaeologists propose that rice farming started somewhere along the Yangzte River in south-central China, and spread from there towards south and northeast into Korea and Japan. Archaeologists working in India, however, have contended that their evidence suggests the root of rice cultivation in the Ganges river valley, by people separated from those of the Yangzte [8,9]. There are even two theories regarding the origin of rice. Single-origin says that indica and japonica were domesticated from the wild rice *Oryza rufipogon*. While the multiple-origin indicates that these two major rice types were independently domesticated and in different parts of Asia [9]. Research also suggests that domesticated rice japonica and indica arose separately from progenitor *O. rufipogon* and *O. nivara* [10]. The multiple-origin model gained popularity, when biologists noticed substantial genetic variations between indica and japonica, and many researches investigating the evolutionary relationship between rice varieties supported domestication in both India and China [9].

Lately, in India rice grains found at the site of Lahuradewa, in Uttar Pradesh shows independent domestication of rice pre-dates known Chinese origins by several hundred years [11,12,13,14]. In order to prove the cultivation or domestication of rice, more documentation is necessary.

3. TYPES OF RICE

The most common species of rice is *Oryza sativa* which is subdivided into the long-grain indica, and short-grain japonica [6]. Japonica rice grows in the temperate and mountain regions. Whereas Indica grows near the equator. Japonica is mostly cultivated in Japan and Korea, and Indica variety in India, China, Sri Lanka, and African parts [15]. There are more than 40,000 varieties of *Oryza sativa*, which can differ in shape, size, colour, texture, aroma, and flavour [1,6].

3.1 Grain Size

Rice can be characterized in different varieties. According to the shape and size of rice grain, they are classified into

three types: Long grain, Medium grain, Short grain. These long slender grains are cylindrical in structure with the longest grain size, which is larger than 6.0 mm [16]. The length of the grain is 4 or even 5 times the width. Medium grain rice varies between 5.3-5.9 [17] mm in size and the width is 3 times shorter than the length of the rice grain. Short grain rice has a kernel size of 5.2 mm and the width is 2 times shorter than its length [18].

3.2 Rice Texture

Rice can also be classified into two types depending on the texture when it's cooked that is glutinous rice and non-glutinous rice. When the starch content and phenolic compound [19] with melatonin [20] increases in rice grain, it shows a more consistent texture. It becomes stickier and considered as glutinous or sticky rice. As examined, the amylose content of rice starch is 0- 2% in glutinous rice, 20-25% in normal or medium range, and up to 30% in high-amylose rice grains [21]. Non-glutinous rice, on the other hand, if the level of starch, phenolic compounds with melatonin decreases with raising the roughness of rice, then it is considered as non-glutinous rice. Generally, it consists of low (<5%) or almost no amylose in its starch but high in amylopectin [22].

3.3 Color

Various shades of rice can be seen, such as white, red, brown, black, and many more. For improving nutritional protection and productivity of rice by modulating the consistency of grains as well as by adding bio-active compounds with micronutrients, these are responsible for rice coloration. Highly nutritious flavonoids such as anthocyanin and pro-anthocyanidin [23] are mainly involved in pigmented rice cultivation [24].

4. CLIMATE CONDITIONS

Rice is grown under different conditions in India from 8° to 25° N latitude and from sea level to around 2,500 meters a high [25]. Rice needs high humid temperature with a hot atmosphere. Average temp range in between 21° - 37°C. Generally, it can't tolerate more than 40° - 42°C. Budding conditions ranges from 26.5° - 29.5°C. The ripening temperature should not exceed 20° - 25°C (source: Banaras Hindu University) [26].

4.1 Rainfall and Soil

Rice Plant needs an adequate amount of water so that the minimum rainfall range should be 115cm and the region having 175-300 cm rainfall per annum is the best suited for rice production. For Sowing 25 mm depth of flooded land and growing is 150 mm for 10 weeks is also required for the positive growth of the rice plant [27].

As a tropical plant, rice requires soil which is having good water holding capacity, organic matter with pH 5.5-6.5 [28, 29]. Clayey Loam is the most suitable soil but various other soils like Alluvial Soil, Riverain Alluvial, Heavy Clay, or any fertile soil can promote the growth of rice plant [30].

4.2 Fertilizer and Labor

Based on of recent study, it is depicted that macronutrient like Nitrogen(N), Phosphorus (P), Potassium (K) and micronutrients like calcium, magnesium, iron and zinc is responsible for good growth of rice plant [31]. Organic manure like Urea consists of 46 % Nitrogen [32] and the chemical fertilizers N-P-K are the most suited for raising growth [33].

