International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Rice and Wheat: The Engine of India's Agricultural Growth and Development towards achieving SDGs of Zero Hunger and Viksit Bharat

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Abstract

India's rice and wheat, the most widely consumed cereals globally, account for around 20% of the country's agricultural GDP, ensuring national food security and economic stability. India, the world's second-largest producer of food grain, primarily rice and wheat, is a major exporter of these products, contributing significantly to its foreign exchange and trade balance. The study analyzes food grain, rice, and wheat production trends in India over the past seven decades using agricultural census data, focusing on area, production, and yield. The analysis utilized statistical tools such as Annual Growth Rate (AGR), decadal mean, and correlation for analytical purposes. India has experienced significant growth in food grain production, particularly rice and wheat, over the past seven decades, but the growth rates have been uneven. The Green Revolution, initiated in the late 1960s, significantly increased production by 8.96% growth rate in food grain during 1969-70 over 1970-71. The food grain production experienced the highest growth of 18.13% during 1979-80 over 1980-81, largely due to favorable monsoon conditions and increased adoption of high-yielding varieties. India experienced negative growth of -6.19% during 1999-2000 over 2000-01, indicating challenges such as droughts, input cost fluctuations, and policy constraints in food grain production. Rice production experienced significant growth of 4.43% and 26.70%, especially during the Green Revolution era of 1969–70 over 1970–71 and 1979–80 over 1980–81. The increase in crop yield can be attributed to the introduction of high-yielding varieties, expansion of irrigation systems, and increased fertilizer usage. The negative growth periods of 1999-2000 over 2000-01, with a growth rate of -5.24%, indicate vulnerability to climatic and economic shocks in rice production. Wheat production experienced 18.62% growth during post-Green Revolution, driven by high-yielding varieties, mechanization, and irrigated areas expansion, particularly in 1969-70 over 1970-71. Negative growth phases of wheat (-8.76%, such as 1999-2000 over 2000-01, indicate vulnerabilities to market fluctuations and climatic variations. The study provides valuable insights for

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policymakers to improve weather forecasting, promote insurance schemes, and encourage farmers to adopt climate-resilient crops through climate adaptation strategies. The study results emphasizes the significance of aligning minimum support prices with cost fluctuations and promoting diversification to achieve sustainable development goals like Zero Hunger and Viksit Bharat.

Keywords: Agrarian prosperity, Economic stability, Food grain, GDP, Productivity, Sustainable agriculture, Viksit Bharat, Zero Hunger

Introduction:

India's agrarian economy heavily relies on its agricultural sector, with food grain production being a crucial component of its food security and economic stability. The country is a major global producer of staples like rice, wheat, and pulses, contributing significantly to global food supplies (FAO, 2022). Analyzing food grain production and yield dynamics is crucial for comprehending the sector's performance, identifying growth patterns, and addressing challenges in a rapidly changing agro-climatic environment. The analysis of India's food grain production aims to evaluate trends, yield patterns, regional disparities, policy impacts, and future growth projections. India is a major global producer of rice and wheat, providing essential food grains to millions of people. The agricultural sector is the primary economic sector in the country, employing nearly 50% of the workforce and contributing around 18% to the GDP. India's agriculture relies heavily on rice and wheat, with over 65% of the population consuming it as a staple food, making it the second-largest rice producer globally. India is the world's second-largest producer of wheat, a crucial crop.

