Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Economics & Management

Master's Thesis

The Role of Rice Exports in International Trade in India

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Business Administration

Thesis title

The Role of Rice Exports in International Trade in India

Objectives of thesis

The main objective of the thesis is to evaluate the role of rice exports in India's international trade, framed by the following sub-objectives:
Assess India's current position and market share in the global rice trade.
Examine the geographical distribution of rice production across states in India.
Identify key factors influencing rice production trends.
Evaluate the significance of rice in India's foreign trade (imports and exports).
Analyze rice consumption patterns in India.
Identify logistical bottlenecks in rice export, including port congestion, transportation challenges, and storage issues.
Calculate India's self-sufficiency ratio in rice.

Methodology

The thesis comprises two sections. The first section reviews existing literature on India's rice production, state-wise output, influencing factors, and logistical challenges in rice exports. It aims to establish a foundational understanding of the topic.

The second section will utilize secondary data from 2000 to 2020 to fulfill the primary research objective. Statistical methods, including correlation analysis, will test hypotheses regarding the relationships between independent and dependent variables. Additionally, the self-sufficiency ratio of rice in India will be calculated. Data will be analyzed using SPSS software and Microsoft Excel.

The proposed extent of the thesis

50 – 70 pages

Keywords

Global Rice Market, India Rice Exports, Basmati Rice Exports, Non-Basmati Rice Exports, Indian Rice Export Trends, Rice Production.

Recommended information sources

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Declaration

I declare that I have worked on my master's thesis titled "The Role of Rice Exports in International Trade in India" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the master's thesis, I declare that the thesis does not break any copyrights.

In Prague on 30/11/2025

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The Role of Rice Exports in International Trade in India

Abstract

One of India's most significant agricultural products from an economic standpoint is rice. It creates a significant amount of job days in rural areas, sustains millions of farmers and makes a significant contribution to the agricultural GDP. India is one of the biggest producers and exporters of rice in globally when it comes to commerce as well as production. India is a major exporter, providing both premium basmati markets as well as bulk non-basmati markets in South Asia, Africa, and across the globe, as per FAO reports. It also accounts for a significant portion of the world's rice production and stockpiles. Therefore, the research aims to examine the patterns, connections, and contributing elements affecting rice production, consumption, availability, imports, and exports in India. Making use of secondary data and statistical techniques the research dives in to long term variations in domestic rice consumption, production, cultivation, per capita availability and trade performance. The results show that, despite little growth in cultivated area, rice output rose significantly by 26.64 million tons throughout the research period. While per capita availability fluctuated periodically, consumption increased by 16.56%. India's export composition showed that parboiled non-Basmati rice accounted for a large portion (35.8%) and that places like South Asia and Africa were becoming more and more dependent on its exports. Strong positive correlations between rice production and consumption, imports, exports, and GDP; significant connections between consumption, export categories, and GDP; and moderate relationships between import and export flows were all revealed by hypothesis testing. On the other hand, there were weak and insignificant connections between output and per capita availability as well as between production area and production. The Self-Sufficiency Ratio (SSR) of 109.32% demonstrated that India is a rice-surplus, export-focused economy.

Keywords: Global Rice Market, India Rice Exports, Basmati Rice Exports, Non-Basmati Rice Exports, Indian Rice Export Trends, Rice Production, Rice Consumption, Foreign Exchange Impact on Exports

Role vývozu rýže v mezinárodním obchodu v Indii

Abstrakt

Z ekonomického hlediska je jedním z nejvýznamnějších zemědělských produktů Indie rýže. Vytváří značné množství pracovních míst ve venkovských oblastech, uživuje miliony zemědělců a významně přispívá k HDP zemědělství. Indie je jedním z největších producentů a vývozců rýže na světě, pokud jde o obchod i produkci. Indie je významným vývozcem a podle zpráv FAO poskytuje jak prémiové trhy s basmati, tak i velkoobchodní trhy s jiným druhem rýže v jižní Asii, Africe a po celém světě. Podílí se také na významné části světové produkce a zásob rýže. Výzkum si proto klade za cíl zkoumat vzorce, souvislosti a přispívající prvky ovlivňující produkci, spotřebu, dostupnost, dovoz a vývoz rýže v Indii. S využitím sekundárních dat a statistických technik se výzkum zabývá dlouhodobými výkyvy v domácí spotřebě, produkci, pěstování, dostupnosti na obyvatele a obchodní výkonnosti rýže. Výsledky ukazují, že navzdory malému růstu obdělávané plochy se produkce rýže během sledovaného období výrazně zvýšila o 26,64 milionu tun. Zatímco dostupnost na obyvatele periodicky kolísala, spotřeba se zvýšila o 16,56 %. Složení indického exportu ukázalo, že parboiled rýže jiná než basmati tvořila velkou část (35,8 %) a že místa jako jižní Asie a Afrika se na jejím exportu stávají stále více závislými. Testování hypotéz odhalilo silné pozitivní korelace mezi produkcí a spotřebou rýže, dovozem, vývozem a HDP; významné souvislosti mezi spotřebou, exportními kategoriemi a HDP; a mírné vztahy mezi dovozními a exportními toky. Na druhou stranu existovaly slabé a nevýznamné souvislosti mezi produkcí a dostupností na obyvatele, jakož i mezi produkční plochou a produkcí. Míra soběstačnosti (SSR) ve výši 109,32 % prokázala, že Indie je ekonomika s přebytkem rýže a zaměřená na export.

Klíčová slova: Globální trh s rýží, Vývoz rýže z Indie, Vývoz rýže Basmati, Vývoz rýže mimo Basmati, Trendy vývozu indické rýže, Produkce rýže, Spotřeba rýže, Devizový dopad na vývoz

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1 Introduction

International commerce expands a country's reach beyond its boundaries and is a key factor in economic growth as well as development. Accessibility to a larger customer base is made possible by this international collaboration, which leads to increased production along with economies of scale. Consequently, this promotes economic progress. Additionally, the promotion of specialization by international commerce enables nations to concentrate on areas in which they have a comparative advantage, resulting in more effective use of resources, increased productivity, and advantages for the world economy. Importing products and services that may not be available or more reasonably priced elsewhere gives consumers additional options, which is one significant benefit. This variety of products raises living standards and increases customer happiness. Because they serve global markets, export-driven businesses often see increases in employment, which lowers unemployment rates and raises wages. Beyond its effects on the economy, international commerce helps countries share best practices, technology, and information. Through the use of cutting-edge techniques and technologies, this exchange fosters innovation and advancement, accelerating global growth. The growth of society as a whole is accelerated by this constant flow of ideas (Saxena et al., 2023).

International commerce in agricultural goods is very important given India's sizable agrarian economy. Considering that 58% of the population depends on agriculture for a living, there are several benefits to participating in international commerce (Government of India, 2021). Worldwide commerce boosts India's agricultural industry by giving it access to worldwide markets, expanding possibilities for farmers and enterprises abroad, boosting foreign currency profits, and facilitating the sharing of best practices, technology, and expertise, among other things. Thus, international commerce in agricultural products, particularly rice, supports the global agricultural landscape while giving India a route to economic growth, technical innovation, and constructive international participation (Kumar, 2019; Nguyen, 2020; Jankulovski and Khan, 2022).

An extensive variety of agricultural goods may be grown in India's varied agroclimatic zones. The nation can fulfill the significant local demand for basic commodities like rice and wheat while also having excess supplies available for export because to its abundant land resources. Low production costs are yet another important element that makes India

competitive in the world market for agricultural products. Economical agricultural production is made possible by India's relatively cheap labor expenses as compared to many other nations. Having access to reasonably priced agricultural supplies is also essential for maintaining competitive production costs. The farming population in India is sizable, well qualified, and has a wealth of agricultural expertise. Agricultural exports are aggressively encouraged by the government via a variety of export promotion programs, incentives, and diplomatic initiatives. By facilitating market access with other nations, this assistance strengthens India's standing as a trustworthy provider of agricultural goods (Nugroho *et al.*, 2021; Gupta and Kumar, 2020; Nguyen *et al.*, 2020).

Therefore, the present research aims to study the role of rice exports in international trade in India. The thesis is quantitative in nature and makes use of secondary data collected from the various secondary sources like websites, blogs, articles, journals, magazines, online news articles, research papers, publications, reports, etc. The data pertaining to the production area, production, Import, Export, Capita availability, Consumption & GDP have been collected from the year 2006-2020 covering a period of 15 years. The data collected is then analysed with the help of graphs, tables and figures. Data has been normalized to reduce redundancy, minimize errors, and to maintain consistency so as to get accurate results. Statistical tools have been implemented to identify the associations between dependent variable and independent variables of the study. For analysis purpose Microsoft office Excel and SPSS have been used.

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2 Objectives and Methodology

2.1 Objectives

The primary aim of the research is to evaluate the role of rice exports in India's International Trade. In order to fulfill the main objective following sub-objectives have been framed:

- To Assess India's current position and market share in the global rice trade.
- To Examine the geographical distribution of Rice production across states in India.
- To Identify key factors influencing rice production trends.
- To evaluate the significance of Rice in India's foreign Trade (Import & Export).
- To Analyse Rice consumption patterns in India.
- To Identify logistical bottlenecks in rice export, including port congestion, transportation challenges, and storage issues.
- To Calculate India's self-sufficiency ratio in Rice.

In order to accomplish the above objectives of research following methodology have been framed.

2.2 Methodology

The thesis will be divided into two sections. First section will concentrate on the published literature that is currently accessible on Rice production in India, state-wise rice production in India, factors affecting the production of rice and key supply chain bottlenecks in rice export logistics like port congestion, transportation issues and storage limitations. It aims to provide a comprehensive picture of the current level of understanding on the present topic. The literature for the same will be collected from the secondary sources like Articles, Blogs, Reports, Journals, Magazines, Newspaper, Conference Proceedings, Websites, etc.

Second section will concentrate on the practical part of the thesis comprising of the secondary data. The second section focuses on the fulfilment of the primary objective of the thesis for which secondary data will be collected for the year ranging from 2006-2020. Quantitative data regarding area of rice production, rice production, consumption of rice, capita availability of rice, import & export of Basmati & Non-Basmati rice, total export of Rice and Gross Domestic Product will be gathered from FAO (Food & Agriculture

Organization) reports & Statista. Data collected will be standardised and normalised for better understanding and comparison. Moreover, it also increases the consistency, accuracy and reliability of the data collected while interpretation. Statistical methods like Pearson's Correlation, Regression and Anova technique will be used for hypothesis testing to determine correlation between Independent and dependent variable. It also calculates the self-sufficiency ratio of India in terms of rice. The data collected will be analyzed using SPSS software and Microsoft office excel.

2.3 Analysis Tools

The present research makes use of following analytical tools to examine the secondary data and draw meaningful conclusions.

2.3.1 Corelation Coefficient

A statistical measure of the relationship between two variables is correlation. It can be described as the quantity change in one variable that corresponds to a change in another. A basic correlation formula can only have a value between -1 and +1. Variables are said to be totally negatively linked if it is -1. In other words, if one variable is moving in one direction, another is moving in the other direction. Variables are said to be perfectly positively connected if it is +1. There is a positive trend in both variables. If it is zero, there is no correlation between the variables. A perfect correlation means that when one variable moves in one direction, the other variable will move in the same exact way. The Pearson product-moment correlation is the most popular method for calculating this metric, though there are other ways as well (Sharma, 2024). The formula for calculating the same is given as under:

$$Corelation\ Coefficient = \frac{\sum(x_{i-\bar{x}})\,(y_{i-\bar{y}})}{\sqrt{\sum(x_{i-\bar{x}})^2\,\sum(y_{i-\bar{y}})^2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where,

x_1 = Values of X-variable in a sample

$\bar{x}$ = mean of the value of the x-variable

y_1 = Values of Y-variable in a sample

$\bar{Y}$ = mean of the value of the x-variable

2.3.2 Regression Analysis

A statistical technique called regression examines the connection between one or more independent variables and a dependent variable. It aids in forecasting or comprehending the relationship between changes in the independent variable or variables and changes in the dependent variable. Regression captures the association between variables observed in a dataset and assesses whether those correlations are statistically significant. The two fundamental kinds of regression are simple linear regression and multivariate linear regression. Simple linear regression employs a single independent variable to explain or predict the outcome of the dependent variable Y. Multiple linear regression employs two or more independent variables to forecast the outcome (Beers, 2025). The formula for calculating Simple and Multiple Linear Regression is as below:

Simple Linear regression = $a + bX + u$

Multiple Linear Regression = $a + b_1X_1 + b_2X_2 + b_3X_3 + \cdots + b_tX_t + u$ …… *(2)*

Where,

Y=The dependent variable trying to predict or explain

X=The independent variable(s) you are using to predict or associate with Y

a=The y-intercept

b=(beta coefficient) is the slope of the independent variable(s)

u=The regression residual or error term

For the above corelation and regression analysis following independent variable and dependent variable associations have been tested for the present research study.

- Production (Dependent) & Area of Production (Independent)
- Capita Availability of Rice (Dependent) & Production (Independent)
- Consumption (Dependent) & Production (Independent)
- Production (Dependent) & Import (Independent)
- Consumption (Dependent) & Import (Independent)
- Export (Dependent) & Production (Independent)
- Export (Dependent) & Import (Independent)
- Gross Domestic Product (Dependent) & Production (Independent)

- Gross Domestic Product (Dependent) & Consumption (Independent)
- Gross Domestic Product (Dependent) & Export of Basmati Rice (Independent)
- Gross Domestic Product (Dependent) & Export of Non-Basmati Rice (Independent)
- Gross Domestic Product (Dependent) & Total Export of Rice (Independent)

2.3.3 Anova

ANOVA is a statistical technique that examines means across many groups at the same time to ascertain whether observed differences are the result of chance or represent real differences. When analyzing data on one independent variable and one dependent variable, analysts employ a one-way ANOVA. There are two independent variables in a two-way ANOVA. There should be at least three distinct groups or categories for the independent variable. ANOVA assesses whether the level of the independent variable affects the dependent variable (Kenton, 2025).

2.3.4 Self Sufficiency Ratio

One indicator of a nation's capacity to satisfy its food needs is the self-sufficiency ratio. A certain crop's domestic output and overall domestic consumption are compared to determine the ratio. It is stated as a percentage, where 100% indicates that the nation's output is sufficient to fulfill its needs for consumption. SSR above 100% shows that the nation is exporting that specific crop, however SSR below 100% shows that the nation is reliant on imports for consumption. Self Sufficiency ratio is calculated with the following formula.

$$\text{SSR Self Sufficiency Ratio} = \frac{Domestic\ production\ of\ wheat}{Total\ Domestic\ Consumption\ of\ Wheat}\ x\ 100 \ldots\ldots\ldots\ldots (3)$$

2.3.5 Growth Rate Calculation

The growth rate indicates how production, consumption, imports, and exports of Rice have increased or decreased. It has been determined using the following formula:

$$Growth\ Rate = \frac{Current\ value\ X\ 100}{Previous\ Value} - 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

3 Literature Review

3.1 Rice

In many parts of the globe, particularly Asia, rice is the most widely consumed staple food. Rice is the most produced crop worldwide, behind maize and sugarcane. At least 130 million years ago, rice began as a wild plant before being cultivated. The earliest recorded cultivation of rice occurred in south-east Asia, likely in India, around 10,000 years ago.The two types of rice that may be grown worldwide are Oryza glaberrima, often known as African rice, and Oryza sativa, also known as Asian rice. Rice is the seed of the grass species (Udhayakumar, 2021). Granulometric measures of grain whiteness and length are highly valued for grading and quality standards in rice markets. When assessing the quality of a dish, the palatability qualities—such as appearance, cohesion, softness, and flavor—are taken into account (Qiu et al., 2015; Weerawatanakorn *et al.*, 2015). The primary factor driving India's rising rice consumption is population growth. Additionally, when income rises, the population's low-income portion will likewise desire more rice. About 120 and 140 Mt of rice are predicted to be needed in India by 2025 and 2050, respectively. Furthermore, India exports around 10 million tons of rice annually, generating significant foreign currency earnings for the nation. The number of middle-class people who eat rice is rising in both local and foreign markets. This would raise the demand for premium rice, giving India excellent chances to export both premium non-basmati and basmati rice. Instead of expanding the area planted to rice—and that too under degrading soil, water, and other natural resources—this enhanced output must inevitably result from higher productivity (Pathak et al., 2018). The different types of Rice have been discussed as below:

3.1.1 Types of Rice

The following are different varieties of rice grown and consumed around the globe**.**

White Rice

Compared to brown rice, white rice is known to have less nutrients and to be higher in calories, carbs, and sugar. But in moderation, white rice consumption is beneficial (Hashimoto et al., 2020). More over half of the world's population depends on rice as a basic diet, and there are more than 110,000 cultivated types of brown and white rice (Fukagawa and Ziska, 2019). White rice has around 205 calories per cup, making it a refined grain. The

risk of elevated blood sugar and weight gain may be reduced by consuming white rice in moderation (Sass, 2024).

Brown Rice

When it comes to the nutrients it contains, brown rice has a minor edge over white rice. It has more vitamins, minerals, fiber, and antioxidants. These variations, nevertheless, aren't really important. The high fiber and magnesium content of brown rice aids in blood sugar regulation (Shoemaker, 2024). Other names for brown rice are hulled rice and unmilled rice. The layers as well as embryos of bran that make up brown rice include a range of nutritious elements, including vitamins, minerals, dietary fiber, and oryzanol, as well as biofunctional components. Because of its worse texture when cooked, brown rice is eaten at a lesser rate than white rice. The rice's chewiness and subtle nutty flavor are still present. The rice has a particular texture and is light and fluffy when cooked. When used to make fried rice, brown rice works well and goes perfectly with a variety of nutritious side dishes, such beans or vegetables. The bran layer stops the rice from absorbing water, thus making it require time to cook (Cho and Lim, 2015).

Golden Rice

Golden rice is expected to be the first commercially accessible genetically engineered biofortified grain with improved micronutrients and quality, especially vitamin A (De Steur et al., 2021). Both golden rice and the beta-carotene it contains are yellow in color. Since rice is the main cereal consumed by the poor in developing nations, it is thought to be the most economical method of treating vitamin A deficiency in millions of people (Rodríguez et al., 2022; Dubock, 2014).