Rice production is labor dependent. It is cultivated through different steps like sowing, weeding, harvesting, threshing. As it is well-consumed food, so large number of cheap, well-trained labor is required for the development of rice production [25,34].

5. PRODUCTION OF RICE

Rice is India's main food crop, covering about one-fourth of the total area cultivated and providing food to over 50 percent of the Indian population. This is the staple food of individuals living in the eastern and southern parts of the country, particularly in areas with annual rainfall of over 150 cm [25, 35, 36]. After China, India is the world's second-largest producer and user of rice and accounts for 17.95 percent of total rice production in the world [35]. Significant growth has been observed in India, the production, area, and yield of rice in the upcoming years.

During the Kharif season, the largest share of rice is cultivated. In terms of harvest season, it is known as winter rice. Winter (Kharif) rice is planted from June to July and harvested from November to December. In the rabi/summer season, a small proportion of rice is grown with guaranteed irrigation. The production of Indian rice largely depends on monsoon rains and irrigation is guaranteed for only 59 percent of the rice region [4].

5.1 State Wise Rice Production

Rice is grown in almost all states in the country, but West Bengal, UP, Andhra Pradesh, Punjab, and Tamil Nadu are the key 5 states in rice production [37].

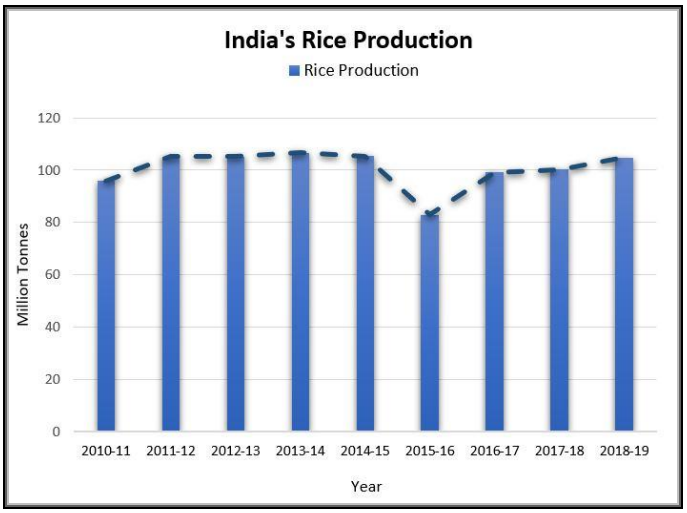

Chart – 1: India's rice production from year 2010-11 to 2018-19 [4]

In the 2009-10 crop year (July-June), the country's rice production decreased to 89.13 million tonnes from a record 99.18 million tonnes in the previous year due to extreme drought affecting almost half of the country but by the back of better monsoon, India's rice production reached to a record high of 104.32 million tonnes in 2011-2012 crop year (July–June) [5]. Besides this in 2013-14, a record production of 106.3 million tonnes was achieved, with a yield of 2,419 kg/hectare at a high stage [35]. In the study of 2010-11 to 2017-18, Andhra Pradesh is India's largest rice-producing state with the highest percentage of the share 15.1 in 2015-16 with production of 15.75 million tonnes. Compared to 2015-2016, the share percentage of the remaining five key states, i.e. West Bengal, Uttar Pradesh, Punjab, and Orissa were 11.99, 11.33, 7.65,7.18 respectively. West Bengal is the second-largest rice producing state in India with the highest share percentage of 13.73 in 2013-14. In West Bengal, a significant increment in rice production can be observed during their study year, with the production of 13.05 million tonnes in 2010 and production of 16.1 million tonnes in 2019 [38,39]. Rice production increased significantly from 99 million tonnes of milled rice in the year 2010-2011 to 116.42 million tonnes of milled rice in the year 2018-2019, that is almost increased by 16.173 percent [40].