India faces challenges in rice and wheat production, including climate change, water scarcity, and soil degradation, despite being a major producer of food grains. The Indian agricultural sector is characterized by low productivity, limited technology adoption, and inadequate market access. A study by Jha et al., (2022) found that understanding yield gaps is important for improving agricultural productivity in India to meet food demands. India’s eastern states, which grow 40% of the country's paddy, are less productive than other regions, indicating they could lead a new Green Revolution. The study used empirical methods to break down yield gaps in paddy and wheat into efficiency and resource-based parts. It applied stochastic frontier analysis to identify key factors causing production inefficiencies, estimating yield gaps of 20–40% for paddy and 20–21% for wheat. Binita Kumari and Sneha Singh (2024) showed a steady increase in area by 0. 33%, production by 1. 94%, and yield by 1. 61%. After a drop in 2015, production improved from 2016, helped by high-yield varieties, better irrigation, and good weather. Yield was the most unstable at 5. 26%, production followed at 4. 17% and area at 2. 41%. Uttar Pradesh was the top producer, while Tripura had the least due to poor conditions. To maintain growth, the study suggests creating stress-resistant varieties and increasing farming in unused areas. Debnath et al., (2023) studied how the Green Revolution affected the nutritional quality of rice and wheat in India. While it increased food availability, it caused a significant drop in important minerals like zinc and iron in rice and wheat over 50 years. Specifically, zinc and iron levels fell by 33% and 27% in rice and by 30% and 19% in wheat. Also, harmful elements increased, and the Mineral-Diet Quality Index decreased by 57% for rice and 36% for wheat from 1960 to 2010. This decline could lead to more health issues, like anaemia and heart diseases, by 2040. The study highlights the need to focus on nutrient quality in future crop breeding programs to ensure both food availability and nutritional health. Mathukar (2020) studied crop yield trends for wheat, rice, and maize in India from 1967 to 2017

using statistical models. The study found that yields for wheat in 13 states, rice in 11 states, and maize in 6 states have stopped improving. This stagnation impacts about 76% of wheat, 47% of rice, and 18% of maize areas in the country. Despite advancements since the Green Revolution, there is a need to find reasons for the stagnation and create strategies to enhance yields. Anwesha Dey et al. (2020) examined rice and wheat production in India from 1950 to 2016. They discovered that wheat production increased more quickly than rice, but both had instability, particularly before the Green Revolution. Yield improvements significantly boosted rice growth, while both area and yield factors mostly drove wheat growth. The study emphasizes the importance of improving yields and stability for ongoing agricultural growth. With this backdrop, this study examines trends in food grain, rice, and wheat production in India, focusing on factors influencing production, productivity, and sustainability. The study explores rice and wheat production's current state and identifies areas for improvement to ensure food security and sustainable agricultural development, aiming to achieve Zero Hunger and Viksit Bharat.

Material and methods

This study employed a secondary data analysis design, utilizing existing data from agricultural reports to examine the trends and patterns of selected food crops such as food grain, rice and wheat production in India over the past seven decades since India's independence. The collected data were analysed using the Annual Growth Rate (AGR) calculated by using the formula of AGR=((Current Year's Value - Previous Year's Value) / Previous Year's Value) x 100. Decadal Average has been calculated by averaging the values for each decade of Decadal Average = (Σ Values) / 10 and correlation analysis conducted to examine the relationship between area devoted for production, quantity production and yield of food grain, rice and wheat in India during the study periods of 1950-51 to 2021-2022.

Results and Discussion:

The discussion section examines the trends and growth rates of food grain, rice, and wheat cultivation in India from 1950-51 to 2021-2022, identifying patterns and correlations among the selected variables of the present study.

Table 1: Decadal average of production trends of selected food crops in India

Year	Food grain			Rice			Wheat		
	Area (MH)	Production (MT)	Yield (Kg. Ha)	Area (MH)	Production (MT)	Yield (Kg. Ha)	Area (MH)	Production (MT)	Yield (Kg. Ha)
1950-1960	107.51	65.47	606	31.58	26.29	829.9	11.46	8.36	728
1960-1970	118.2	85.00	807	32.45	32.40	897.6	14.00	13.30	937
1970-1980	124.81	213.59	892	38.64	44.76	1156.3	20.11	27.78	1375
1980-1990	126.81	146.55	1156	40.65	59.78	1467.2	23.30	44.76	1918
1990-	123.6	188.54	1526	43.21	80.10	1852.	25.55	63.91	2496