Red Rice

Asian cuisine often uses red rice, which has several uses. Both fully and partly hulled red rice are possible. Like brown rice, it has a comparable nutritional profile. Red rice has a higher amount of antioxidants than white rice. Because it is sweeter, chewier, as well as nuttier in comparison to white rice, this rice is a great alternative. Red rice requires more time for preparation than other kinds of rice, but soaking it for 30 minutes beforehand allows it to soften the texture and expedite the cooking process (Agustin et al., 2021).

Basmati Rice

A popular alternative for cooking, basmati rice has a heady scent and is a favorite dish (Singh et al., 2018). Both local and foreign markets value rice of the Basmati and Jasmine kinds highly. Originally from India and Pakistan, this long, thin rice grain is

currently farmed all over the globe (Bera, 2020). The blade form is somewhat curved while being white. It almost doubles in size and gives out a subtle scent when baked, yet it keeps its light texture and separation and has a glossy appearance (Prodhan and Qingyao, 2020).

Ponni Rice

Ponni rice has a plump, shorter, and almost round kernel in comparison to other types of rice (Valarmathi *et al.*, 2019). Cooked grains have a tiny springiness to the biting, but they are still solid. Originally from India, this rice is a great option for daily cooking (Ramchander et al., 2015). It is highly renowned among Indians for being served with hot curries and other delectable foods (Valarmathi et al., 2019).

Waxy Rice

Glutinous rice types are grown in many nations, such as the Lao People's Democratic Republic, Japan, China, Thailand, Vietnam, Myanmar, Bangladesh, Cambodia, Malaysia, and India. Glutinous rice is the staple diet of the Laotian people. Traditionally, it was originally consumed as a morning cereal, dessert, or steaming glutinous rice wrapped in banana leaves. Glutinous rice has special processing qualities because of its distinct starch content. Several pretreatments, including parboiling, which decreases internal slits and enhances head rice yield, and tempering during the post-harvest tempering process, may improve the productivity of rice milling and grain quality (Qiu et al., 2021; Nawaz, 2018).

3.1.2 Rice Utilization

One of the most vital grains for human consumption worldwide is rice. Rice is the most essential staple meal in the heavily populated Asian nations, including Bangladesh, China, India, Indonesia, Iran, Japan, Korea, Pakistan, and Sri Lanka. In some Asian nations, rice accounts for up to 80% of the daily calorie intake of individuals (Luh, 1991).

A substantial amount of calories and a range of vital vitamins, minerals, and other nutrients may be found in rice. It has more nutrients than potatoes, wheat, and maize. Along with carbs, thiamine, calcium, folate, and iron, it is also acknowledged as an excellent source of vitamin E and vitamin B5. Sterols, flavonoids, terpenoids, anthocyanins, tocopherols, tocotrienols, oryzanol, and phenols are some of the phenolic chemicals present in rice, along with phytotic acid. These substances have been favorably associated with antioxidant qualities and have additionally been found to aid in preventing diabetes as well as cardiovascular disease (Mohidem et al., 2022). The hull, or husk, encloses the harvested rice kernel, sometimes referred to as uncooked rice or paddy. A coating of talc and glucose is

applied at times to the kernel to give it a glossy appearance, however milling often eliminates the kernel's hull as well as bran layers. Brown rice, which is rice that has simply had the husks removed, is a cereal that is high in thiamine, niacin, riboflavin, iron, and calcium. It has around 8% protein and trace quantities of fat. White rice is rice that has been processed to remove the bran as well, which significantly reduces its nutritional value. The risk of beriberi, a condition caused by a lack of thiamine and minerals, increases when white rice makes up a significant amount of the diet (Allston, 2025).

Other forms of rice consumption include fermented sweet rice, puffed rice, noodles, and snack items prepared using extrusion cooking. Vinegar, rice wine, and beer are all made using it. Some oriental delicacies need glutinous or sweet rice, which has just amylopectin in its starch, as opposed to nonglutinous rice, which includes both amylopectin and amylose (10-30%). Rich in vitamin E, rice oil derived from the bran has drawn a lot of interest from experts as a possible oil supply for underdeveloped nations. The activation of the enzymes lipase and lipoxygenase during milling has resulted in rancidity and the creation of an off-flavor, which has led the usage of rice oil to lag behind its potential value up to this point (Luh 1980). Rice oil stability has increased when rice bran is heated by extrusion as soon as it is milled to deactivate the enzymes. As developing nations get access to new technologies for oil extraction and refinement, rice oil use should progressively boost regional cereal crop productivity (Luh, 1991).

By-products of milling, such as bran and rice polish (finely ground bran and starch after polishing), may be utilized as feed for animals. Using the bran, oil is extracted for use in industry and cuisine. Starch and rice flour are made from broken rice, which is also utilized in distillation and brewing. Fuel, packing material, fertilizer, industrial grinding, as well as furfural, an industrial chemical, are all examples of uses for hulls. Feed, cattle bedding, matting, clothing, packing materials, roof thatching, and broomstraws are all made from straw (Allston, 2025).

3.1.3 Rice Prices & Storage

Since ancient times, Indians have recognized the value and need of storing grain due to its seasonal production (one harvest per year), susceptibility to weather fluctuations, and significance as a key edible. To guarantee there will always be food in the home, the Indians devised ways to preserve grains. Rice, paddy grain, and seed must be stored carefully since

they make up two-thirds of the Indian population's primary meal. These days, producers, consumers, traders, and the government all handle storage. Paddy is used to store the majority of the rice harvest since it stores better and lasts longer, and it can be husked as needed. The weather, environment, storage level, and user needs may all affect the storage technique and structure (Ahuja and Ahuja, 2014).

Approximately 60 and 70 percent of India's food grain production is thought to be kept in domestic storage facilities for both seed and domestic consumption. Both need somewhat different storage methods since seed requires more cautious handling. Bulk grains are kept in storage buildings, while seeds are kept in pots, cartons, baskets, or sacks. Ancient treatises make mention of the collecting, preservation, and storage of seeds, which have long been regarded as a crucial component of agriculture. According to Kashypiyakrishisukti, the king has a responsibility to store seeds and distribute them in the appropriate season, making seed storage the primary responsibility of a farmer for the success of his household (Ahuja and Ahuja, 2010).

The general consensus is that rice is kept for a long time before being eaten. Insects, mites, germs, birds, rats, and environmental factors including dampness cause the most rice losses during storage. As a result, paddy losses amount to around 10% of overall yield. The paddy that is kept at fann level is kept in locally constructed storage facilities such granaries, sacks, and bamboo structures, among others, which are unable to fully shield the paddy from rats, birds, insects, and other pests. There is enough waste from this kind of non-scientific storing to feed at least 60 million people. Jute bags were often used by dry land farmers for storing seed. Employing bags has the benefit of making it simple to remove as well as treat infected bags, and since the surface of the bags has access to the environment, "sweating" of the grains is prevented (Firdouse et al., 2009).

The majority of families followed the customary practices of sieving, sifting, and wiping the threshing floor, as well as storing rice bags on dunnage. In order to offer the embryo the best protection possible, it was also noted that rice stored for seed purposes was hand sorted without the use of a sieve. Other practices that were uncommon among farm families included the adoption of the trapping technique, winnowing, storing rice just after it had dried in the sun, and covering the top of the storage building (mar, dully) with straw as well as cowdung. It was also noted that houses who saw rats and rodents as a gift from

Siva did not bother using trapping techniques to keep them under control. No home ever embraced the scientific approach of storing procedures. Therefore, In order to reduce post-harvest losses, farm families need to be strongly educated and encouraged to employ scientific storage (Kalita and Pathok, 2001).

Agricultural Price Policy is crucial for fostering development and fairness within the Indian economy, namely in the agricultural sector. The primary aim of the Government's Price Policy is to safeguard the interests of consumers and producers alike. Securing food at both national and household levels is a significant concern in India today. The Food Security System and Price Policy primarily include three instruments: Procurement Prices/Minimum Support Prices (MSPs), Buffer Stocks, as well as the Public Distribution System (PDS). Agricultural Price Policy is a crucial strategy for attaining food security by enhancing productivity, employment, and farmers' incomes. It is essential to provide equitable pricing to farmers to ensure food security and enhance their earnings (Sudhakar and Wale, 2017).

In 1965, the Indian government established the Agricultural Prices Commission (APC) to provide guidance on creating a fair and cohesive pricing system. In 1980, the policy framework was changed to place more attention on the equilibrium between foodgrain supply and demand. It was represented in the updated APC terms of reference, which were subsequently renamed the Commission for Agricultural Costs and Prices. Instead of focusing on maximizing output, the organization now developed a production pattern that was in line with the economy's overall demands (Acharya, 1997).

Paddy, wheat, cotton, oilseeds, and pulses are the most significant of the 25 agricultural products pertaining to which the Commission for Agricultural Costs and Prices (CACP) proposes a Minimum Support Price (MSP). Since its establishment, the MSP policy has been controversial, with many believing that it exclusively benefits food-sufficiency areas like Punjab and Haryana states, where substantial grain supplies are purchased for the Public Distribution System (PDS) (Chand, 2003). The MSP for Paddy Common and Paddy -Grade A is given in the below table (₹/quintal).

Table 1 Minimum Support Price for Paddy Common & Grade-A for the year 2013-2024 (₹/quintal)

Year	MSP for Paddy - Common (₹/quintal)	MSP for Paddy - Grade-A (₹/quintal)
2013-14	1310	1345
2014-15	1360	1400
2015-16	1410	1450
2016-17	1470	1510
2017-18	1550	1590
2018-19	1750	1770
2019-20	1815	1835
2020-21	1868	1888
2021-22	1940	1960
2022-23	2040	2060
2023-24	2183	2203
2024-25	2300	2320

Source: (Government of India, 2025)

From the above table it can be observed that in the year 2013-14 the MSP for Paddy Common was 1310₹/quintal and for Grade-A was 1345₹/quintal. In the year 2014-15 it increased to 1360₹/quintal for Common and for Grade-A it was 1400₹/quintal. In the year 2019-20 it increased to 1815₹/quintal for common and for Grade-A it was 1835₹/quintal. While, for the year 2022-23 it was 2040₹/quintal for common and 2060₹/quintal for Grade-A. For the year 2024-25 it can be observed that for common paddy it is 2300₹/quintal and for Grade-A it is 2320₹/quintal. Thus, it can be concluded that the ₹/quintal have shown an increasing trend and the price of paddy have kept on increasing ensuring that the farmers did not incur any losses. The pricing policy is seen as ineffectual in other parts of the nation as the government isn't as interested in procurement activities because of the modest marketable surpluses. As a result, it is maintained that, unlike in regions with excess production, market prices for wheat and paddy are often less than the MSP in these regions during the post-harvest period and spike higher during lean seasons (Ali et al., 2012).

3.2 Rice Production

Early rice farming has been documented in a number of cultures, including Southeast Asian, Indian, and Chinese civilizations. The oldest archeological evidence, however, dates to about 7000 and 5000 bce and originates from central and eastern China. Over ninety percent of the world's rice is produced in Asia, mostly in Bangladesh, Indonesia, China, and

India. Japan, Pakistan, and many countries in Southeast Asia also produce minor quantities of rice. Australia, North and South America, and portions of Europe also grow rice. Except for the upland variety, the plant is cultivated on waterlogged land in tropical, semitropical, as well as temperate areas' river basins, tidal deltas, and coastal plains. After the seeds are sowed in prepared beds, the seedlings are moved to a field, or paddy, which has been surrounded by levees and kept below 5 to 10 cm (2 to 4 inches) of water for the duration of the growth season. To maintain the fields watered at different heights, rice farms are often terraced in mountainous regions (Allston, 2025).

In many regions of India, rice is farmed extensively, and the growing season varies according to the local climate. According to when the crop is harvested, India's three primary rice-growing seasons are autumn, winter, and summer. Pre-kharif, or autumn season rice, is often sown in May and continues through August. The precise time of sowing, however, varies slightly amongst Indian states and is mostly influenced by the weather (monsoon rainfall) or water release from irrigation projects. Harvesting depends on the variety selected, the time of sowing, and other factors, and it is typically harvested in September or October. These seasons are also given local names based on their culture and traditions. For example, the fall rice harvest is called "Bhadai" in Bihar, "Virippu" in Kerala, "Aus" in West Bengal, "Beali" in Orissa, "Kuruvai/kar/Sorna vari" in Tamil Nadu, and "Ahu" in Assam. In the eastern and southern parts of the nation, the average growth temperature is determined to be ideal for rice all year round. Therefore, two or even three rice harvests are planted in these areas. However, rice is often farmed as a single crop in western, northern, and northwest India from May to November since the temperatures there are too low to support rice cultivation throughout the winter (Surendran et al., 2021).

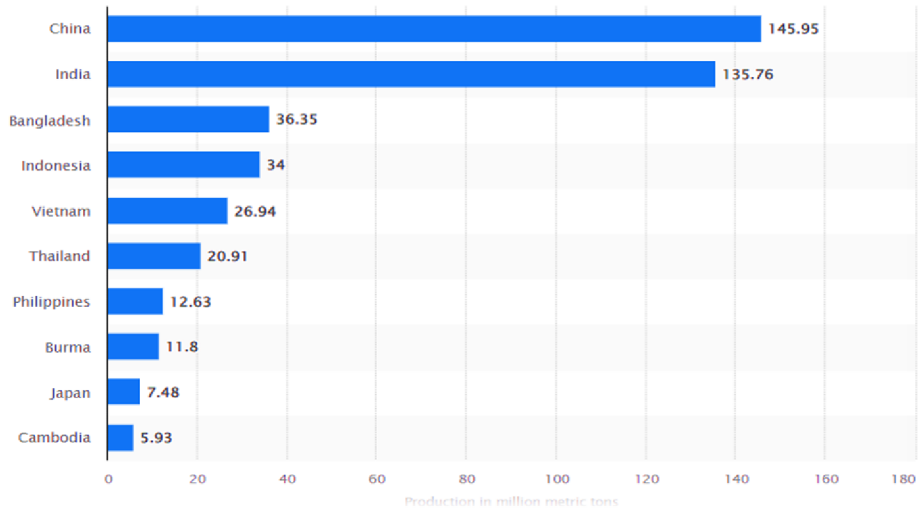
The International Rice Research Institute (IRRI) has recognized four types of rice agro-ecosystems: flood-prone rice ecosystems, lowland rice that is rainfed, upland rice, and irrigated rice. Approximately 30% of fresh groundwater worldwide is used for rice farming (Bouman, 2007). One kilogram of rice requires between 800 and 5000 L (average of 2500 L) of water to manufacture (Bouman, 2003). Compared to other cereals, conventional rice production methods (puddled transplanting) use two to three times as much water (Barker et al., 1999). It has been observed that in regions heavily watered for rice, the ground water table is dropping alarmingly quickly. These elements contribute to the rapidly declining freshwater supplies globally, endangering the food as well as livelihood security of rice

producers and consumers (Tuong et al., 2004). Given the present climate change and variability environment, the development of appropriate adaptation strategies and technologies that boost productivity is necessary to sustainably minimize the consequences of climate change upon rice production agricultural ecosystems (Shekhawat *et al.*, 2020; Chakraborty *et al.*, 2017; Sapkota *et al.*, 2015; Jayakumar et al., 2004).

3.2.1 Rice Production Worldwide

One of the most significant grains produced worldwide is rice, which comes in second to maize (Awika et al., 2012). A record 481.3 million tons of rice were expected to be produced worldwide in 2017; Asia accounted for the majority of this output (Childs and Skorbiansky, 2017). Rice consumption is high in developing nations, where it was around 340 metric tons (Mt) in 2002–2004 and 392 Mt. (15% increase) in 2012–2014, respectively (OECD-FAO, 2015). It is anticipated that consumption would reach 449 Mt. in 2024, a 32% increase from 2004 levels (OECD-FAO, 2015). On the other hand, developed nations used 17 million tons of rice in 2002–2004 and an additional 17.5 million tons in 2012–2014, with an anticipated 18.2 million tons eaten. Despite being a significant producer of rice worldwide, 75% of South Asian rice producers are smallholders (John and Fielding, 2014). About 70–80% of the food produced in Africa, sub-Saharan Africa, and Asia is produced by smallholder farmers, who are important food producers in emerging nations (John and Fielding, 2014). Since they generate more than half of the food needed to feed 9 billion people by 2050, emerging nations play a critical role in ensuring food security (Crowley, 2013). The following figure illustrates rice production worldwide for the year 2022-23.

Figure 1 Rice Production Worldwide for the year 2022-23 (in million metric tons)



Source: (Statista, 2024)

The graph illustrates China's and India's worldwide leadership in milled rice output in 2022–2023. India comes in second with 135.76 million metric tons, while China leads with 145.95 million metric tons. Because of their vast rice-growing areas, considerable domestic demand, and broad agricultural foundation, these two nations together contribute significantly to the world's rice production. There is a substantial output gap outside of the top two producers, with Indonesia (34 million metric tons) and Bangladesh (36.35 million metric tons) in distant third and fourth place, respectively (Statista, 2024).

There are three countries that contribute at a moderate level: Vietnam (26.94 million metric tons), Thailand (20.91 million metric tons), and the Philippines (12.63 million metric tons). These three countries are significant regional players because of their contributions. On the other hand, nations like as Burma (11.8 million metric tons), Japan (7.48 million metric tons), and Cambodia (5.93 million metric tons) make a relatively little contribution to the overall output around the world. Based on the region's agricultural traditions, suitable climate, and the crop's importance as a staple food, the data highlights Asia's pivotal position in the world's rice farming. This production distribution emphasizes how important it is to manage resources and trade policies effectively in order to promote global food security (Statista, 2024).

3.2.2 State-Wise Rice Production in India

The following lists the top 10 rice-producing states in India by state in terms of rice output (in million tonnes) and area under cultivation (million hectares) in 2024.