5.2 District Wise Rice Production of West Bengal

The study area here is the state of West Bengal which is situated in a key position of Eastern India, is encompassed on the north by Bhutan and Sikkim, on the east by Bangladesh and northeast by Assam, on the south by the Bay of Bengal and the south-west by Orissa, on the north-west by Nepal and on the west by the state of Bihar. It possesses a geographical area of approximately 88,752 sq. km which is 2.70 percent of India's total geographical area [41,42]. West Bengal is the biggest maker of rice in India contributing around 20 percent of the entire rice generation from 14.5 percent of the rice creating range of the nation. Rice occupies three-fourths of the full edited region within the lower Ganga Fields. Over two-thirds of the generation come from Medinipur, Bardhaman, North and South Twenty-Four Parganas, Bankura, Birbhum, and West Dinajpur districts. The other creating areas are Howrah, Hugli, Jalpaiguri, Coochbehar, and Malda [43,35]. Rice is the most predominant crop in West Bengal. Three types of Paddy are developed, viz. Aus Paddy in Bhadui season taken after by Aman Paddy in Winter season and Boro Paddy in Summer season [44].

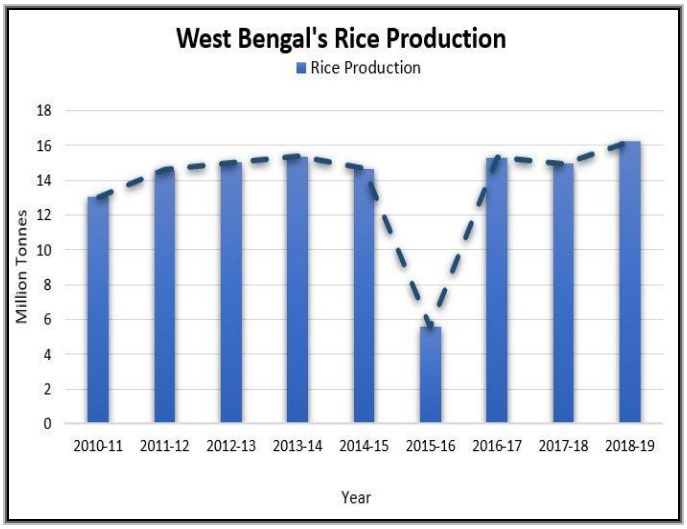

Chart – 2: West Bengal's rice production from year 2010-11 to 2018-19 [4]

The area under rice crop was 5.72 million hectares in 2007-2008 which has decreased to 5.444 million hectares during 2012-2013 which is nearly 4.94 percent decrement. The rice production has enlisted an increment from 1.472 million tonnes in 2007-08 to 1.502 million tonnes during 2012-13 that is increased by 2.044 percent. The yield was 2574 kg/ha in 2007-08 which has expanded to 2760 kg/ha amid 2012-13 increment by 6.974 percent [45].

The total Aman (Clean Rice) production in 2014-15 was 10.98 million tonnes, up about 7% from 10.26 million tonnes in 2011-12, about 6% from 10.41 million tonnes in 2012-13 and about 4% from 10.54 million tonnes in 2013-14 and in 2012-13, Aman (Clean Rice) total production was 10.41 million tonnes, up about 24 percent from 8.43 million tonnes in 2010-11 and about 1.5 percent from 10.26 million tonnes in 2011-12. Compared to 2010-11, the Birbhum district's total production increased by about 74 percent during 2011-12 and 63 percent during 2012-13. The aforementioned growth rates are 164% and 135% for Bankura district and 180% and 179% for Purulia district during 2011-12 and 2012-13, respectively. Total production in 2010-11, 2011-12 and 2012-13 were 4.5 million tonnes, 3.87 million tonnes and 4.06 million tonnes respectively. Maximum Boro (Clean Rice) was collected from the district of Bardhaman around 0.6 million tonnes in 2012-13, followed by Paschim Medinipur, Purba Medinipur, Murshidabad, and Nadia. Significant quantities of Boro (Clean Rice) from Hugli, North

24 Parganas, Malda, and Birbhum were collected. Total production of Aus (Clean Rice) in West Bengal amounted to 0.5 million tonnes in 2013-14, up about 9% from 0.45 million tonnes in 2010-11, about 5% from 0.47 million tonnes in 2011-12, and about 5% from 0.47 million tonnes in 2012-13. Within the year 2012-13 most extreme generation was harvested by Bardhaman area, taken after by Paschim Medinipur and Birbhum. Paschim Medinipur district, followed by Bardhaman and Birbhum, revealed that maximum output was harvested in the year 2014-15 and the bottom three districts were Darjeeling, Howrah, and Dakshin Dinajpur. In the rest 5 years from 2015 to 2019 the total production of rice in West Bengal were; 15.95 million tonnes, 15.3 million tonnes, 14.97 million tonnes, 15.95 million tonnes, 16.1 million tonnes [4, 44, 45].