2000	4					0			
2000-2010	121.48	210.52	1731	43.41	89.19	2052.5	26.9	73.42	2727
2010-2020	125.33	267.24	2132	43.70	108.09	2473.0	30.24	85.19	3175

Source: Annual Report-2021-2022, Department of Agriculture & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Government of India, Krishi Bhawan, New Delhi-110 001

Table 1 highlights the decadal averages of food grain cultivation in India from 1950 to 2020, focusing on cultivated area, production, and yield. A consistent upward trend in food grain production and yield is evident, while the cultivated area shows moderate fluctuations. The average area under food grain cultivation increased from 107.51 million hectares in 1950-1960 to 125.32 million hectares in 2010-2020. However, a slight decline occurred between 1990-2000 and 2000-2010, possibly due to land-use changes, technological advancements, or might be caused by crop diversification. Food grain production experienced a significant growth, rising from 65.47 million tonnes in 1950-1960 to 267.24 million tonnes in 2010-2020, driven by the Green Revolution, which introduced high-yielding varieties, improved irrigation systems, and modern farming techniques. Similarly, yield per hectare surged from 606 kg/ha in 1950-1960 to 2132 kg/ha in 2010-2020, reflecting substantial productivity gains through the adoption of advanced technologies, better seed varieties, fertilizers, and mechanization of Indian agriculture. The increased in production and yield, despite a relatively stable cultivation area, underscores improved agricultural efficiency supported by technological progress and government policies. The temporary decline in the cultivated area could be linked to factors such as urban expansion, environmental constraints, or policy-driven crop diversification. Overall, the data demonstrates how technological innovations and policy interventions have significantly advanced agricultural productivity in India over the decades. Jeyanthi T and A. Kannan (2024) report that the area used for food grain production grew significantly from 97. 32 million hectares in 1950-51 to 129. 34 million hectares in 2020-21. The total food grain produced also rose sharply, increasing from 50. 8 million tonnes to 310. 7 million tonnes over the same period. Additionally, food grain productivity saw a notable rise, going from 522 kg per hectare to 2394 kg per hectare. India's population has been growing, but agriculture needs to grow more to meet the food needs of the increasing population. This is important for achieving food security and eliminating hunger.

It further indicates the rice production area's average growth rate increased from 31.58 million hectares in 1950–1960 to 43.70 million hectares in 2010–2020, showing slow but steady growth. Since 1990, the area has stabilized around 43 million hectares. The rice production is grown significantly from 26.29 million tonnes to 108.09 million tonnes, indicating a fourfold increase over 70 years. Growth is mainly driven by improved productivity rather than expanded area. The yield, increased sharply from 829.9 kg/ha to 2473 kg/ha between 1950-60 and 2010-2020, reflecting technological improvements like high-yielding varieties and irrigation. Yield has fluctuated slightly since the 2000s, requiring further innovation for growth. The wheat production expanded significantly from 11.46 million hectares in 1950–1960 to 30.24 million hectares in 2010–2020 reflects wheat's growing importance in agriculture. The rise in production of wheat increased tenfold from 8.36 million tonnes to 85.19 million tonnes between 1950-60 and 2010- 2020, showing rapid growth due to both expanded in area and higher productivity. The rise in yield of wheat increased four-fold from 728 kg/ha to 3175 kg/ha between 1950-

60 and 2010-2020. This highlights the impact of the green revolution, better seeds, and farming practices in Indian agriculture during the study periods.