Table 2 Top 10 Rice Producing States in India with Production (Million Tons) & Area Cultivation (Million Hectares)

Rank	State	Production (in million tons)	Area Cultivation (million hectares)
1	West Bengal	15.75	5.46
2	Uttar Pradesh	12.5	5.86
3	Punjab	11.82	2.97
4	Tamil Nadu	7.98	2.04
5	Andhra Pradesh	7.49	2.16
6	Bihar	6.5	3.21
7	Chhattisgarh	6.09	3.82
8	Odisha	5.87	3.94
9	Assam	5.14	2.46
10	Haryana	4.14	1.35

Source: (Arora, 2024)

The above table lists the top 10 rice-producing states in India for 2024 in detail, with output measured in million tons and cultivated area measured in million hectares. West Bengal is at the top of the list, using 5.46 million hectares of agricultural land to produce 15.75 million tons. This highlights the effectiveness of the state's rice cultivation and its important contribution to the nation's rice supply. Second place goes to Uttar Pradesh, which produces 12.5 million tons from a somewhat bigger 5.86 million hectares agricultural area. Punjab is the third-most productive state, with 11.82 million tons produced, despite having a comparatively lesser cultivated area i.e. 2.97 million hectares (Arora, 2024).

With 7.98 and 7.49 million tons of rice produced, respectively, Tamil Nadu and Andhra Pradesh rank fourth and fifth. With somewhat lesser cultivation areas of 2.04 and 2.16 million hectares, both states demonstrate their effective methods for raising rice. Bihar comes next with a somewhat productive output of 6.5 million tons from 3.21 million hectares. Odisha (5.87 million tons) and Chhattisgarh (6.09 million tons) are in seventh and eighth place, respectively. Both make use of somewhat bigger cultivated areas (3.82 and 3.94 million hectares), suggesting that technical developments might lead to higher output. With respective productions of 5.14 and 4.14 million tons, Assam and Haryana complete the list. Of the top 10, Haryana uses the least amount of land (1.35 million hectares), which is indicative of its very effective farming methods (Arora, 2024).

3.2.3 Factors Affecting Rice Production in India

India is a third-world nation, with the bulk of its people living in rural areas. The majority of the rural population here makes their living from agriculture. Even though rice is a basic crop in India, growing it is not a lucrative endeavor for Indian farmers. We highlight some of the main factors affecting rice production in India (Bhattacharya, 2022). Dwivedy (2016), has talked about a few issues facing the Indian agriculture industry, including low socioeconomic status, illiteracy, ignorance of contemporary tools and technologies, tiny and dispersed land holdings, natural disasters, etc. Zaveri et al. (2016), demonstrates how over use of ground water threatens to deplete ground water supplies, which ultimately causes a drop in agricultural output. Climate change is also severely impacted by this. Gandhi et al. (2001), investigates the function of India's agroindustries in relation to the growth of small and rural farmers. Dhakshana and Rajandran (2017), explores the obstacles that farmers experience while using direct marketing. Due to intense rivalry

and the limited supply of cold storage, direct marketing becomes even more challenging. The marketing issues that traditional as well as organic farmers confront are insufficient storage, ignorance of market prices, imbalances between agricultural supply and demand, transportation issues, price variations between marketplaces, lack of government assistance, etc Azam *et al.* (2019).

Figure 2 Factors Affecting Rice Production In India

Source: Researcher's own compilation based on (Bhattacharya, 2022, Tu et al., 2020; Deng et al., 2015, Bairagi and Morat, 2021; Mishra et al., 2019, etc.)

Poor Irrigation Facility

Paddy farming requires a lot of water. Rice may be grown in areas with an average rainfall of 100 to 200 cm. The necessary rainfall is absent from many parts of India. Thus, the farmers rely on irrigation systems, which are necessary for agricultural growth. After the United States, India possesses the second-largest area of irrigated land. However, just one-

third of the area that is irrigated has adequate irrigation infrastructure. Due to the year-round quantity of water coming from snow-melt rivers and dams, Punjab has over 98% of its land under irrigation. However, things are quite different in other regions of India. Rain falls on rivers in central India. Water is not carried by them all year round. Thus, farmers in this area must wait for the unpredictable monsoon (Bhattacharya, 2022).

Temperature and Radiation

High temperatures dramatically reduced grain output and lengthened the time it took for rice to mature, according to a number of studies examining the impact of temperature on grain development (Tu et al., 2020; Deng et al., 2015). High temperatures have been linked to poor rice quality, including low head rice rate (Shi et al., 2016; Ambardekar et al., 2011), high chalky grain rate, high chalkiness level (Cheng et al., 2019; Shi et al., 2017), and physicochemical degradation. Solar radiation is also strongly linked to photosynthesis and is a major factor in affecting the production and quality of rice grains, according to a number of studies (Zhang et al., 2017). Therefore, temperature and sun radiation are important factors that affect rice grain output and quality.

Unavailability of Good Quality of Seeds

Poor and marginal farmers are unable to purchase high-quality seeds due to their high cost and limited availability. Private businesses make up the majority of seed producers. Poor farmers are forced to purchase subpar, less productive seeds because they have no other choice (Bhattacharya, 2022). Quality seed is the most important component of a successful production, since it may increase output by 20% on its own. Other inputs and technologies are useless without high-quality seed. However, 63% of the seed supply to farmers is handled by the formal seed system with high-quality seed, while the other 37% is handled by the informal seed sectors, mostly by unregistered farmers and seed producers, where the quality of the seed is questionable, according to agricultural experts and authorities. Aiming for high-quality seed is the greatest strategy to get a significant increase in output and productivity (Sahu et al., 2020).

Poor Economic Conditions of Farmers

The socioeconomic conditions within the nation are closely linked with its agricultural dynamics, since over 80% of its people lives in rural regions and depends on agriculture for their subsistence (Scheidel et al., 2014). The majority of rural Indians rely on agriculture as their main source of income. Eighty percent of farmers produce tiny and marginal yields. Together with their family, they put in 80 hours a week at work to support themselves. They often take out high-interest loans from moneylenders to purchase equipment, seeds, fertilizer, insecticides, pesticides, and other items. Interest paid to moneylenders is consistently more than interest collected on loans from government agencies. However, many choose these high interest payers because the government programs are unavailable or they are not aware of them. These have a serious negative influence on farmers, even leading to suicide (Bhattacharya, 2022). High input prices and financial constraints can push agricultural families into debt, making them more vulnerable and occasionally requiring the sale of land to pay off debt (Green, 2019).

Small and Fragmented Land

Inefficiency is positively and strongly correlated with land fragmentation, whereas inefficiency is negatively and dramatically correlated with crop diversification and land ownership. It seems that small farms are less inefficient than huge ones. Furthermore, when compared to their counterparts, diverse cropping patterns, big farms, owner-operated farms, as well as unfragmented farms have better average profit efficiencies (Manjunatha et al., 2013). Each year, the amount of land used for farming shrinks for each farmer. This is because of India's inheritance law structure. For instance, if a person dies with four children—two each—his land is split into four parts, which are further divided into eight parts. The majority of farmers own a modest amount of scattered land as a result of this structure. Due to the fact that the irrigated water often travels to other fields, a small area of land suffers greater irrigation issues (Bhattacharya, 2022).

Weeds, Rodents, Insects-Pests

In the rice producing sector, rodents present a special challenge since they cause issues from seeding to harvest. In rice-growing regions, the typical loss from the rice field rat is between 10 and 20 percent. Rice cultivation is hampered by a variety of rodent species. Nonetheless, the smaller bandicoot rat, black rat, and rice field rat remain the primary rodent problems. In many different ways, rodents harm rice harvests. Rats will eat the rice seed

after it has been disseminated, as well as early seedlings and mature plants. Additionally, rats will destroy the rice bunds by digging tunnels and creating nests. The bunds may fall as a result of this (King, 2024). Rice needs a lot of water, and obstructed water breeds bacteria, mosquitoes, and other insects. This is because mosquito larvae prefer stagnant water as their breeding ground. Malaria, dengue, and other deadly illnesses are transmitted by them (Bhattacharya, 2022). The threat concerning weeds along with destruction from termites, nematodes, rats, insects, and illnesses may drastically lower the production of component crops in rice-wheat systems. How pest species as well as their pressure vary from a particular crop to another, in addition to how the system alters the vulnerability of the two crops by increasing or decreasing pest populations or activity, or permitting some kind of management, are the key concerns for rice-wheat systems (Timsina and Connor, 2001).

Recurrent Floods and Droughts

The first quarter of the twenty-first century saw more than half of all floods, droughts, and storms which have taken place in the last 120 years, severely affecting the nations that produce the majority of the world's rice. Those whose livelihoods rely on rice cultivation and the world rice market may be seriously at danger from these catastrophic weather occurrences. More than half of the world's population depends on rice as a staple diet, and it is mostly grown in Asia, where drought and flooding are significant problems. Approximately one-third of Asia's 140 million hectares of rice fields are vulnerable to drought and flooding. Rice output may be impacted by droughts in a variety of ways, depending on the crop's stage. Thus, food shortages of various intensities have traditionally resulted from drought, which has had a considerable economic impact. For example, in India, from 1870 to 2016, six of the seven main famines were brought on by crop failure brought on by extreme droughts (Bairagi and Morat, 2021; Mishra *et al.*, 2019). Water shortage is now a persistent issue in many regions of the globe because of rising greenhouse gas emissions and more frequent severe weather events. Approximately 1.3 billion people currently lack access to clean water, and the UN estimates that one-third of the world's population lives in areas that are severely water scarce. In the world's rice bowls, particularly in China and India, the scarcity of water is most noticeable (Surendran et al., 2021).

Inadequate Technology Usage

Due to illiteracy, high expenses, and impracticability for small land holdings, adoption of modern agricultural methods and technologies is insufficient. It takes considerable planning before introducing any new technology since agricultural methods in India are too random and non-scientific. Technology must be screened since not all breakthroughs are applicable or appealing to all fields (Bhagde, 2014). Most Indian farmers do not employ contemporary agricultural equipment because they are unaware of the latest technological advancements. Traditional implements like sickles and bullock-drawn ploughs are very important to them. It requires more personnel, energy, and labor expenses. It yields a lower reward in exchange. Wealthy farmers employ equipment for transporting, harvesting, and irrigation. However, these devices need a steady source of electricity (Bhattacharya, 2022).

Insufficient Input Usage

Insufficient input usage is prevalent in the rainfed environment of eastern India due to concerns about failure of crops or other input-related limitations, such as high input prices, delayed delivery of input in the necessary amount, and other technical as well as socioeconomic restrictions. Agrochemicals and insecticides are expensive, which limits their usage on farms. Policies are thus required to guarantee the timely delivery of essential inputs as well as to promote the use of possible biological alternatives to agrochemicals. Lastly, it is imperative that development agencies work together to maximize irrigation potential via water collecting (Singh et al., 2012).

3.3 International Trade

The exchange of money, products, and services beyond national boundaries or territories due to a need or desire for such commodities or services is known as international commerce. In the majority of nations, this kind of commerce accounts for a significant portion of GDP. Goods and services are traded between nations in international commerce. Regarding the degree of regulation imposed on global commerce, there are two extreme points of view: protectionism and free trade. A free trade paradigm allows for the unrestricted movement of commodities and services between or within nations, free from governmental interference. Trade restrictions include tariffs and non-tariff trade obstacles, as well as levies. On the other hand, protectionism aims to safeguard indigenous companies

and decent pay. Tariffs on imported products, subsidies, and quotas are the three most prevalent types of protectionism (Hans and Prasanna, 2023).

Agricultural trade is defined as the buying and selling of products produced by the farming and forestry fields. Customers may be able to acquire a greater variety of agricultural goods via it, sometimes at reduced prices. Exporting and importing agricultural products and related services between nations is known as international agricultural commerce. Agricultural exporting is the practice of selling products and services related to agriculture from one's own nation to another. However, the term "agricultural importing" refers to the acquisition of agriculturally related foreign products and their transit into one's own country (SinghSaluja and Jangde, 2022).

"Agricultural trade" describes the business operations involved in transferring agricultural commodities and services, including farm, horticultural, and related products, across one nation to another. The term "agricultural marketing" encompasses all activities necessary to transmit agricultural goods from producers to consumers via a variety of marketing channels, such as ownership transfer, place (transportation), time (storage), and form (processing). The Indian economy is based on agriculture. The agricultural sector employs 170 million of the 320 million total workers (Rehman et al., 2012).

India is among the world's leading exporters of agricultural products. In 2021–2022, the country's total exports of agricultural products came to US$49.6 billion, up 20% from US$41.3 billion in 2020–21. India's agricultural sector exports mostly textile and related items, marine products, plantation products, and agriculture and related products. Over 19% of India's total agricultural exports in 2021–2022 were rice, making it the country's top agricultural export (SinghSaluja and Jangde, 2022). In order for farmers and those working along the food supply chain to make a living, trade is essential. Along with giving consumers more options for consumer products, it also helps to lessen food insecurity worldwide. In comparison to the Rs. 20734.8 Crore exported during the same time in 2019, the exports of agricultural goods from March 2020 to June 2020 were Rs. 25552.7 Crore, indicating a significant 23.24% rise. The share of India's agricultural exports in its agricultural GDP climbed from 9.4% in 2017–18 to 9.9% in 2018–19. India had an agriculture and allied product trade surplus of $11.8 billion worldwide in 2021. The top exports were refined sugar, carabeef, prawns, seafood, spices, and Basmati rice (Hans and Prasanna, 2023).

Agriculture has been the main driver of the Indian economy for a long period after independence, and it has expanded significantly throughout time. Recent agricultural data demonstrates that agricultural output growth has outpaced domestic demand and produced a sizable quantity of marketable surplus. India can compete in international markets and earn valuable foreign cash thanks to this excess quantity (Gohain and Biswas, 2022). For every nation, the exchange rate is seen to be one of the most useful tools for imports or exports. An overpriced native currency may promote imports while having a negative impact on exports from the home nation. It would raise the price of exporting nations' goods abroad and vice versa. There is a wealth of research on the connection between foreign commerce and currency rates (Gohain and Biswas, 2022).

According to Bhatnagar *et al.* (2019), they found that the income elasticity was higher than the elasticity of import and export prices. Imports, which were less susceptible to changes in currency rates, were explained by the shift in India's gross domestic product. Consequently, India's import and export will not be significantly impacted by changes in the real currency rate. Similarly, a country's exports would rise if global tariffs dropped, and vice versa. Increased import taxes in destination nations result in higher import costs and lower exports for local exporters. Another important factor affecting a nation's exports is its world GDP per capita. If the global GDP rises, home exports should rise as well. An improvement in yield per hectare productivity would result in greater exportable excess from a supply-side perspective. In addition, the difference in the prices of comparable goods in the United States and other countries is the best measure of the prevalence of international commerce. A country's export prospects would be stronger if the price difference between its domestic and international goods was greater since there would be a demand for its items if the local price was lower than the global price (Gohain and Biswas, 2022).

3.4 India’s growing importance in Global Rice Trade

India has been a major participant in the world rice trade during the 2010s thanks to a number of causes.The major reason behind it is the rise in domestic rice output. Secondly, there has been a strong and increasing demand over the last few years for agricultural grain imports from a number of nations, notably India's neighbors, Bangladesh, Sri Lanka, and Nepal. Furthermore, frequent grain shipments from India to Western African nations have been made easier by improved access to deep-water ports, which are built to handle big,

heavily laden ships (Trego, 2021).Third, the amount of grain that can be exported is limited by the domestic demand for food, which has generally remained low and hasn't increased in tandem with the rise in output. The way Indian rice prices have behaved in comparison to global levels is a fourth element (Thomas and Satheesha, 2024).

From 2017 to 2018, India started to outperform other significant rice-exporting Asian nations in terms of the rates at which rice is sold in the international marketplace. When Vietnam and Pakistan were able to export rice at lower prices than India in the early 2010s, the scenario was different. Nonetheless, domestic demand in Vietnam, Pakistan, and Thailand has remained robust, despite the sharp increase in rice export prices since the late 2010s. India's rice exports increased dramatically in 2019–20 as a consequence of its superior Indica (non-basmati) rice being offered for far less than its rivals. There is a great deal of volatility in the rice export business. Export prices decline as export quantities rise, and vice versa. Food shortages and uncertainty among farmers were caused by the substantial increases in food prices that occurred globally in 2007–2008 and 2010–2012. Vietnam was the first country to restrict rice exports during the 2007–2008 food crisis, followed by India, Pakistan, and Thailand. As a result, rice shipments decreased worldwide, which raised rice prices on the global market (Glauber and Mamun, 2024a; Thomas and Satheesha, 2024; Piesse and Thirtle, 2009).

International cereals prices started to climb rapidly after the interruptions caused by COVID-19, starting in September 2020. In April 2020, rice prices have already risen to a high level before those of other grains (maybe as a result of more severe supply-chain disruptions in developing nations that grow rice). In export markets, the price increase was promptly exploited by the Indian dealers. India exported 9.8 million tons of rice in 2018–19, 14.6 million tonnes in 2020–21, and 22.1 million tonnes in 2021–22. The actions of India, a major participant in the rice export market, have a big influence on rice prices worldwide. The stagnating rice shipments from other Asian nations were more than offset by India's increased rice exports in 2021, which caused worldwide rice prices to begin declining (Thomas and Satheesha, 2024).

Since the 2010s, India's rice exports have grown rapidly. Because India accounts for around 40% of global rice exports, any change in the amount of grain sold by India has direct implications for international rice commerce. India prohibited the export of non-basmati

white rice in July 2023, mostly to secure enough local supply, raising fears of a large increase in global rice prices. According to recent sources, during the ten months after the export ban, India's rice shipments to Africa and Asia fell by 43% and 25%, respectively. Furthermore, these limitations have caused a significant spike in rice prices in surrounding countries, particularly Nepal and Sri Lanka (Glauber and Mamun, 2024b). At least in the shorter term, India's prohibition on the export of non-basmati rice types is probably going to make worries about food shortages in Africa worse. Africa received over 45% of India's total rice exports in 2022–2023. Kenya, Guinea, Madagascar, Côte d'Ivoire, and Benin are major importers of Indian rice. The interruptions in international food grain commerce brought on by the conflict between Russia and Ukraine also impact Africa, an area that suffers from a food shortfall (Thomas and Satheesha, 2024).