6. BASMATI RICE AND IT'S EXPORT

Basmati rice is a type of long-grain rice variety which is famous for its fragrance among several other dishes and Indian cuisine. It is having a superior aroma with distinct flavour, taste, and fluffy texture when cooked [16, 46, 47].

At a compounded annual growth rate (CAGR) of 27%, the exports of Basmati rice have increased from Rs 28.24 billion in year 2004-05 to Rs 275.98 billion in year 2014-15 [48]. India is one of the top global exporter of Basmati rice. During the year 2019-20, the nation exported 44,54,656.69 metric tons of Basmati Rice to the world for the amount of Rs. 310.25 billion [49, 50]. The illustrations of Basmati rice export for the last 3 years have been shown in Table-1.

Table – 1: Three Year Export Statement [50]

Qty - Quantity in Million Tonnes; Rs. in Crore						
PRODUCT	YEAR					
	2017-18		2018-19		2019-20	
	Qty.	Rs.	Qty.	Rs.	Qty.	Rs.
Basmati Rice	4.05	26870.17	4.41	32804.30	4.45	31025.88
Non-Basmati Rice	8.64	22967.82	7.60	21185.28	5.04	14364.66

7. RICE TRADE POLICY IN INDIA

India is a major producer and transporter of rice. It is the third-highest producer and exporter. So, India's export policy on rice affects almost half of the world's population. India has a huge market of both basmati and non-basmati rice. UAE, Iran, and Saudi Arabia being the most consumers of Indian basmati rice, and Nigeria and South Africa being the biggest consumers of non-basmati rice. India's profit from the export of rice increased from 459.63 crore in 1990-91 to 33858.19 crore in 2012-13. India's trade policy for rice concerns mostly about only two things: building food safety in national standards and enhancing the export market to increase the farmer's income. Although the food shortage in 2008 pushed India to rethink its own trade policy and export policy once again. In 2008 the food shortage caused a scarcity of rice in the world market, which eventually caused the increase of the price of rice in India's market. To protect its customers India had to put restrictions on international trade on rice which forced the sellers to sell the rice in the domestic market. But the new policy adopted by most of the nation has lowered the limitation of rice export. It has helped India to get a dynamic market. Now India has developed a huge market of non-basmati [51].

7.1 General Agreement on Tariffs and Trade (GATT)

General Agreement on Tariffs and Trade (GATT) was signed in 1947 between 24 countries to liberalize trade and to create new opportunities to explore the new market. This agreement agreed for mutual removal and lowering of tariffs so that the price could be controlled and new sectors of the export could be explored. In recent times the countries included in this agreement have agreed to a free trade policy. Eventually, these policies have benefited the non-agricultural products as agricultural products have not been included in this fully [52].

7.2 Doha development agenda

Doha development agenda is a trade negotiation between the developed and developing countries supervised by WTO (World Trade Organization). The main agenda of this was to get a common beneficial policy for subsidies through negotiations. The developed countries included USA, Japan etc., and developing countries were led by India, China, South Africa etc., but this development agenda has not been successful as most of the countries have not found a way through the negotiations. Especially the main intense negotiations going on between India and China. Apart from the international negotiation policies India has completed its own free trade policies, with various countries on agricultural sectors to overcome the trade barriers [53].

7.3 COVID-19 Impact on rice

The rice industry, which is the backbone of food production and security for half of the world's population, faces numerous difficulties from both nature and people. The COVID-19 pandemic will intensify the problems and people suffering as the food supply chains in the world have been interrupted. The threat of climate change to crop production in significant regions supplying rice, is further enhanced by the declining number of rice farmers and an increasingly growing number of global populations. [54]

8. CONCLUSIONS

A complete run-through of rice has been given in this report. India's state-wise production of rice has been discussed as

India's contribution to the production of world rice is very significant. The production of rice in West Bengal, trade policies that are in effect, export details, and many more are also discussed here. According to market demand, the forms and exports of rice vary. This paper introduces, together with its trade policies and exports, a recent rice production scenario. In the near future, the growing demand for rice due to the increase in the world's population, would become a major challenge for future civilization. There are also several other variables, such as climate change, land unavailability, low yielding rice seeds, labor scarcity, insufficient infrastructure, etc. Rice storage facilities may be improvised to reduce losses. Other emerging technology and developments in the control of supply will be helpful for better rice production.

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