Table 2: Annual growth rate of selected food crops in India

Year	Food grain			Rice			Wheat		
	Area (MH)	Production (MT)	Yield (Kg. Ha)	Area (MH)	Production (MT)	Yield (Kg. Ha)	Area (MH)	Production (MT)	Yield (Kg. Ha)
1950-51 over 1951-52	-0.37	2.30	2.68	-3.18	3.50	6.89	-2.87	-4.33	-1.51
1959-1960 over 1960-61	-0.21	6.98	7.25	0.92	9.15	8.11	-3.36	6.59	10.23
1969-1970 over 1970-71	0.6	8.96	8.32	-0.24	4.43	4.66	9.68	18.62	8.20
1979-1980 over 1980-81	1.17	18.13	16.78	1.85	26.70	24.39	0.50	14.07	13.51
1989-1990 over 1990-91	0.84	3.13	2.30	1.23	0.98	-0.29	2.85	10.61	7.54
1999-2000 over 2000-01	-1.67	-6.19	-4.58	-1.00	-5.24	-4.28	-6.40	-8.76	-2.52
2009-2010 over 2010-11	4.40	12.09	7.34	2.24	7.73	5.36	2.14	7.51	5.25
2019-2020 over 2020-21	2.21	4.45	2.18	4.83	4.63	-0.18	-0.73	1.60	2.35
2020-2021 over 2021-22	0.56	1.60	1.04	1.33	4.76	3.39	-2.12	-2.51	-0.40

Source: Estimate by author

The table 2 presents the annual growth rate of selected food crops in India such as food grain, rice, and wheat across different decades, with data spanning from 1950–51 to 2021–22. The growth rates are measured in three key dimensions such as area in Million Hectares (MH), production in Million Tonnes (MT), and yield by Kilograms per Hectare (Kg/Ha). Analyzing these trends provides valuable insights into the evolution of Indian agriculture, technological advancements, and the impacts of policy interventions, climatic variations, and economic factors.

Trends in Food Grain Growth Rates (1950–2022):

The area under food grain cultivation has experienced fluctuations, with both negative and positive growth rates. The initial decades saw minor variations, but from the 1990s onwards, the area under cultivation has shown periods of decline, such as in 1999–2000 over 2000–01 it was -1.67% and 2020–21 over 2021–22 it was observed at 0.56%. This decline indicates possible shifts in land use patterns due to urbanization, diversification towards high-value crops, and climate-related constraints. The production of food grains has generally exhibited a positive trajectory, reflecting improvements in agricultural productivity. The Green Revolution, which began in the late 1960s, played a crucial role in enhancing production, as seen in the significant increase of 8.96% from 1969–70 to 1970–71. The highest growth of 18.13% in production was recorded during 1979–80 over 1980–81, likely due to favourable monsoon conditions and increased adoption of high-yielding varieties (HYVs). However, periods of negative growth, such as 1999–2000 over 2000–01 was observed at -6.19%, suggest challenges like droughts, input cost fluctuations, and policy constraints. Yield, a critical factor determining agricultural efficiency, has mostly shown positive growth, aligning with technological improvements, better irrigation facilities, and increased mechanization. However, yield growth in recent years has slowed, as seen as 1.04% in 2020–21 over 2021–22, possibly indicating saturation in productivity improvements without significant technological breakthroughs.

Trends in Rice Growth Rates (1950–2022):

Rice, a staple food crop, has seen a relatively stable area under cultivation. The post-Green Revolution period (1969–70 over 1970–71) recorded a minor decline of -0.24%, but by 1979–80 over 1980–81, area growth turned positive as 1.85%, indicating a shift towards intensive rice farming. Recent years (2020–21 over 2021–22) show slower growth of 1.33%, reflecting land constraints and competition with other crops. Rice production has seen remarkable growth of 4.43% and 26.70%, especially during the Green Revolution era of 1969–70 over 1970–71 and 1979–80 over 1980–81. This increase was due to high-yielding varieties, irrigation expansion, and fertilizer usage. However, periods of negative growth of -5.24%, was observed during 1999–2000 over 2000–01, highlight vulnerability to climatic and economic shocks. Yield growth in rice has followed a pattern similar to production, with major gains of 4.66% during the Green Revolution period of 1969–70 over 1970–71 and subsequent stabilization. Recent years have seen slower yield growth of 3.39% during 2020–21 over 2021–22, suggesting the need for further innovations in seed technology and sustainable farming practices.