3.4.1 Types of Rice & their Export Destination

India's rice production, supply, as well as exports have all spiked dramatically over the last 20 years, and they are all significantly higher than the comparable wheat data. The output of rice in India increased steadily between the middle and the end of the 2000s, then leveled off at 105 million tonnes in the first half of the 2010s before soaring once again in the second half of the decade to reach 135.5 million tonnes in 2022–2023. In the early 2010s, India started exporting huge amounts of rice. For the most of that decade, the nation's rice exports fell between 10 and 12 million tons. India's rice exports increased even more after 2020–21, reaching 20 million tons or more. Since 2018–19, exports have contributed at least one-third of the nation's increased rice output (Thomas and Satheesha, 2024). The table below offers information on the proportion of different varieties of rice in India's exports for 2022–2023, as well as the main export markets and export limitations.

Table 3 Different Varieties of Rice India Exports to Major Destinations with Export Restrictions for the year 2022-23

Rice types	Shares in India's rice exports in 2022-23 (in %)	Major export destinations	Export restrictions (if any)
Non-basmati Rice, Parboiled	35.8	Africa, South Asia	No restrictions
Non-basmati Rice, White	29.4	Africa, South Asia	Exports banned in July 2023
Basmati Rice	21.2	West Asia	No restrictions
Broken rice	13.8	China	Exports banned in September 2022

Source: (Ministry of Consumer Affairs, 2023)

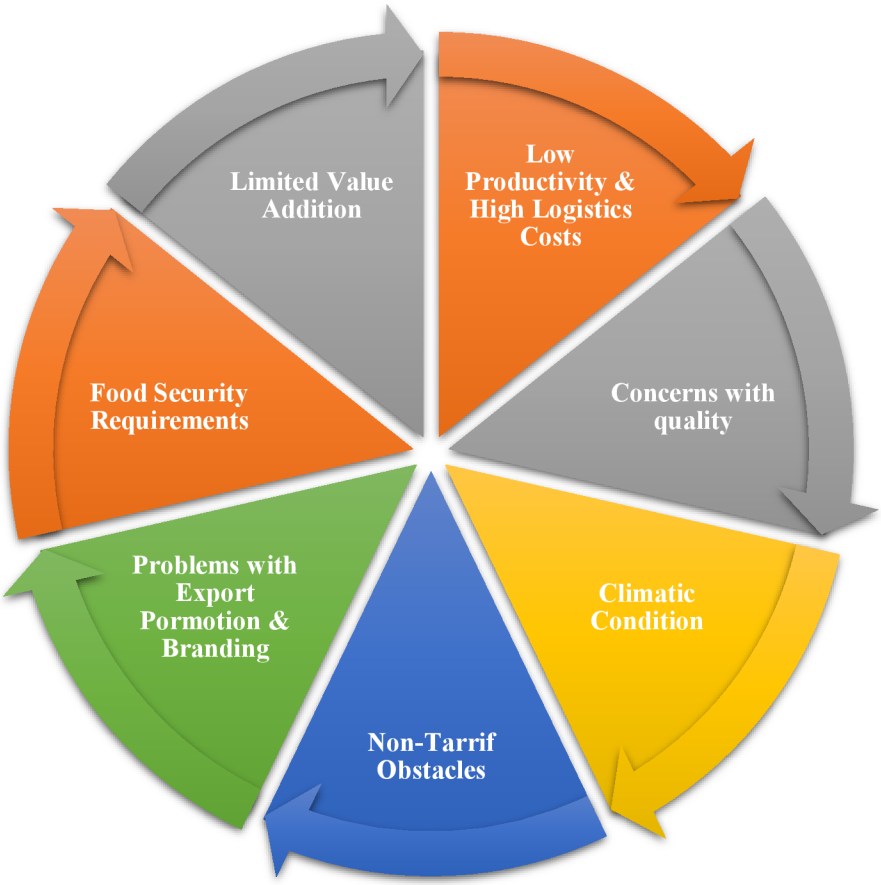
From the above table it can be observed that Parboiled non-basmati rice makes up the majority of India's rice exports, with 35.8% in 2022–2023. Its main export markets are South Asia and Africa, two continents that significantly depend on rice imports to satisfy their demands for food security. Crucially, this kind is unrestricted in its exports, guaranteeing a consistent supply to these areas. However, 29.4% of exports are non-basmati white rice, which is mostly sent to South Asia and Africa. However, in July 2023, white rice exports were prohibited, which would cause disruptions in these markets. With a substantial 21.2% market share in India's rice exports, basmati rice is renowned for its exceptional quality and fragrance. West Asian nations are the main export markets for basmati rice, which is a mainstay in many of their cuisines. Interestingly, export limits on basmati rice do not exist, which enables India to continue dominating this high-end market (Ministry of Consumer Affairs, 2023).

China is the main destination for broken rice, which makes up 13.8% of India's total rice exports and is used there for industrial and animal feed applications. However, in September 2022, broken rice exports were prohibited, perhaps to guarantee local supply considering its significance in low-cost food manufacture and other uses. India's emphasis on maintaining domestic food security in the face of possible supply constraints is reflected in the export limitations on non-basmati white rice and broken rice. These policies have the potential to have a major effect on importing nations, particularly those that rely largely on Indian rice exports, which might result in changes in prices and shortages of supply on the international market (Ministry of Consumer Affairs, 2023).

3.5 Challenges in Indian Rice Export

Agri-exports have advanced significantly since independence. The value of India's agricultural exports increased from about Rs. 149 crore in 1950–51 to Rs. 305469 crore in 2020–21. Almost all agricultural goods have seen significant increases in exports over the last 12 years; nevertheless, India fails to place amongst the most prominent exporters of agricultural commodities, even though it is one of the top producers of agricultural commodities (Kumar, 2021). The following are some of the issues that lead to India's comparatively poor ranking in terms of agricultural exports worldwide.

Figure 3 Issues Leading to India's poor ranking in Agriculture Exports Globally



Source: Researher's own Compilation based on (Sharma and Karthikeyan, 2024, Kumar, 2021, Sharma, 2023)

Low Productivity & High Logistics Costs

When it comes to yield per hectare, India behind other major producers for a variety of commodities, such as buffalo, shrimp, mango, and spices. The fact that Indian farms are typically tiny (1-2 hectares) makes it more difficult to get economies of scale. Furthermore, very little mechanization occurs, and Indian farmers do not use many of the high-yield input types seen in other agricultural nations. Logistics costs in India are now over 14% of GDP, which is more than those in industrialized exporting nations like the US (9.5%). India's enormous efforts to get logistical costs down to less than 10% will have a big effect on how competitive it is in exporting farms (Kumar, 2021).

Concerns with quality

Indian agricultural products satisfy domestic sanitary and phytosanitary (SPS) requirements, but they face problems in the US and the EU. SPS problems prevent India from making a substantial inroad into the European market and result in at-port rejections, particularly for shrimp and spices. India, for example, received the most US notices and rejections between 2014 and 2018, highlighting the quality issues India would face in order to increase exports (Kumar, 2021).

Climatic Condition

One of the challenges behind India rice export is its climatic condition, El Niño's dry circumstances. Global concerns have been raised about El Niño's effects on rice production, which have been seen across Asia. A decrease in rice output has historically occurred during El Niño episodes. A shortage of supply on the international market as a consequence of the decline in rice output brought on by these unfavorable weather patterns raises the price of rice exports (Sharma and Karthikeyan, 2024).

Non-tariff obstacles

Indian agricultural exports are also subject to non-tariff hurdles in lucrative markets like Europe (such as stricter inspections for shrimp compared to other leading exporting nations and restrictions on buffalo foot and mouth disease, which is really uncommon in India). One of the main obstacles to significantly growing Indian agricultural exports is the absence of robust trade agreements with target countries and non-tariff trade restrictions (Kumar, 2021).

Problems with Export Promotion and Branding

India has made significant investments in a variety of export promotion programs, although its export incentives have decreased over time. The nation has the chance to increase export incentives along with creating a more focused, well-coordinated investment plan for fostering the growth of agricultural exports with an emphasis on the creation of value as it responds to WTO compliance in export promotion (Kumar, 2021).

Food Security Requirements

Considering local production and food security requirements, the government is always keeping an eye on the situation and evaluating possible changes. Concerns about domestic food security, climate change and its effects on rice output owing to monsoon unpredictability as well as droughts, along with price stability as a result of international wars, internal politics, and power dynamics have all been mentioned as justifications for export constraints (Sharma, 2023).

Limited Value Addition

India ranks 10th in the world for processed meat exports, 18th for processed fruit and vegetable exports, 35th for dairy exports, and 61st for poultry and eggs. This indicates that the nation exports more commodities than value-added agricultural goods. Just 16% of India's agricultural exports are processed foods. Relatively little private sector investment and insufficient incentives are among the causes of poor value addition (Kumar, 2021).

3.6 Supply Chain Bottle Necks in Rice Export Logistics

Given that rice is the staple grain of everyday life in India, rice is constantly in high demand and exhibits a seasonal upward tendency, particularly during festivals and other cultural events. The main goal of the rice supply chain is to determine the right demand and satisfy it in a manner that is profitable. In order to satisfy client requests without losing revenue, sourcing, processing, distribution, and retailing must be done efficiently, which requires a strong supply chain management framework. One of the oldest and most significant difficulties facing the Indian economy is the production and sale of rice, yet no suitable supply chain architecture has yet been established for it, which often results in unmet demand, stock outs and overstocking, and distribution problems (Sharma et al., 2013).

A rise in fuel prices has resulted in higher transportation costs for rice exporters, both basmati and non-basmati, while the second wave of the coronavirus has slowed demand in the Gulf. The price of basmati rice has dropped 4–7% over the last ten days, while exporters claim that the cost of shipping the rice from Haryana to the ports of Mundra and Kandla has risen by more than 20% (Ghosal, 2021). There has been a significant coal shortage in the nation in recent months. The railway ministry was forced to redirect the freight trains in order to transport coal to the power plants because of the severe shortage. Rice cannot be transported from the manufacturing hubs to the ports due to a lack of freight trains. Five

hundred thousand tons of rice are to be sent from Chhattisgarh to the ports on the east coast. In fact, these train shortages may be impeding the 1.5 million trains that are expected to be exported from different regions of India (Garg, 2022).

Even with favorable weather, harvesting has been slowing down because private rice millers won't keep government paddy, and about 90% of the purchased crop is stranded in mandis. Without immediate action, the logistical, administrative, and political issues that are causing this scenario are certain to become worse (Chaba, 2024). Storage space is becoming a major challenge as the state government prepares to purchase 185 lakh metric tons (LMT) of paddy valued at Rs 48,380 crore beginning on October 1. Approximately 123 LMT of rice will be produced by the purchase. However, finding storage for the additional harvest is a major difficulty since granaries are filled to capacity with the rice and wheat supplies from prior years (Khanna, 2024).

More than 200,000 metric tons of goods are stranded at all of the main container ports, including Mundra, Nhava Sheva, and Vizag, according to Varun Goel, vice president of the Indian Rice Exporter's Federation (Rana and Anand, 2024). The dilemma of container shortages is putting pressure on Indian rice exporters. As per S&P Global Commodity Insights, they are dealing with abrupt and sporadic freight cancellations due to a severe container scarcity in the area. The sudden container shortage has been attributed to a number of causes, including the increase in demand for freight from China to the US and the lengthier transit routes resulting from the Red Sea battle. According to estimates, the rice export sector in India has been negatively affected by the shipping lines' exceptional increase in ocean freight prices of up to 150%. Rice exporters claim that large amounts of the grain are languishing at major container ports, which are congested. Release orders for several confirmed bookings have been canceled since May (“Exim”, 2024).

4 Practical Part

4.1 Fundamentals of Rice Production in India

The fundamentals of rice production include the amount of rice produced in India, its consumption, imports, exports, and availability per capita. The production of rice determines how much is consumed or how much is available per person. Additionally, rice production is a prerequisite for rice exports. Furthermore, adjustments to imports may result in adjustments to output, which may alter the production's dependent variables, such as availability, exports, and consumption. Changes in production, imports, exports, or consumption will also have an impact on the country's GDP. Therefore, it is vital to examine each variable and its pattern in order to ascertain how one variable affects another.

4.1.1 Area of Rice Production & Growth Rate

The following table shows the Area of Rice production (in million hectares) in India from the year 2006-2020. It also shows the growth rate (Calculated using Formula 4) in the area of production of Rice in India for the duration

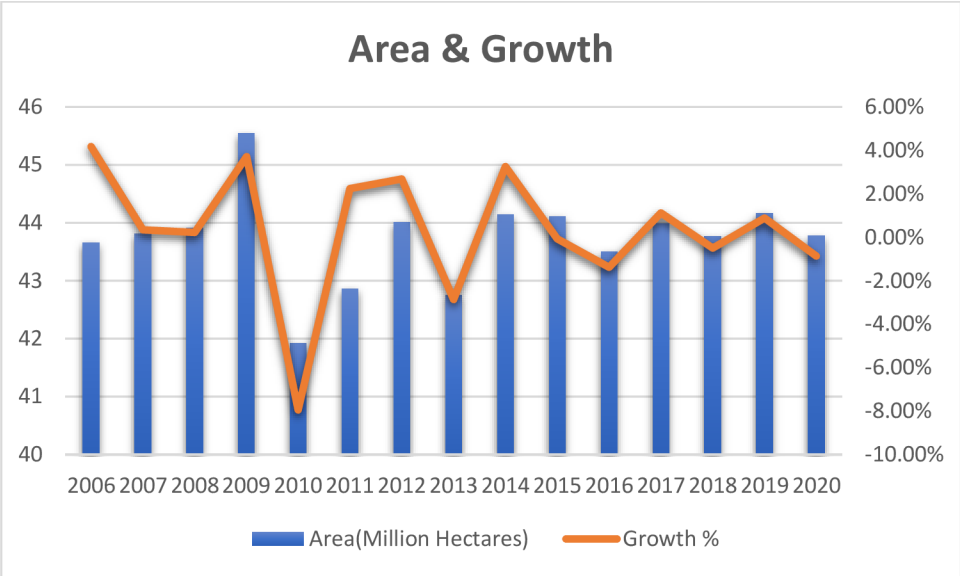
Table 4 Area of Rice Production (in million hectares) & its growth rate (%) in India from the year 2006-2020

Year	Area(Million Hectares)	Growth %
2006	43.66	4.18%
2007	43.81	0.34%
2008	43.91	0.23%
2009	45.54	3.71%
2010	41.92	-7.95%
2011	42.86	2.24%
2012	44.01	2.68%
2013	42.75	-2.86%
2014	44.14	3.25%
2015	44.11	-0.07%
2016	43.5	-1.38%
2017	43.99	1.13%
2018	43.77	-0.50%
2019	44.16	0.89%
2020	43.78	-0.86%

Source: Researher's own Compilation based on FAO data

The graphical representation for the above table is given in the following clustered bar graph for the better comparison of area of production of Rice and its growth rate for the year 2006-2020.

Figure 4 Area of Rice Production & its Growth rate from 2006-2022



Source: Researher's own Compilation based on FAO data

The above figure highlights the changes in the area under cultivation (measured in million hectares) and its annual growth percentage for rice production in India from 2006 to 2020. Over the course of the 15-year period, the cultivated area saw both periods of increase and contraction. This demonstrated how agricultural practices are dynamic and how outside factors affect how land is used. Early on, there was a noticeable gain of 4.18% in the area under cultivation, followed by lesser but still good growths of 0.34% in 2007 and 0.23% in 2008. The largest area in the dataset, 45.54 million hectares, was reached in 2009 after a notable rise of 3.71%. But by 2010, the area had drastically shrunk by -7.95% to 41.92 million hectares, either as a result of crop diversification, policy changes, or adverse weather. Following 2010, the area saw a period of recovery, with modest increase in 2011 (2.24%) and 2012 (2.68%), returning to 44.01 million hectares by 2012.

However, there was a -2.86% drop in 2013, and then a 3.25% growth in 2014. From 2015 to 2019, there were only slight variations in the cultivated area, alternating between slight decreases (for example, -0.07% in 2015 and -1.38% in 2016) and small increases (for example, 1.13% in 2017 and 0.89% in 2019). The area decreased by a further -0.86% in 2020, reaching 43.78 million hectares. These patterns imply that while the cultivated area has mostly stayed within a stable range.

4.1.2 Rice Production & its Growth Rate

The following table shows the Rice production (in million tonnes) in India from the year 2006-2020. It also shows the growth rate (Calculated using Formula 4) in the production of Rice in India for the duration.

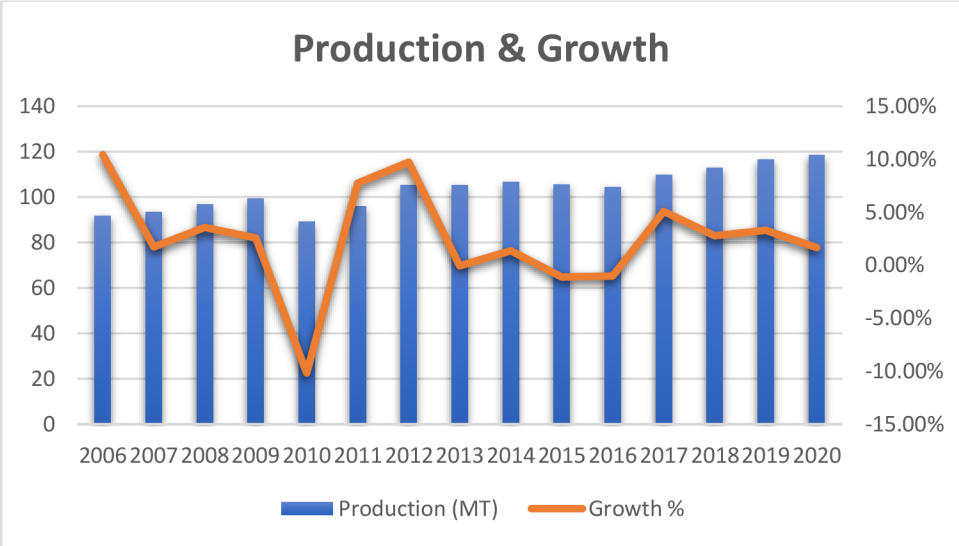
Table 5 Rice production (in million tonnes) & its growth rate (%) in India for the year 2006-2020

Year	Production (MT)	Growth %
2006	91.79	10.42%
2007	93.36	1.71%
2008	96.69	3.57%
2009	99.18	2.58%
2010	89.09	-10.17%
2011	95.98	7.73%
2012	105.3	9.71%
2013	105.23	-0.07%
2014	106.65	1.35%
2015	105.48	-1.10%
2016	104.41	-1.01%
2017	109.7	5.07%
2018	112.76	2.79%
2019	116.48	3.30%
2020	118.43	1.67%

Source: Researher's own Compilation based on FAO data

The graphical representation for the above table is given in the following clustered bar graph for the better comparison of rice production and its growth rate for the year 2006-2020.

Figure 5 Rice Production & its Growth rate from 2006-2022



Source: Researher's own Compilation based on FAO data

The above figure presents information on India's rice output (measured in million tonnes) and its yearly growth % from 2006 to 2020. It shows a tendency of fluctuation during the 15-year period, but an overall upward trend. The output of rice increased significantly in the early years, rising by 10.42% to 91.79 MT in 2006. Production reached 99.18 MT with modest growth rates of 1.71% in 2007, 3.57% in 2008, and 2.58% in 2009. But in 2010, output dropped precipitously by -10.17% to 89.09 MT, most likely as a result of unfavorable meteorological events like droughts or floods or restrictions imposed by legislation. In the year 2011, production of rice saw the start of the recovery with a strong 7.73% gain, raising output to 95.98 MT. The trend continued in 2012, when output reached 105.3 MT, the biggest growth in the decade, a notable 9.71% increase. Nonetheless, 2013 was a stabilizing year, with a little decrease of -0.07%, while 2014 saw a tiny increase of 1.35%. Production decreased by -1.10% and -1.01%, respectively, during 2015 and 2016, indicating difficulties such input limitations or climate unpredictability. In 2017, output increased by 5.07% to reach 109.7 MT, marking a recovery.

The greatest output in the dataset, 118.43 MT in 2020, was the result of this rising trend, which persisted through 2018 (2.79%) and 2019 (3.30%). A stabilizing phase is suggested by the modest rise of 1.67% in 2020. Although rice production has generally shown resilience and steady increase over time, the variations underscore the industry's susceptibility to outside influences including weather patterns, the adoption of new technologies, and legislative actions.

4.1.3 Consumption of Rice & its Growth Rate

The following table shows the Rice consumption (in 1000 million tonnes) in India from the year 2006-2020. It also shows the growth rate (Calculated using Formula 4) in the consumption of Rice in India for the duration.

Table 6 Rice consumption (in 1000 million tonnes) & its growth in India from the year 2006-2020

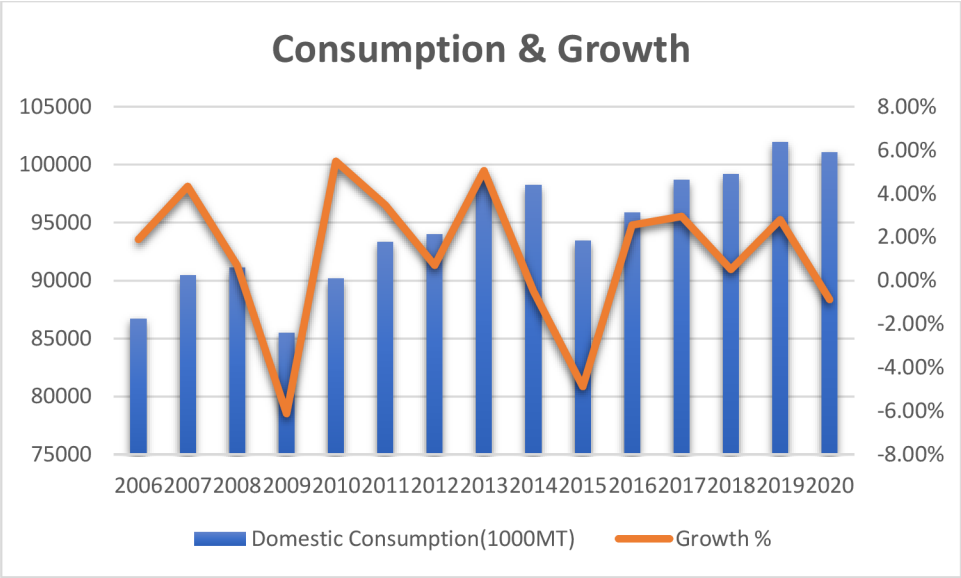
Market Year	Domestic Consumption(1000MT)	Growth %
2006	86695	1.89%
2007	90458	4.34%
2008	91082	0.69%
2009	85501	-6.13%
2010	90196	5.49%
2011	93325	3.47%
2012	93972	0.69%
2013	98727	5.06%

Market Year	Domestic Consumption(1000MT)	Growth %
2014	98244	-0.49%
2015	93451	-4.88%
2016	95838	2.55%
2017	98667	2.95%
2018	99164	0.50%
2019	101950	2.81%
2020	101052	-0.88%

Source: Researher's own Compilation based on FAO data

The graphical representation for the above table is given in the following clustered bar graph for the better comparison of rice consumption and its growth rate for the year 2006-2020.

Figure 6 Rice consumption (in 1000 million tonnes) & its growth in India from the year 2006-2020



Source: Researher's own Compilation based on FAO data

The above figure presents information on domestic rice consumption (measured in thousand metric tons) and its yearly increase % between 2006 and 2020. It shows how consumption patterns fluctuated. In the early years, domestic rice consumption increased steadily, rising by 1.89% in 2006 and hitting a noteworthy 4.34% rise in 2007 to reach 90,458 thousand MT. Growth slowed to 0.69% in 2008, but consumption fell precipitously to 85,501 thousand MT in 2009. While the year 2010 had a strong 5.49% increase, indicating a recovery and returning consumption to 90,196 thousand MT. During 2011 (3.47%) and 2012 (0.69%), this upward trend persisted, and consumption peaked at 93,972 thousand MT. Consumption reached 98,727 thousand MT in 2013, the highest level for the decade, after a

noteworthy 5.06% increase. However, a modest reduction of -0.49% occurred in 2014, and a more severe loss of -4.88% occurred in 2015.

With modest increase of 2.55% in 2016 and 2.95% in 2017, domestic rice consumption began to show indications of recovery in 2016 and reached 98,667 thousand MT. The consumption trends in 2018 (0.50%) and 2019 (2.81%), which peaked at 101,950 thousand MT, were then more consistent. Consumption fell by -0.88% in 2020, to finish the period with 101,052 thousand MT, which may have been caused by changes in consumer behavior or interruptions brought on by the pandemic. Overall, the data shows that domestic rice consumption is trending upward.

4.1.4 Capita Availability of Rice & its Growth Rate

The following table shows the Per Capita Net Availability of Rice (in 1000 million tonnes) in India from the year 2006-2020. It also shows the growth rate (Calculated using Formula 4) in the Capita Availability of Rice in India for the duration.

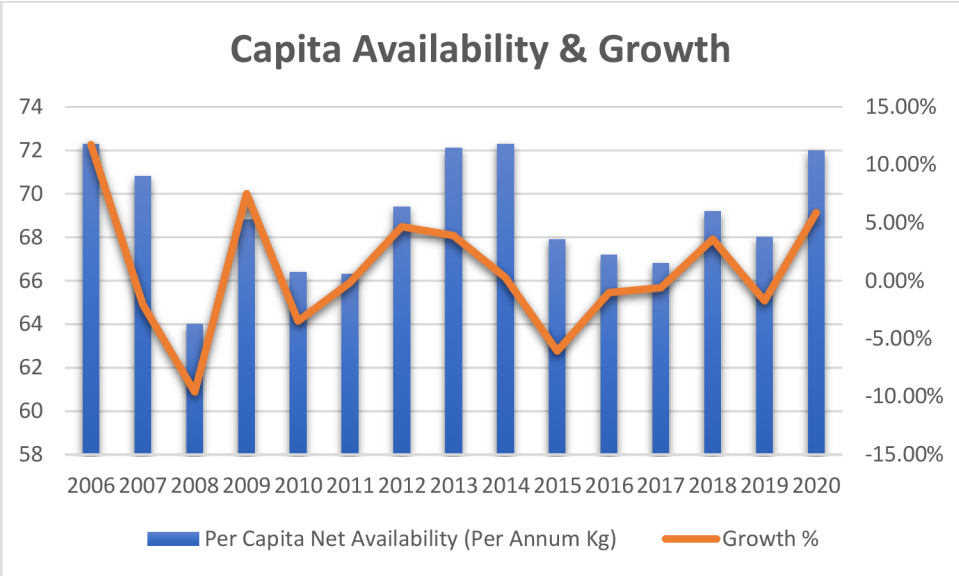
Table 7 Per Capita Net Availability of Rice (in 1000 million tonnes) & its Growth in India from the year 2006-2020

Year	Per Capita Net Availability (Per Annum Kg)	Growth %
2006	72.3	11.75%
2007	70.8	-2.07%
2008	64	-9.60%
2009	68.8	7.50%
2010	66.4	-3.49%
2011	66.3	-0.15%
2012	69.4	4.68%
2013	72.1	3.89%
2014	72.3	0.28%
2015	67.9	-6.09%
2016	67.2	-1.03%
2017	66.8	-0.60%
2018	69.2	3.59%
2019	68	-1.73%
2020	72	5.88%

Source: Researher's own Compilation based on FAO data

The graphical representation for the above table is given in the following clustered bar graph for the better comparison of capita availability of rice and its growth rate for the year 2006-2020.

Figure 7 Per Capita Net Availability of Rice (in 1000 million tonnes) & its Growth in India from the year 2006-2020



Source: Researher's own Compilation based on FAO data

The above figure shows the net yearly availability of rice per person (in kilograms) and its annual growth rate between 2006 and 2020. The availability of rice per person was 72.3 kg in 2006, representing a robust growth rate of 11.75%. However, availability dropped by -2.07% to 70.8 kg in 2007 and had a steep drop of -9.60% to 64 kg in 2008, while for the year 2009 it had a rebound that increased availability to 68.8 kg by 7.50%. The year 2010 saw another -3.49% drop in per capita availability, to 66.4 kg. The availability rose at moderate yearly growth rates (e.g., 4.68% in 2012 and 3.89% in 2013) from 2011 to 2014, peaking at 72.3 kg in 2014 after beginning at 66.3 kg in the year 2011. However, there were repeated decreases from 2015 to 2017, with availability slowly declining to 66.8 kg in 2017 after falling to 67.9 kg in 2015 (-6.09%). In 2018, the recovery phase started, and availability increased by 3.59% to 69.2 kg. However, in 2019, it declined slightly by -1.73% to 68 kg. In 2020, availability increased by 5.88% to 72 kg, either as a result of increased production or changes in demand brought on by the COVID-19 pandemic.

4.1.5 Import of Rice & its Growth Rate

The following table shows the Import of Rice (in 1000 million tonnes) in India from the year 2006-2020. It also shows the growth rate (Calculated using Formula 4) in the Import of Rice in India for the duration.

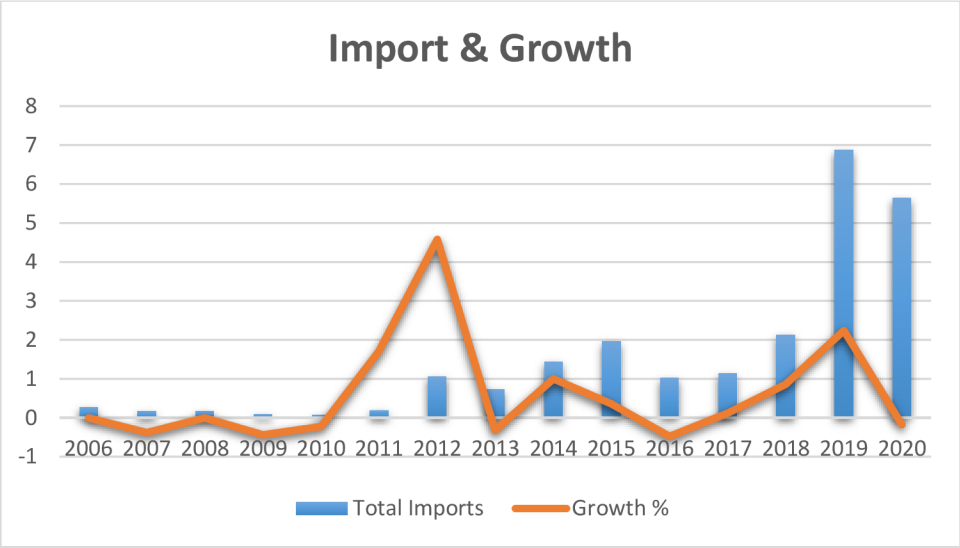
Table 8 Import of Rice (in 1000 million tonnes)& its growth in India from the year 2006-2020.

Year	Total Imports (1000 MT)	Growth %
2006	0.26	0.00%
2007	0.16	-38.46%
2008	0.16	0.00%
2009	0.09	-43.75%
2010	0.07	-22.22%
2011	0.19	171.43%
2012	1.06	457.89%
2013	0.72	-32.08%
2014	1.44	100.00%
2015	1.96	36.11%
2016	1.02	-47.96%
2017	1.14	11.76%
2018	2.12	85.96%
2019	6.87	224.06%
2020	5.64	-17.90%

Source: Researher's own Compilation based on FAO data

The graphical representation for the above table is given in the following clustered bar graph for the better comparison of rice import and its growth rate for the year 2006-2020.

Figure 8 Import of Rice (in 1000 million tonnes)& its growth in India from the year 2006-2020.



Source: Researher's own Compilation based on FAO data

From 2006 to 2020, the above figure shows India's total rice imports (in thousand metric tons) and their yearly growth rates, showing notable variations caused by local production, trade regulations, and market forces. Rice imports in 2006 were negligible at 0.26 thousand MT and remained unchanged from the year before. 2007 had a sharp decline in imports of -38.46% to 0.16 thousand MT, which held steady in 2008. After a sharp

reduction of -43.75% in 2009, which brought imports down to 0.09 thousand MT, the downturn continued in 2010, when imports fell by another 22.22% to barely 0.07 thousand MT. With imports increasing by 171.43% to 0.19 thousand MT in 2011, there was a substantial turnaround. This pattern became much more pronounced in 2012, when imports increased by 457.89% to 1.06 thousand MT, the biggest percentage rise in the record. In 2013, however, imports dropped by -32.08% to 0.72 thousand MT.

Imports doubled to 1.44 thousand MT in 2014, a 100% gain, and then increased by 36.11% in 2015 to reach 1.96 thousand MT. In 2016, the trend drastically reversed, with imports falling to 1.02 thousand MT, a -47.96% decrease. An 11.76% rise to 1.14 thousand MT in 2017 marked a moderate comeback. The imports increased considerably in 2019 to reach 6.87 thousand MT, a 224.06% rise, after rising by 85.96% to 2.12 thousand MT in 2018. Nevertheless, 2020 saw a drop of -17.90%, bringing imports down to 5.64 thousand MT, which may have been brought on by increased local production or decreased demand during the epidemic. In general, India has continued to import a very small amount of rice in relation to its levels of production and consumption.

4.1.6 Export of Basmati Rice & its Growth Rate

The following table shows the Export of Basmati Rice (in 1000 tonnes) in India from the year 2006-2020. It also shows the growth rate (Calculated using Formula 4) in the Export of Basmati Rice in India for the duration.

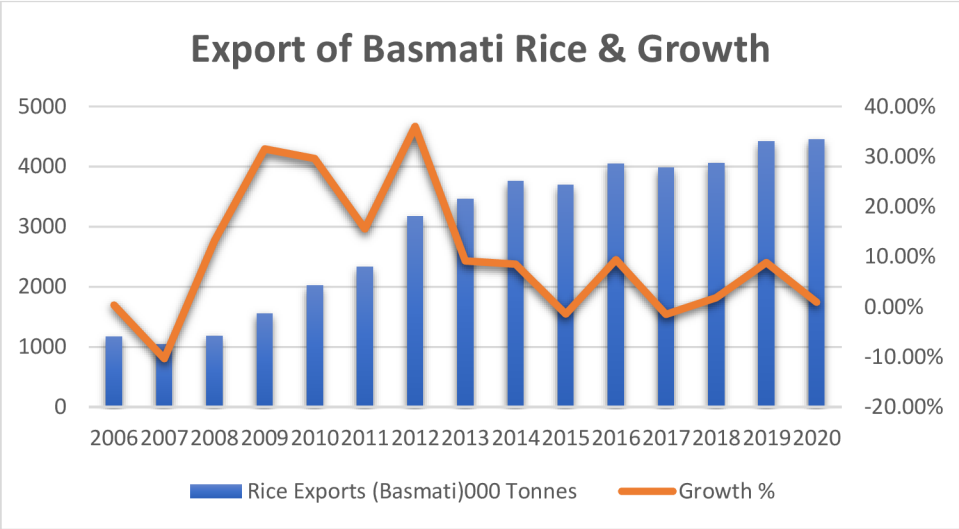
Table 9 Export of Basmati Rice (in 1000 tonnes) & its growth in India from the year 2006-2020

Year	Rice Exports (Basmati)000 Tonnes	Growth %
2006	1166.57	0.31%
2007	1045.73	-10.36%
2008	1183.36	13.16%
2009	1556.41	31.52%
2010	2016.87	29.58%
2011	2330.25	15.54%
2012	3169.45	36.01%
2013	3459.83	9.16%
2014	3754.1	8.51%
2015	3698.93	-1.47%
2016	4045.83	9.38%
2017	3985.21	-1.50%
2018	4056.85	1.80%
2019	4414.61	8.82%
2020	4454.77	0.91%

Source: Researher's own Compilation based on FAO data

The graphical representation for the above table is given in the following clustered bar graph for the better comparison of basmati rice export and its growth rate for the year 2006-2020.