Trends in Wheat Growth Rates (1950–2022)

Wheat, a key rabi crop, has shown a fluctuating area trend. Initial declines as observed as -2.87%, during 1950–51 over 1951–52, were followed by rapid expansion of 9.68% in later years, particularly post-Green Revolution such as 1969–70 over 1970–71. However, recent years show a declining trend of -2.12% in 2020–21 over 2021–22, which may indicate crop substitution and changing climatic conditions. Wheat production has experienced significant growth of 18.62%, particularly in the post-Green Revolution period such as 1969–70 over 1970–71. This reflects the success of high-yielding varieties, increased mechanization, and expansion of irrigated wheat areas. Negative growth phases (-8.76%), such as 1999–2000 over 2000–01, highlight vulnerabilities to market fluctuations and climatic variations. Yield improvements in wheat have been notable (13.51%), particularly in the 1960s and 1970s, due to Green Revolution interventions during 1979–80 over 1980–81. However, recent trends

show lower growth of -0.40% during 2020–21 over 2021–22, signalling potential productivity stagnation that requires renewed research and policy focus.

The Green Revolution (1960s–1980s) significantly improved production and yield, particularly for wheat and rice. The adoption of HYVs, increased use of fertilizers, irrigation expansion, and mechanization were the primary drivers. However, the yield growth has slowed in recent decades, requiring a shift towards more sustainable and innovative agricultural practices. Periods of negative growth, such as 1999–2000 over 2000–01, suggest the impact of adverse climatic conditions like droughts and erratic monsoons. Climate resilience strategies, including drought-resistant crop varieties, improved irrigation infrastructure, and climate-smart agriculture, are crucial to maintaining food security. The declining trend in cultivated area, particularly in recent years, suggests a shift towards diversification, urbanization, and industrial expansion. While diversification towards high-value crops and horticulture can enhance farm incomes, ensuring food grain security remains a policy priority. While Green Revolution technologies boosted productivity, recent stagnation in yield growth indicates the need for advanced breeding techniques, biotechnology innovations, and precision agriculture to sustain long-term productivity. The historical trends in food grain, rice, and wheat growth rates in India reveal the dynamic nature of agricultural development, marked by phases of rapid expansion, stagnation, and fluctuations due to climatic and economic factors. The Green Revolution played a transformative role in enhancing productivity, but recent slowdowns necessitate a shift towards sustainable and technologically advanced agricultural practices. Policy frameworks must address climate resilience, land use efficiency, and research-driven productivity improvements to ensure long-term food security and economic stability. It enables us to give more importance in investment on agricultural research for developing climate-resilient and high-yielding crop varieties through genomics and biotechnology and for promoting organic farming, conservation agriculture, and efficient water-use techniques through sustainable farming practices. It further gives insight for policy makers for enhancing weather forecasting, promoting insurance schemes, and supporting farmers in adopting climate-resilient crops by climate adaptation strategies. The present study emphasizes the significance of aligning minimum support prices with cost fluctuations and promoting diversification to achieve sustainable development goals like Zero Hunger and Viksit Bharat.

Table 3: Association between area, production and yield of food grain, rice and wheat in India

Variables	Area of food grain in MH	Food grain production in MT	Yield of food grain in Kg/ha	Area of rice in MH	Rice production in MT	Yield of rice in Kg/ha	Area of wheat in MH	Wheat production in MT
Area of food grain MH	-	-	-	-	-	-	-	-
Food grain production in MT	.585**	-	-	-	-	-	-	-
Yield of food grain in Kg/ha	.533**	.997**	-	-	-	-	-	-
Area of rice MH	.783**	.895**	.878**	-	-	-	-	-

Rice production in MT	.577**	.996**	.995**	.908**	-	-	-	-
Yield of rice in Kg/ha	.560**	.996**	.997**	.887**	.998**	-	-	-
Area of wheat MH	.722**	.952**	.940**	.953**	.948**	.941**		-
Wheat production in MT	.556**	.995**	.995**	.893**	.991**	.990**	.959**	-
Yield of wheat in Kg/ha	.580**	.986**	.986**	.918**	.985**	.982**	.963**	.994**

Source: Estimate by authors

**. Correlation is significant at the 0.01 level (2-tailed).

The correlation analysis of the table 3 provides valuable insights into the relationship between the area, production, and yield of Indian agricultural crops such as food grains, rice, and wheat during the study period of 1950-51 to 2021-2022. The strength and direction of these correlations help in understanding the underlying trends in agricultural productivity of Indian agricultural sector in the above mentioned periods. It showed that a moderate positive correlation exists between the area of food grains and production (0.585), suggesting that expanding the cultivation area leads to increased output, though the relationship is not absolute. There was a strong correlation between food grain production and yield (0.997) indicates that improvements in yield are almost entirely responsible for production growth. This suggests that policies promoting high-yielding seed varieties, improved irrigation, and modern farming techniques can significantly enhance the production of food grain production to achieve sustainable development goals like Zero Hunger and Viksit Bharat.

It finds that a strong positive correlation exists between rice production and yield (0.998), indicating that yield improvements are the primary driver of production increases. This suggests that focusing on technological advancements, fertilizer optimization, and irrigation efficiency can further boost rice production. The correlation between the area of rice cultivation and production (0.908) is also strong which is indicating that increasing the cultivated area contributes substantially to higher output. However, the slightly weaker correlation compared to production-yield suggests that yield improvements are more impactful than land expansion. The correlation between wheat area and its production (0.953) is very strong, suggesting that expansion in cultivated area strongly influences total output of wheat production in India. The correlation between wheat production and yield (0.994) is nearly perfect, implying that yield improvements directly enhance total production. This underscores the importance of research into higher-yielding wheat varieties, improved soil management, and better mechanization of Indian agricultural sector.

Conclusion and policy recommendations

The study looked at how food grain, rice, and wheat production in India changed from 1950-51 to 2021-2022. It found that there was a notable increase in production, the land used for farming, and the yield of these crops over the last seventy years. However, the growth rates have not been steady. There is a clear increase in food grain production and yield, while the area cultivated has varied moderately. The area under food grain cultivation has experienced fluctuations, with both negative and positive growth rates. The production of food grains has generally exhibited a positive trajectory, reflecting improvements in

agricultural productivity. The yield of food grain is very important for how efficient agriculture is. It has mostly increased, thanks to the use of better technology, improved irrigation, and more machines in farming.

Across all crop categories, the highest correlations are observed between production and yield. This suggests that yield-enhancing strategies, such as the use of hybrid seeds, improved irrigation systems, and better agronomic practices, are more effective than mere land expansion in increasing production. Given the strong link between yield and production, significant investments in research and development, precision farming, and climate-smart agriculture could lead to sustainable increases in food production. The correlation analysis highlights that yield improvements play a crucial role in driving agricultural production, especially for food grains, rice, and wheat in India. These findings suggest that future agricultural strategies should prioritize productivity-enhancing measures, research on high-yielding varieties, and efficient resource management to ensure sustainable food production growth to achieve the SDGs of zero hunger and Viksit Bharat. Supporting farmers with access to credit, markets, and technology is crucial. By overcoming challenges and seizing opportunities, India can boost its rice and wheat production. This will help ensure food security and promote sustainable agricultural development for future generations. Improving agricultural extension services through education and digital tools will help farmers use modern farming technologies more effectively. This will increase efficiency and lessen knowledge gaps. Doing this can help India maintain agricultural growth, improve food security, and create a strong economy in the farming sector. These recommendations are based on real evidence from past trends that show important factors for farming success and ongoing challenges.

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