Figure 9 Export of Basmati Rice (in 1000 tonnes) & its growth in India from the year 2006-2020



Source: Researher's own Compilation based on FAO data

The above figure highlights the annual export volumes of Basmati rice (in thousand tonnes) from 2006 to 2020 and their corresponding growth rates, showcasing a trend of significant growth disrupted by occasional declines. In 2006, Basmati rice exports were 1,166.57 thousand tonnes, with minimal growth of 0.31%. In 2007, exports dropped by -10.36%, falling to 1,045.73 thousand tonnes. Recovery began in 2008, with a growth of 13.16%, increasing exports to 1,183.36 thousand tonnes. This trend accelerated in 2009, with a substantial rise of 31.52%, bringing exports to 1,556.41 thousand tonnes. The upward trajectory continued in 2010, with exports growing by 29.58% to 2,016.87 thousand tonnes, followed by a 15.54% increase in 2011, reaching 2,330.25 thousand tonnes. A remarkable growth of 36.01% in 2012 pushed exports to 3,169.45 thousand tonnes, the highest annual growth rate in the dataset. In 2013, exports grew by 9.16% to 3,459.83 thousand tonnes, and further by 8.51% in 2014, reaching 3,754.1 thousand tonnes.

However, in 2015, exports declined slightly by -1.47%, dropping to 3,698.93 thousand tonnes. This was followed by a recovery in 2016, with growth of 9.38%, increasing exports to 4,045.83 thousand tonnes. A small decline occurred in 2017 (-1.50%), reducing exports to 3,985.21 thousand tonnes. The following years showed moderate growth: 1.80% in 2018, reaching 4,056.85 thousand tonnes, and 8.82% in 2019, taking exports to 4,414.61 thousand

tonnes. In 2020, growth slowed to 0.91%, with exports amounting to 4,454.77 thousand tonnes. Overall, Basmati rice exports displayed a strong upward trend over the period, driven by increasing global demand for premium rice varieties.

4.1.7 Export of Non-Basmati Rice & its Growth Rate

The following table shows the Export of Rice (in 1000 tonnes) in India from the year 2006-2020. It also shows the growth rate (Calculated using Formula 4) in the Export of Non-Basmati Rice in India for the duration.

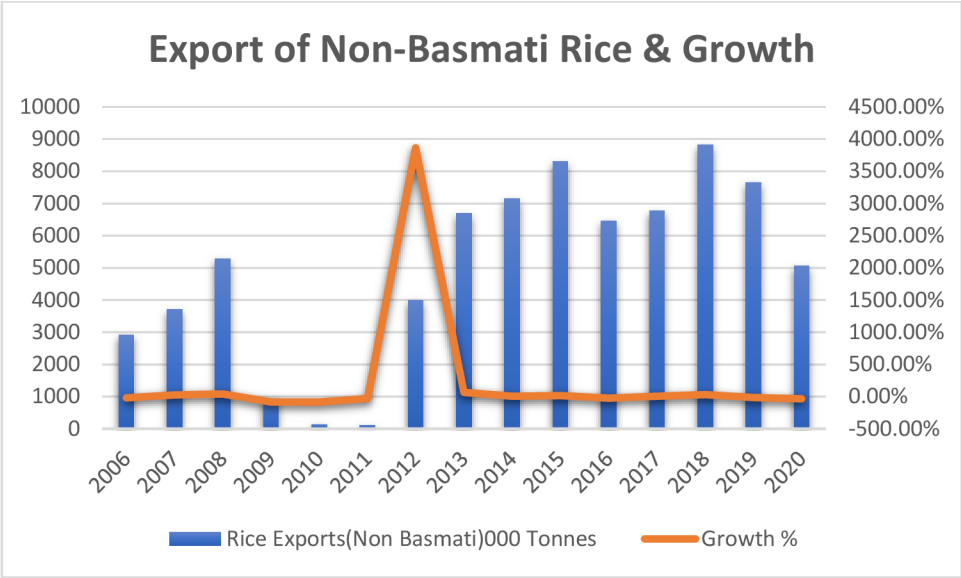
Table 10 Export of Non-Basmati Rice (in 1000 tonnes) & its growth in India from the year 2006-2020

Year	Rice Exports(Non Basmati)000 Tonnes	Growth %
2006	2921.6	-19.18%
2007	3702.22	26.72%
2008	5286.08	42.78%
2009	931.89	-82.37%
2010	139.55	-85.03%
2011	100.68	-27.85%
2012	3991.77	3864.81%
2013	6687.85	67.54%
2014	7148.47	6.89%
2015	8302.21	16.14%
2016	6464.59	-22.13%
2017	6770.83	4.74%
2018	8818.53	30.24%
2019	7648	-13.27%
2020	5056.28	-33.89%

Source: Researher's own Compilation based on FAO data

The graphical representation for the above table is given in the following clustered bar graph for the better comparison of non-basmati rice export and its growth rate for the year 2006-2020.

Figure 10 Export of Non-Basmati Rice (in 1000 tonnes) & its growth in India from the year 2006-2020



Source: Researher's own Compilation based on FAO data

India's yearly exports of non-Basmati rice (measured in thousand tons) from 2006 to 2020 are shown in the above figure, along with the corresponding growth percentages. Exports of non-Basmati rice came to 2,921.6 thousand tonnes in 2006, a decrease of -19.18% from the year before. However, due to strong worldwide demand, exports rose sharply by 26.72% in 2007 to reach 3,702.22 thousand tonnes, and then by 42.78% in 2008 to reach 5,286.08 thousand tonnes. The year 2009 saw a sharp loss in exports of -82.37%, which caused them to fall to 931.89 thousand tonnes. In 2010, exports fell even more, falling to 139.55 thousand tonnes. With exports dropping by -27.85% to 100.68 thousand tons in 2011.

In 2012, exports of non-basmati rice soared by 3,864.81% to reach 3,991.77 thousand tonnes, showing a significant reversal. Exports increased by 67.54% in 2013 to reach 6,687.85 thousand tonnes, and then by 6.89% in 2014 to reach 7,148.47 thousand tonnes, continuing the rising trend. Exports decreased by -22.13% to 6,464.59 thousand tonnes in 2016 after increasing by 16.14% to 8,302.21 thousand tonnes in 2015. After a slight rebound in 2017, exports increased by 4.74% to 6,770.83 thousand tonnes, and then by a robust 30.24% in 2018, reaching 8,818.53 thousand tonnes. However, exports plummeted by -13.27% in 2019 to 7,648 thousand tonnes, and then by -33.89% in 2020 to 5,056.28 thousand tonnes, probably as a result of the COVID-19 pandemic's impact on world trade.

4.1.8 Total Export of Rice & its Growth Rate

The following table shows the Total Export of Rice (in 1000 tonnes) in India from the year 2006-2020. It also shows the growth rate (Calculated using Formula 4) in the Total Export of Rice in India for the duration.

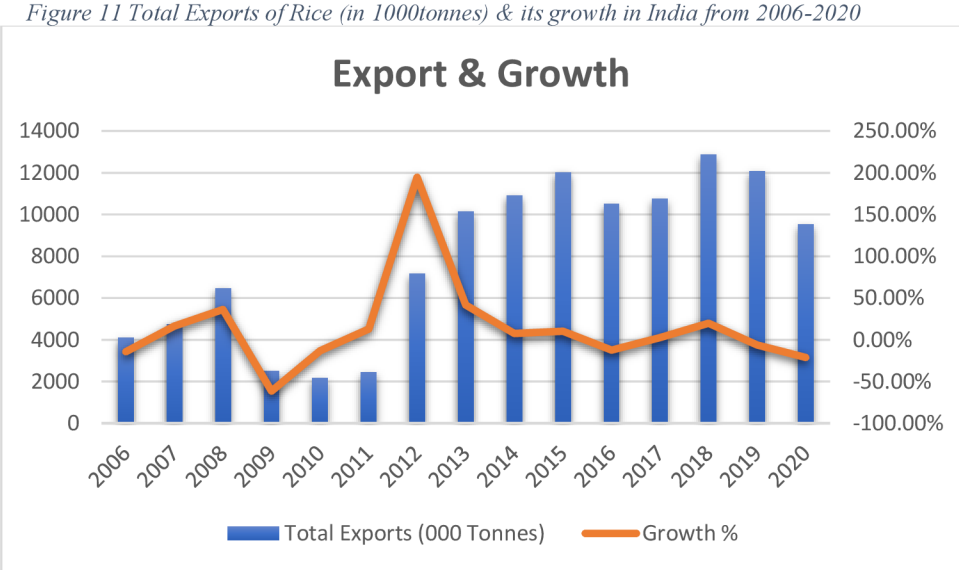
Table 11 Total Exports of Rice (in 1000tonnes) & its growth in India from 2006-2020

Year	Total Exports (000 Tonnes)	Growth %
2006	4088.17	-14.44%
2007	4747.95	16.14%
2008	6469.44	36.26%
2009	2488.3	-61.54%
2010	2156.42	-13.34%
2011	2430.93	12.73%
2012	7161.22	194.59%
2013	10147.68	41.70%
2014	10902.57	7.44%
2015	12001.14	10.08%
2016	10510.42	-12.42%
2017	10756.04	2.34%
2018	12875.38	19.70%
2019	12062.61	-6.31%
2020	9511.05	-21.15%

Source: Researher's own Compilation based on FAO data

The graphical representation for the above table is given in the following clustered bar graph for the better comparison of total rice export and its growth rate for the year 2006-2020.

Figure 11 Total Exports of Rice (in 1000tonnes) & its growth in India from 2006-2020



Source: Researher's own Compilation based on FAO data

From 2006 to 2020, the above figure shows the total yearly rice exports (in thousand tonnes) and their growth percentages. It also shows the notable variations in export volumes brought about for the period under consideration. A total of 4,088.17 thousand tonnes of rice were exported in 2006, a decrease of -14.44% from the year before. In 2007, exports increased by 16.14% to 4,747.95 thousand tonnes. In 2008, they increased significantly by 36.26% to 6,469.44 thousand tonnes. However, exports fell by -13.34% in 2010 to 2,156.42 thousand tonnes after plunging by -61.54% in 2009 to 2,488.3 thousand tonnes. The year 2011 saw a modest recovery in exports, which increased by 12.73% to 2,430.93 thousand tonnes. In the year 2012, exports surged by 194.59% to reach 7,161.22 thousand tonnes. This pattern persisted in 2013, when exports reached a notable high of 10,147.68 thousand tonnes, a 41.70% increase.

The exports expanded by 7.44% in 2014 to 10,902.57 thousand tonnes and by 10.08% in 2015 to 12,001.14 thousand tonnes. Exports, however, fell -12.42% to 10,510.42 thousand tonnes in 2016, indicating shifting market conditions. 2017 saw a little rebound, increasing by 2.34% to 10,756.04 thousand tonnes. After a robust 19.70% gain in 2018, exports reached 12,875.38 thousand tonnes. However, in 2019, exports fell -6.31% to 12,062.61 thousand tonnes. Exports fell 21.15% to 9,511.05 thousand tonnes in 2020, most likely as a result of the COVID-19 pandemic's impact on global commerce.

4.1.9 Gross Domestic Product & its Growth Rate

The following table shows the Gross Domestic Product (in billion US Dollars) of India from the year 2006-2020. It also shows the growth rate (Calculated using Formula 4) in GDP for the duration.

Table 12 Gross Domestic Product (in billion US Dollars) of India & its growth from the year 2006-2020

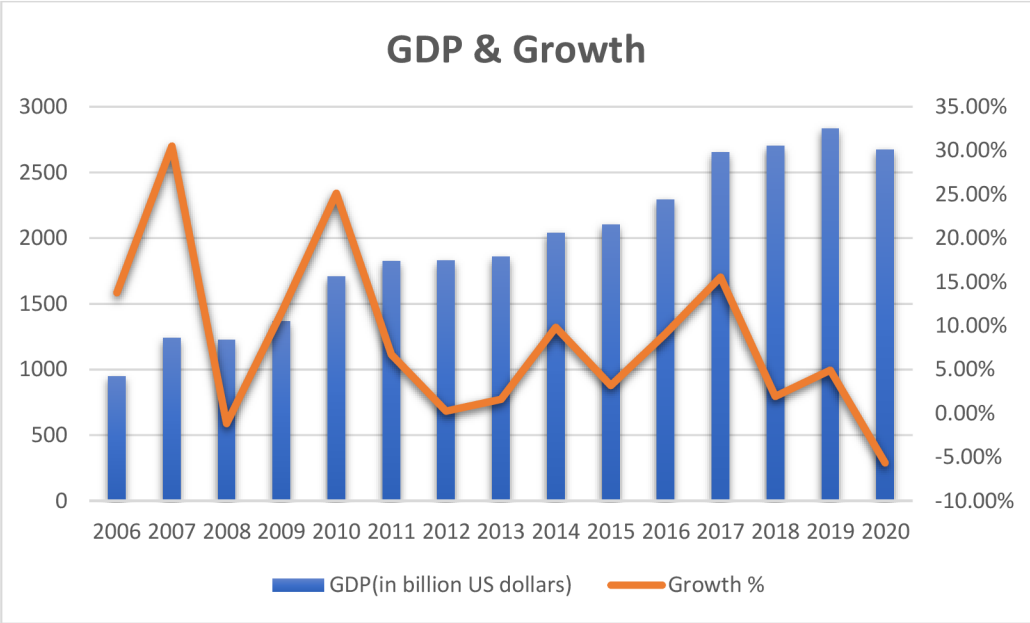
Year	GDP(in billion US dollars)	Growth %
2006	949.12	13.77%
2007	1238.7	30.51%
2008	1224.1	-1.18%
2009	1365.37	11.54%
2010	1708.46	25.13%
2011	1823.05	6.71%
2012	1827.64	0.25%
2013	1856.72	1.59%

Year	GDP(in billion US dollars)	Growth %
2014	2039.13	9.82%
2015	2103.59	3.16%
2016	2294.8	9.09%
2017	2651.47	15.54%
2018	2702.93	1.94%
2019	2835.61	4.91%
2020	2674.85	-5.67%

Source: Researher's own Compilation based on (Statista, 2025)

The graphical representation for the above table is given in the following clustered bar graph for the better comparison of change in GDP and its growth rate for the year 2006-2020.

Figure 12 Gross Domestic Product (in billion US Dollars) of India & its growth from the year 2006-2020



Source: Researher's own Compilation based on (Statista, 2025)

The above figure shows the nation's Gross Domestic Product (in billion US dollars) along with its yearly growth rate between 2006 and 2020. The data shows periods of expansion, downturn, and recovery during this 15-year span. The GDP saw a strong 13.77% rise in 2006, reaching $949.12 billion. It had a remarkable 30.51% increase in 2007 to reach $1,238.7 billion. However, the minor contraction of -1.18% in 2008, which saw it drop to $1,224.1 billion.

In 2009, GDP increased by 11.54% to $1,365.37 billion. This was followed by a significant increase of 25.13% in 2010, which brought GDP to $1,708.46 billion. In the year

2011 there was an increase of 6.71%, and it reached $1,827.64 billion in 2012, when it stalled with just 0.25% increase. In 2013, GDP increased by 1.59% to $1,856.72 billion after a modest rebound. GDP increased 9.82% in 2014, 3.16% in 2015, and 9.09% in 2016 to reach $2,294.8 billion. This growth was consistent from 2014 to 2016. With a notable increase in 2017, GDP increased by 15.54% to $2,651.47 billion. At a record of $2,835.61 billion, growth slowed once again in 2018 (1.94%) and 2019 (4.91%). However, the COVID-19 pandemic's economic effect, which interrupted worldwide commerce, manufacturing, and consumption, caused the GDP to drop by -5.67% to $2,674.85 billion in 2020.

4.2 Hypothesis Testing

The following hypotheses have been developed and put to the test in order to investigate the type, degree, and importance of the relationship between the independent and dependent variables. Regression, Anova, and Corelation have been used for hypothesis testing.

4.2.1 Correlation between Area & Production of Rice

The following table provides the co-relation coefficient for the relationship between Area and Production of Rice using Formula No. 1:

Table 13 Correlation between Area & Production of Rice

	Area	*Production*
Area	1	
Production	0.32595781	1

Source: Researher's own Calculation from SPSS

It can be observed from the above table that there is weak positive correlation i.e. 32.6% between area of production and rice production. It indicates that when area of rice production increases the production of rice also increases, and with the decrease in area of production of rice the rice production decreases as well.

Table 14 Regression Statistics for Area & Production of Rice

Regression Statistics	
Multiple R	0.32595781
R Square	0.106248494
Adjusted R Square	0.037498378
Standard Error	0.297122881
Observations	15

Source: Researher's own Calculation from SPSS

Formula No. 2 has been used to do the calculations mentioned above. Regression analysis may be used to forecast the independent variable's relationship to the dependent variable based on the table above. The R-square value in this table is 0.106, indicating the degree to which the independent variables are affecting the dependent variable. It may be deduced that the study's independent variable, area of production, influences the dependent variable, production of rice, by 10.6% only.

Table 15 Anova for Area & Production of Rice

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.136433664	0.136434	1.54543	0.235765
Residual	13	1.14766608	0.088282		
Total	14	1.284099744			

Source: Researher's own Calculation from SPSS

It is evident from the above table that the p-value is 0.2357, which is significantly higher than 0.05. Therefore, it may be concluded that, at the standard significance level, there is no statistically significant correlation between the area of production (Independent variable) and production of rice (Dependent Variable).

4.2.2 Correlation between Production of Rice & Capita Availability of Rice

The following table provides the co-relation coefficient for the relationship between Production of Rice & Capita Availability of Rice using Formula No. 1:

Table 16 Correlation between Production of Rice & Capita Availability of Rice

	Production	***Capita Availability***
Production	1	
Capita Availability	0.212876174	1

Source: Researher's own Calculation from SPSS

It can be observed from the above table that there is weak positive correlation i.e. 21.3% between production of rice and Capita availability of rice. It indicates that when production of rice increases the Capita availability of rice also increases, and with the decrease in production of rice the Capita availability of rice decreases as well.

Table 17 Regression Statistics for Production of Rice & Capita Availability of Rice

Regression Statistics	
Multiple R	0.212876174
R Square	0.045316266
Adjusted R Square	-0.028120945
Standard Error	0.307084195
Observations	15

Source: Researher's own Calculation from SPSS

Formula No. 2 has been used to do the calculations mentioned above. Regression analysis may be used to forecast the independent variable's relationship to the dependent variable based on the table above. The R-square value in this table is 0.045, indicating the degree to which the independent variables are affecting the dependent variable. It may be deduced that the study's independent variable production of rice, influences the dependent variable, Capita availability of rice, by 4.5% only.

Table 18 Anova for Production of Rice & Capita Availability of Rice

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.058190605	0.058191	0.617074986	0.446217886
Residual	13	1.225909139	0.094301		
Total	14	1.284099744			

Source: Researher's own Calculation from SPSS

It is evident from the above table that the p-value is 0.4462, which is significantly higher than 0.05. Therefore, it may be concluded that, at the standard significance level, there is no statistically significant correlation between the production of rice (Independent variable) and capita availability of rice (Dependent Variable).

4.2.3 Correlation between Production of Rice & Consumption of Rice

The following table provides the co-relation coefficient for the relationship between Production of Rice & Consumption of Rice using Formula No. 1:

Table 19 Correlation between Production of Rice & Consumption of Rice

	Production	***Consumption***
Production	1	
Consumption	0.863219653	1

Source: Researher's own Calculation from SPSS

It can be observed from the above table that there is strong positive correlation i.e. 86.32% between production of rice and Consumption of rice. It indicates that when production of rice increases the Consumption of rice also increases, and with the decrease in production of rice the Consumption of rice decreases as well.

Table 20 Regression Statistics for Production of Rice & Consumption of Rice

Regression Statistics	
Multiple R	0.863219653
R Square	0.74514817
Adjusted R Square	0.725544183
Standard Error	0.15866151
Observations	15

Source: Researher's own Calculation from SPSS

Formula No. 2 has been used to do the calculations mentioned above. Regression analysis may be used to forecast the independent variable's relationship to the dependent variable based on the table above. The R-square value in this table is 0.745, indicating the degree to which the independent variables are affecting the dependent variable. It may be deduced that the study's independent variable production of rice, influences the dependent variable, Consumption of rice, by 74.5%.

Table 21 Anova for Production of Rice & Consumption of Rice

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.956844574	0.956845	38.01003	0.0000
Residual	13	0.32725517	0.025173		
Total	14	1.284099744			

Source: Researher's own Calculation from SPSS

It is evident from the above table that the p-value is 0.000, which is significantly lower than 0.05. Therefore, it may be concluded that, at the standard significance level, there is statistically significant correlation between the production of rice (Independent variable) and consumption of rice (Dependent Variable).

4.2.4 Correlation between Import of Rice & Production of Rice

The following table provides the co-relation coefficient for the relationship between Import of Rice & Production of Rice using Formula No. 1:

Table 22 Correlation between Import of Rice & Production of Rice

	Import	***Production***
Import	1	
Production	0.813285	1

Source: Researher's own Calculation from SPSS

It can be observed from the above table that there is strong positive correlation i.e. 86.32% between import of rice and production of rice. It indicates that when import of rice increases the production of rice also increases, and with the decrease in import of rice the production of rice decreases as well.

Table 23 Regression Statistics for Import of Rice & Production of Rice

Regression Statistics	
Multiple R	0.813285
R Square	0.661433
Adjusted R Square	0.635389
Standard Error	0.181681
Observations	15

Source: Researher's own Calculation from SPSS

Formula No. 2 has been used to do the calculations mentioned above. Regression analysis may be used to forecast the independent variable's relationship to the dependent variable based on the table above. The R-square value in this table is 0.661, indicating the degree to which the independent variables are affecting the dependent variable. It may be deduced that the study's independent variable import of rice, influences the dependent variable, production of rice, by 66.1%.

Table 24 Anova for Import of Rice & Production of Rice

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.83831	0.83831	25.39707	0.000227
Residual	13	0.429106	0.033008		
Total	14	1.267416			

Source: Researher's own Calculation from SPSS

It is evident from the above table that the p-value is 0.000, which is significantly lower than 0.05. Therefore, it may be concluded that, at the standard significance level, there is statistically significant correlation between the import of rice (Independent variable) and production of rice (Dependent Variable).

4.2.5 Correlation between Import of Rice & Consumption of Rice

The following table provides the co-relation coefficient for the relationship between Import of Rice & Consumption of Rice using Formula No. 1:

Table 25 Correlation between Import of Rice & Consumption of Rice

	Import	***Consumption***
Import	1	
Consumption	0.714633765	1

Source: Researher's own Calculation from SPSS

It can be observed from the above table that there is strong positive correlation i.e. 71.4% between import of rice and production of rice. It indicates that when import of rice increases the consumption of rice also increases, and with the decrease in import of rice the production of rice decreases as well.

Table 26 Regression Statistics for Import of Rice & Consumption of Rice

Regression Statistics	
Multiple R	0.714633765
R Square	0.510701418
Adjusted R Square	0.473063066
Standard Error	0.218411228
Observations	15

Source: Researher's own Calculation from SPSS

Formula No. 2 has been used to do the calculations mentioned above. Regression analysis may be used to forecast the independent variable's relationship to the dependent variable based on the table above. The R-square value in this table is 0.5107, indicating the degree to which the independent variables are affecting the dependent variable. It may be deduced that the study's independent variable import of rice, influences the dependent variable, consumption of rice, by 51.07%

Table 27 Anova for Import of Rice & Consumption of Rice

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.647271	0.647271	13.56864	0.002755
Residual	13	0.620145	0.047703		
Total	14	1.267416			

Source: Researher's own Calculation from SPSS

It is evident from the above table that the p-value is 0.002, which is significantly lower than 0.05. Therefore, it may be concluded that, at the standard significance level, there is statistically significant correlation between the import of rice (Independent variable) and consumption of rice (Dependent Variable).

4.2.6 Correlation between Production of Rice & Export of Rice

The following table provides the co-relation coefficient for the relationship between Production of Rice & Export of Rice using Formula No. 1:

Table 28 Correlation between Production of Rice & Export of Rice

	Production	*Export*
Production	1	
Export	0.826425237	1

Source: Researher's own Calculation from SPSS

It can be observed from the above table that there is strong positive correlation i.e. 82.64% between production of rice and export of rice. It indicates that when production of rice increases the export of rice also increases, and with the decrease in production of rice the export of rice decreases as well.

Table 29 Regresssion Statistics for Production of Rice & Export of Rice

Regression Statistics	
Multiple R	0.826425237
R Square	0.682978673
Adjusted R Square	0.658592417
Standard Error	0.17695871
Observations	15

Source: Researher's own Calculation from SPSS

Formula No. 2 has been used to do the calculations mentioned above. Regression analysis may be used to forecast the independent variable's relationship to the dependent variable based on the table above. The R-square value in this table is 0.683, indicating the degree to which the independent variables are affecting the dependent variable. It may be deduced that the study's independent variable production of rice, influences the dependent variable, export of rice, by 68.3%.

Table 30 Anova for Production of Rice & Export of Rice

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.877013	0.877013	28.0067	0.000146
Residual	13	0.407087	0.031314		
Total	14	1.2841			

Source: Researher's own Calculation from SPSS

It is evident from the above table that the p-value is 0.000, which is significantly lower than 0.05. Therefore, it may be concluded that, at the standard significance level, there is statistically significant correlation between the production of rice (Independent variable) and export of rice (Dependent Variable).

4.2.7 Correlation between Import of Rice & Export of Rice

The following table provides the co-relation coefficient for the relationship between Import of Rice & Export of Rice using Formula No. 1:

Table 31 Correlation between Import of Rice & Export of Rice

	Import	***Export***
Import	1	
Export	0.577078	1

Source: Researher's own Calculation from SPSS

It can be observed from the above table that there is moderate positive correlation i.e. 57.70% between Import of rice and Export of rice. It indicates that when import of rice increases the export of rice also increases, and with the decrease in import of rice the export of rice decreases as well.

Table 32 Regression Statistics for Import of Rice & Export of Rice

Regression Statistics	
Multiple R	0.577078
R Square	0.333019
Adjusted R Square	0.281713
Standard Error	0.255003
Observations	15

Source: Researher's own Calculation from SPSS

Formula No. 2 has been used to do the calculations mentioned above. Regression analysis may be used to forecast the independent variable's relationship to the dependent variable based on the table above. The R-square value in this table is 0.333, indicating the degree to which the independent variables are affecting the dependent variable. It may be deduced that the study's independent variable import of rice, influences the dependent variable, export of rice, by 33.3%.

Table 33 Anova for Import of Rice & Export of Rice

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.422074	0.422074	6.490814	0.024298
Residual	13	0.845342	0.065026		
Total	14	1.267416			

Source: Researher's own Calculation from SPSS

It is evident from the above table that the p-value is 0.02, which is lower than 0.05. Therefore, it may be concluded that, at the standard significance level, there is statistically significant correlation between the import of rice (Independent variable) and export of rice (Dependent Variable).

4.2.8 Correlation between Production of Rice & Gross Domestic Product

The following table provides the co-relation coefficient for the relationship between Production of Rice & Gross Domestic Product using Formula No. 1:

Table 34 Correlation between Production of Rice & Gross Domestic Product

	Production	***GDP***
Production	1	
GDP	0.874865	1

Source: Researher's own Calculation from SPSS

It can be observed from the above table that there is strong positive correlation i.e. 87.48% between production of rice and gross domestic product. It indicates that when production of rice increases the gross domestic product of India also increases, and with the decrease in production of rice the gross domestic product of India decreases as well.

Table 35 Regression Statistics for Production of Rice & Gross Domestic Product

Regression Statistics	
Multiple R	0.874865
R Square	0.765389
Adjusted R Square	0.747342
Standard Error	0.152231
Observations	15

Source: Researher's own Calculation from SPSS

Formula No. 2 has been used to do the calculations mentioned above. Regression analysis may be used to forecast the independent variable's relationship to the dependent variable based on the table above. The R-square value in this table is 0.765, indicating the degree to which the independent variables are affecting the dependent variable. It may be deduced that the study's independent variable production of rice, influences the dependent variable, gross domestic product of India, by 76.5%.

Table 36 Anova for Production of Rice & Gross Domestic Product

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.982835	0.982835	42.41077	0.000
Residual	13	0.301264	0.023174		
Total	14	1.2841			

Source: Researher's own Calculation from SPSS

It is evident from the above table that the p-value is 0.000, which is significantly lower than 0.05. Therefore, it may be concluded that, at the standard significance level, there is statistically significant correlation between the production of rice (Independent variable) and gross domestic product of India (Dependent Variable).

4.2.9 Correlation between Consumption of Rice & Gross Domestic Product

The following table provides the co-relation coefficient for the relationship between consumption of rice and gross domestic product of India using Formula No. 1:

Table 37 Correlation between Consumption of Rice & Gross Domestic Product

	Consumption	***GDP***
Consumption	1	
GDP	0.886277	1

Source: Researher's own Calculation from SPSS

It can be observed from the above table that there is strong positive correlation i.e. 88.63% between consumption of rice and gross domestic product of India. It indicates that when consumption of rice increases the gross domestic product of India increases, and with the decrease in consumption of rice the gross domestic product of India decreases as well.

Table 38 Regression Statistics for Consumption of Rice & Gross Domestic Product

Regression Statistics	
Multiple R	0.886277
R Square	0.785487
Adjusted R Square	0.768986
Standard Error	0.148662
Observations	15

Source: Researher's own Calculation from SPSS

Formula No. 2 has been used to do the calculations mentioned above. Regression analysis may be used to forecast the independent variable's relationship to the dependent variable based on the table above. The R-square value in this table is 0.785, indicating the degree to which the independent variables are affecting the dependent variable. It may be deduced that the study's independent variable consumption of rice, influences the dependent variable, gross domestic product of India, by 78.5%.

Table 39 Anova for Consumption of Rice & Gross Domestic Product

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1.05203	1.05203	47.6025	0.000
Residual	13	0.287304	0.0221		
Total	14	1.339334			

Source: Researher's own Calculation from SPSS

It is evident from the above table that the p-value is 0.000, which is significantly lower than 0.05. Therefore, it may be concluded that, at the standard significance level, there is statistically significant correlation between the consumption of rice (Independent variable) and gross domestic product of India (Dependent Variable).

4.2.10 Correlation between Export of Basmati Rice & Gross Domestic Product

The following table provides the co-relation coefficient for the relationship between Export of Basmati rice and gross domestic product of India using Formula No. 1:

Table 40 Correlation between Export of Basmati Rice & Gross Domestic Product

	Basmati Export	***GDP***
Basmati Export	1	
GDP	0.940359	1

Source: Researher's own Calculation from SPSS

It can be observed from the above table that there is Very Strong positive correlation i.e. 94.03% between Export of Basmati rice and gross domestic product of India. It indicates that when Export of Basmati rice increases the gross domestic product of India increases, and with the decrease in Export of Basmati rice, the gross domestic product of India decreases as well.

Table 41 Regression statistics for Export of Basmati Rice & Gross Domestic Product

Regression Statistics	
Multiple R	0.940359
R Square	0.884275
Adjusted R Square	0.875373
Standard Error	0.131417
Observations	15

Source: Researher's own Calculation from SPSS

Formula No. 2 has been used to do the calculations mentioned above. Regression analysis may be used to forecast the independent variable's relationship to the dependent variable based on the table above. The R-square value in this table is 0.884, indicating the degree to which the independent variables are affecting the dependent variable. It may be deduced that the study's independent variable Export of Basmati rice, influences the dependent variable, Gross Domestic Product of India, by 88.4%.

Table 42 Anova for Export of Basmati Rice & Gross Domestic Product

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1.715574	1.715574	99.33565	0.000
Residual	13	0.224516	0.01727		
Total	14	1.940091			

Source: Researher's own Calculation from SPSS

It is evident from the above table that the p-value is 0.000, which is significantly lower than 0.05. Therefore, it may be concluded that, at the standard significance level, there is statistically significant correlation between the Export of Basmati rice (Independent variable) and Gross Domestic Product of India (Dependent Variable).

4.2.11 Correlation between Export of Non-Basmati Rice & Gross Domestic Product

The following table provides the co-relation coefficient for the relationship between Export of Non-Basmati rice and gross domestic product of India using Formula No. 1:

Table 43 Correlation between Export of Non-Basmati Rice & Gross Domestic Product

	Non-Basmati Rice Exports	***GDP***
Non-Basmati Rice Exports	1	
GDP	0.60734	1

Source: Researher's own Calculation from SPSS

It can be observed from the above table that there is moderate positive correlation i.e. 60.7% between Export of Non-Basmati rice and gross domestic product of India. It indicates that when Export of Non-Basmati rice increases the gross domestic product of India increases, and with the decrease in Export of Non-Basmati rice, the gross domestic product of India decreases as well.

Table 44 Regression Statistics for Export of Non-Basmati Rice & Gross Domestic Product

Regression Statistics	
Multiple R	0.60734
R Square	0.368862
Adjusted R Square	0.320313
Standard Error	0.272747
Observations	15

Source: Researher's own Calculation from SPSS

Formula No. 2 has been used to do the calculations mentioned above. Regression analysis may be used to forecast the independent variable's relationship to the dependent variable based on the table above. The R-square value in this table is 0.369, indicating the degree to which the independent variables are affecting the dependent variable. It may be deduced that the study's independent variable Export of Non-Basmati rice, influences the dependent variable, Gross Domestic Product of India, by 36.9%.

Table 45 Anova for Export of Non-Basmati Rice & Gross Domestic Product

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.565202	0.565202	7.597729	0.016337
Residual	13	0.967082	0.074391		
Total	14	1.532284			

Source: Researher's own Calculation from SPSS

It is evident from the above table that the p-value is 0.016, which is lower than 0.05. Therefore, it may be concluded that, at the standard significance level, there is statistically significant correlation between the Export of Non-Basmati rice (Independent variable) and Gross Domestic Product of India (Dependent Variable).

4.2.12 Correlation between Export of Total Rice & Gross Domestic Product

The following table provides the co-relation coefficient for the relationship between Total Export of rice and gross domestic product of India using Formula No. 1:

Table 46 Correlation between Export of Total Rice & Gross Domestic Product

	Export	***GDP***
Export	1	
GDP	0.760804	1

Source: Researher's own Calculation from SPSS

It can be observed from the above table that there is strong positive correlation i.e. 76.1% between Total Export of rice and gross domestic product of India. It indicates that when Total Export of rice increases the gross domestic product of India increases, and with the decrease in Total Export of rice, the gross domestic product of India decreases as well.

Table 47 Regression Statistics for Export of Total Rice & Gross Domestic Product

Regression Statistics	
Multiple R	0.760804
R Square	0.578823
Adjusted R Square	0.546424
Standard Error	0.243213
Observations	15

Source: Researher's own Calculation from SPSS

Formula No. 2 has been used to do the calculations mentioned above. Regression analysis may be used to forecast the independent variable's relationship to the dependent variable based on the table above. The R-square value in this table is 0.579, indicating the degree to which the independent variables are affecting the dependent variable. It may be deduced that the study's independent variable Total Export of rice, influences the dependent variable, Gross Domestic Product of India, by 57.9%.

Table 48 Anova for Export of Total Rice & Gross Domestic Product

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1.056811	1.056811	17.86586	0.000989
Residual	13	0.768983	0.059153		
Total	14	1.825794			

Source: Researher's own Calculation from SPSS

It is evident from the above table that the p-value is 0.000, which is significantly lower than 0.05. Therefore, it may be concluded that, at the standard significance level, there is statistically significant correlation between the Total Export of rice (Independent variable) and Gross Domestic Product of India (Dependent Variable).

4.3 Self Sufficiency Ratio

The self-sufficiency ratio is computed by dividing the total amount of rice produced by the total amount consumed and then multiplying the result by 100. If the SSR is under one hundred percent, the nation is reliant on rice imports to satisfy its consumption demands; if the ratio is more than 100%, the nation is a net exporter of rice. The following table is used to determine the rice self-sufficiency ratio for the years 2006–2020.

Table 49 Production & Consumption of Rice from the year 2006-2020 (MT)

Year	Production (MT)	Consumption (MT)
2006	91.79	86.70
2007	93.36	90.46
2008	96.69	91.08
2009	99.18	85.50
2010	89.09	90.20
2011	95.98	93.33
2012	105.3	93.97
2013	105.23	98.73
2014	106.65	98.24
2015	105.48	93.45
2016	104.41	95.84

Year	Production (MT)	Consumption (MT)
2017	109.7	98.67
2018	112.76	99.16
2019	116.48	101.95
2020	118.43	101.05
Total	**1550.53**	**1418.32**

Source: Researher's own Calculation from Excel

$$\text{Self Sufficiency Ratio} = \frac{Domestic\ production\ of\ rice}{Total\ Domestic\ Consumption\ of\ rice}\ x\ 100$$

$$= \frac{1550.53}{1418.32}\ x\ 100$$

$$= 109.3214$$

Based on the self-sufficiency ratio of rice calculated above, the SSR is 109.3214%, which is higher than 100%. Therefore, it may be concluded that India is a rice exporting nation.

5 Results and Discussion

The Results section presents the key outcomes of the study, whereas the Discussion section interprets these outcomes and explains their significance. The combined results and interpretations from the current research are summarized below.

5.1 Results

From the research it can be found that price of the rice have kept on increasing for Paddy Common being ₹1310 (₹/quintal) from the year 2013-14 to ₹2300(₹/quintal) in the year 2024-25. While for Paddy -Grade A it increased from ₹1345(₹/quintal) in the year 2013-14 to ₹2320(₹/quintal) in the year 2024-25. It can also be found that China ranks first with India being second largest producer of milled rice with an output of 135.76 million metric tons. Whereas, in India West Bengal, Uttar Pradesh and Punjab are the leading producer of Rice with the highest area under cultivation. It is also found from the study of literature review that some of the factors affecting the production of rice are poor irrigation facility, poor economic condition of farmers, Inadequate technology usage, etc. It is also found that parboiled non-basmati rice accounts for the largest share of India's rice exports, contributing 35.8% in 2022–2023. Most of these exports go to countries in South Asia and Africa, regions that rely heavily on imported rice to support their food security needs. Broken rice accounts for 13.8% of India's total rice exports, with China being the primary import destination, where it is mainly used for industrial purposes and as animal feed. While some of the challenges leading to India's poor ranking in Agriculture exports are Quality Concerns, Food Security Requirements, etc.

It is found from the research that from 2006 to 2020, there were only slight variations in the cultivated area with an increase by 0.12 million hectares. It is also found that the rice production has shown a steady increase over time, with an increase of 26.64 million tonnes from 2006 to 2020. The consumption of rice have also increased by approx. 16.56%, being 86695(1000MT) in the year 2006 and in the year 2020 the consumption is 101052(1000MT). It is also found that per capita availability of rice remined stagnant with periodic fluctuations. The major decrease in capita availability occurred in the year 2008,2010 and 2015. The study also revealed that India continues to import a very small amount of rice, with an import showing a steady increase. In the year 2006 imports were 0.26(1000MT), while in the year 2020 it increased to 5.64(1000MT). The export of Basmati rice shows an increasing trend

from the year 2006 to 2020, increasing from 1166.57(1000MT) to 4454.77(1000MT). The highest growth in export was in the year 2012 by 36.01% compared to its previous year. Whereas, the export of Non -Basmati rice shows major decline in the year 2010 and 2011. Moreover, exports fell by -13.27% in 2019 to 7,648 thousand tonnes, and then by -33.89% in 2020 to 5,056.28 thousand tonnes.

The research also revealed that the total export of rice shows a fluctuating trend from the year 2006 to 2020, with a sharp decrease in the year 2009. It rebounded back with a high growth rate of 194.59% in the year 2012 and then decreased in the year 2016, 2019 and 2020 maybe due to Covid-19 pandemic. Though it has been found that total rice exports increased by 132.65% from the year 2006 i.e. 4088.17(1000MT) to 9511.05(1000MT) in the year 2020. It is also found that the COVID-19 pandemic's economic effect, which interrupted worldwide commerce, manufacturing, and consumption, caused the GDP to drop by -5.67% to $2,674.85 billion in 2020 when compared with its previous year.

5.1.1 Findings from the Hypothesis Testing

From Hypothesis 1, it can be found that there is weak positive correlation i.e. 32.6% between area of production and rice production. While, the independent variable, area of production influences the dependent variable production of rice by 10.6% only. The p-value of 0.2357, which is significantly higher than 0.05, reveals that, there is no statistically significant correlation between the area of production (Independent variable) and production of rice (Dependent Variable).

From Hypothesis 2, it can be found that there is weak positive correlation i.e. 21.3% between production of rice and Capita availability of rice. Moreover, the independent variable production of rice influences the dependent variable Capita availability of rice by 4.5% only. The p-value is 0.4462 which is significantly higher than 0.05, reveals that there is no statistically significant correlation between the production of rice (Independent variable) and capita availability of rice (Dependent Variable).

From Hypothesis 3, it can be found that there is strong positive correlation i.e. 86.32% between production of rice and Consumption of rice. It may be deduced that the study's independent variable production of rice influences the dependent variable Consumption of rice by 74.5%. The p-value is 0.000, which is significantly lower than 0.05,

reveals that there is statistically significant correlation between the production of rice (Independent variable) and consumption of rice (Dependent Variable).

From Hypothesis 4, it can be found that there is strong positive correlation i.e. 86.32% between import of rice and production of rice. It is found that the independent variable import of rice, influences the dependent variable, production of rice, by 66.1%. Moreover, the p-value is 0.000, which is significantly lower than 0.05, reveals that there is statistically significant correlation between the import of rice (Independent variable) and production of rice (Dependent Variable).

From Hypothesis 5, it can be found that there is strong positive correlation i.e. 71.4% between import of rice and production of rice. It is also found that the independent variable import of rice, influences the dependent variable, consumption of rice, by 51.07% Moreover, the p-value is 0.002, which is significantly lower than 0.05, reveals that there is statistically significant correlation between the import of rice (Independent variable) and consumption of rice (Dependent Variable).

From Hypothesis 6, it can be found that there is strong positive correlation i.e. 82.64% between production of rice and export of rice. It is also found from the research that the independent variable production of rice, influences the dependent variable, export of rice, by 68.3%. Moreover, that the p-value is 0.000, which is significantly lower than 0.05. Thus, it can be concluded that there is statistically significant correlation between the production of rice (Independent variable) and export of rice (Dependent Variable).

From Hypothesis 7, it can be found that there is moderate positive correlation i.e. 57.70% between Import of rice and Export of rice. It is also found that the independent variable import of rice, influences the dependent variable, export of rice, by 33.3%. Moreover, the p-value is 0.02, which is lower than 0.05. Thus it can be concluded that there is statistically significant correlation between the import of rice (Independent variable) and export of rice (Dependent Variable).

From Hypothesis 8, it can be found that there is strong positive correlation i.e. 87.48% between production of rice and gross domestic product. It can be found that the independent variable production of rice, influences the dependent variable, gross domestic product of India, by 76.5%. Moreover, the p-value is 0.000, which is significantly lower than 0.05.

Thus, it can be concluded that there is statistically significant correlation between the production of rice (Independent variable) and gross domestic product of India (Dependent Variable).

From Hypothesis 9, it can be found that there is strong positive correlation i.e. 88.63% between consumption of rice and gross domestic product of India. It is also found that the independent variable consumption of rice, influences the dependent variable, gross domestic product of India, by 78.5%. Moreover, the p-value is 0.000, which is significantly lower than 0.05. Thus, it can be concluded that there is statistically significant correlation between the consumption of rice (Independent variable) and gross domestic product of India (Dependent Variable).

From Hypothesis 10, it can be found that there is Very Strong positive correlation i.e. 94.03% between Export of Basmati rice and gross domestic product of India. It is also found that the independent variable Export of Basmati rice, influences the dependent variable, Gross Domestic Product of India, by 88.4%. Moreover, the p-value is 0.000, which is significantly lower than 0.05. Thus, it can be concluded that there is statistically significant correlation between the Export of Basmati rice (Independent variable) and Gross Domestic Product of India (Dependent Variable).

From Hypothesis 11, it can be found that there is moderate positive correlation i.e. 60.7% between Export of Non-Basmati rice and gross domestic product of India. It is also found that the independent variable Export of Non-Basmati rice, influences the dependent variable, Gross Domestic Product of India, by 36.9%. Moreover, the p-value is 0.016, which is lower than 0.05. Therefore, it may be concluded that there is statistically significant correlation between the Export of Non-Basmati rice (Independent variable) and Gross Domestic Product of India (Dependent Variable).

From Hypothesis 12, it can be found that there is strong positive correlation i.e. 76.1% between Total Export of rice and gross domestic product of India. It is also found that the independent variable Total Export of rice, influences the dependent variable, Gross Domestic Product of India, by 57.9%. Moreover, the p-value is 0.000, which is significantly lower than 0.05. Thus, it can be concluded that there is statistically significant correlation between the Total Export of rice (Independent variable) and Gross Domestic Product of India (Dependent Variable).

Whereas, from the self-sufficiency ratio it can be concluded that the SSR is 109.3214%, which is higher than 100%, disclosing the fact that India is a Rice Exporting Nation

5.2 Discussions

Poor irrigation and antiquated agricultural methods are identified in the literature as the main obstacles to production development, which is sluggish in comparison to area expansion (Bhattacharya, 2022). A slight link between area and productivity was also demonstrated by Hypothesis 1. Therefore, in order to increase production without requiring additional land, it is advised that the government and state agencies invest in modern irrigation, extend canal systems, encourage micro-irrigation (drip and sprinkler), and guarantee year-round water supply.

An examination of the literature identifies insufficient use of technology as a production hindrance. To increase productivity and lower output variability, it is advised that farmers have access to high-yielding seed types, automated equipment, soil health testing, and digital advice services (Sahu et al., 2020).

From 2013–14 to 2024–2025, MSP for both Paddy Common and Grade A climbed steadily, reflecting rising production costs and inflation. In order to guarantee that farmers receive fair remuneration and are motivated to maintain or expand output, it is advised to update MSPs based on input-cost inflation and to ensure prompt procurement.

Non-Basmati rice that has been parboiled makes up 35.8% of exports. 13.8% of broken rice shipments go to China. Between 2006 and 2020, the trajectory of Basmati exports was robust and growing. Therefore, it is advised to prioritize export promotion for Basmati and Parboiled types by negotiating trade agreements, enhancing logistics, and promoting Indian rice in developing markets in South Asia, Africa, and the Middle East. To fulfill international standards for residue limits, grain uniformity, and processing quality, it is also advised to implement more stringent quality testing laboratories, certification procedures, and training for millers and exporters.

The analysis reveals that non-Basmati exports exhibit significant swings, with significant drops in 2010–2011 and again in 2019–2020. Therefore, in order to maintain steady export volumes, it is advised to develop export-stabilization policies including

decreased export prohibitions, long-term contracts with importing countries, and minimum export quotas. Moreover, the impact of COVID-19 on international commerce caused a considerable decline in total exports in 2020. To reduce interruptions from pandemics, climatic shocks, or geopolitical crises, it is advised to create robust supply chains with decentralized storage, improved port infrastructure, and digital export platforms.

According to the research, there is a substantial positive link between production and consumption (Hypothesis 3), indicating that food intake is strongly impacted by domestic availability. In order to maintain food security, it is advised to maintain output increases by providing farmers with crop insurance, fertilizer, and seed subsidies.

The economic importance of rice trading is found in the strong link between exports (particularly Basmati) and GDP (Hypothesis 10). Therefore, it is advised to promote value-added exports that give larger margins than raw rice, such as fortified rice, ready-to-cook packets, and rice-based snacks.

The research also recommends to promote value addition and product diversification, Improving farm level productivity, reduce transportation and logistics costs by improving connectivity, expand modern storage units, increasing mechanization at ports to address supply chain bottlenecks.

6 Conclusion

India's economy, culture, and food system all revolve around rice. Rice provides a significant portion of both proteins and calories in many Indian diets, making it a key staple for approximately half of the population worldwide. As such, it serves as the foundation for national food security and nutrition initiatives. The calorie density and micronutrient relevance of rice in normal Indian meals are highlighted by studies, which also highlight the nutritional trade-offs between highly polished white rice and more nutritious types and fortified goods. Rice is essential to agricultural policy, rural life, and commerce because of its dual function as an export commodity and dietary staple.

Thus, the present research aims to evaluate the role of rice exports in India's International Trade. For the fulfillment of the primary objective sub-objectives were framed, which aimed at assessing India's current position and market share in the global rice trade. Moreover, it also aimed to examine the geographical distribution of Rice Production across states in India. It also tried to identify key factors influencing rice production trends as well as to evaluate the significance of rice in India's foreign trade (Import & Export). It also analyses rice consumption pattern in India. The research also aims to identify the logistical bottlenecks in rice exports, including port congestion, transportation challenges and storage issues. And, lastly it aims to calculate India's Self-Sufficiency ratio in Rice. For the accomplishment of Primary and Sub-objectives research thesis is divided into two sections. Where the first section focuses on the available literature relevant to the thesis research topic, for which the secondary data has been gathered from various secondary sources like journals, magazines, reports, publication, articles, news, blogs, websites, etc. It gives overview about Rice as a staple food, types of rice, rice utilization, price and storage of rice, production at national and worldwide level, factors affecting rice production in India, International Trade, India's growing importance in Global Rice Trade, Types of rice and their export destinations, Challenges faced in Indian Rice Exports and Supply Chain Bottlenecks.

Whereas, the second section of the research thesis focuses on the practical part comprising of the analysis and interpretation of the secondary data ranging from the year 2006-2020 collected from FAO website. Trend analysis was carried out using graphs, charts, and tables to examine patterns in rice production, consumption, imports, and exports. Additionally, hypothesis testing was conducted to evaluate the relationships among the study

variables. Econometric tools such as correlation coefficients, regression analysis, and ANOVA were applied to assess the strength, direction, and statistical significance of the associations between independent and dependent variables. The analysis also includes an assessment of India's self-sufficiency ratio in rice.

From the first sub-objective i.e. to evaluate India's current position and market share in the international rice trade, it can be concluded that India ranks second with an export of 135.76 million metric tons of rice (Statista, 2024). Almost covering 46% of market share. From the Second Sub-Objective i.e. to describe the geographical structure of Rice Production in India, it can be concluded that West Bengal is at the top of the list, using 5.46 million hectares of agricultural land to produce 15.75 million tons. Whereas, second place goes to Uttar Pradesh, which produces 12.5 million tons from a somewhat bigger 5.86 million hectares agricultural area. Punjab is the third-most productive state, with 11.82 million tons produced, despite having a comparatively lesser cultivated area i.e. 2.97 million hectares (Arora, 2024). From the Third Sub-Objective i.e. to determine the factors affecting the production of rice, it can be concluded that Poor Irrigation Facility, Temperature and Radiation, Unavailability of Good Quality of Seeds, Poor Economic Conditions of Farmers, Small and Fragmented Land, Weeds, Rodents, Insect-Pests, Recurrent floods and droughts, Inadequate technology usage and Insufficient input usages are the factors affecting production of rice (Scheidel et al., 2014; Cheng et al., 2019; Timsina and Connor, 2001; Surendran et al., 2021; Bhagde, 2014; Singh et al., 2012).

From the fourth and fifth sub-objective of the research i.e. to evaluate the importance of rice in India's foreign trade and the consumption pattern of Rice in India. It can be concluded from the research that over the past fifteen years, India's rice industry has demonstrated strong success in terms of production, consumption, and export competitiveness. Despite a minimal increase in cultivated area, production climbed gradually, indicating higher productivity as well as yield enhancement. While imports and consumption increased somewhat, supply changes caused per capita availability to remain unstable. Strong rise in Basmati rice shipments and a fluctuating trend in non-Basmati exports, mainly impacted by trade policies, global demand, and supply shocks, were found by export research.

From the Sixth sub-objective of the research i.e. to identify the key supply chain bottlenecks in rice export logistics such as port congestion, transportation issues and storage

limitations. It can be concluded that Limited Value Addition, Low Productivity & High Logistics Costs, Quality Concerns, Climatic Condition, Non Tarriff Obstacles, Problems with export promotion and branding and food security requirements, Rising fuel prices, lack of freight trains, Storage space & Container shortages are key supply chain bottlenecks in rice export logistics (Rana and Anand, 2024; Khanna, 2024; Garg, 2022; Ghosal, 2021; Sharma et al., 2013; Sharma, 2023; Kumar, 2021).

Whereas, the seventh sub-objective of the research i.e. to calculate the self sufficiency ratio of India in Rice, it can be concluded that with an SSR above 100%, India continues to be a net rice exporter. The hypothesis's findings support rice's pivotal position in India's economic system. The rice industry is a significant contribution to the growth of the national economy, as seen by the strong relationships found between production, consumption, exports, and GDP. Strong positive correlations highlight the significance of high-value export categories, particularly between Basmati exports and GDP. Weak relationships between cultivated area and per capita availability draw attention to structural issues such resource inefficiencies, unequal distribution, and land limits.

The research recommends upgrading irrigation networks, supporting modern farming methods and mechanization, boosting farmer income assistance, raising export quality requirements, and promoting value-added rice products to increase export revenues in order to solve the production related issues and to promote value addition and product diversification, Improving farm level productivity, reduce transportation and logistics costs by improving connectivity, expand modern storage units, increasing mechanization at ports to address supply chain bottlenecks. By taking these steps, it will be possible to guarantee steady domestic supply, sustained production growth, and a greater contribution of rice to India's agricultural and economic advancement.

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8.3 List of abbreviations

GDP- Gross Domestic Product
MSP- Minimum Support Price
MT – Million Tons
PDS- Public Distribution System

APC- Agricultural Prices Commission

CACP- Commission for Agricultural Costs and Prices