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INDIAN AGRICULTURE: RECENT PERFORMANCE AND PROSPECTS IN THE WAKE OF LIBERALIZATION

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ABSTRACT

This seven-decade study analyzed the performance and prospects of Indian agriculture using secondary data from various government sources. Specifically, it evaluated production and productivity trends and the overall performance of the agricultural sector before and after the new economic reforms to assess their impact. The findings revealed that between 1950-51 and 2020-21, the area under rice and wheat cultivation increased to 45.77 million hectares and 31.13 million hectares, respectively, while the area under jowar and bajra declined. Meanwhile, oilseeds, cotton, and sugarcane experienced notable growth. In terms of output, rice and wheat production rose significantly to 124.37 million tons and 109.59 million tons, respectively, by 2020-21. Maize, oilseeds, sugarcane, and cotton also exhibited substantial growth over the period. Regarding productivity, rice and wheat yields increased more than fourfold and fivefold, respectively, while maize and coarse cereals grew sixfold and fivefold. Commercial crops like sugarcane and jute showed significant gains, whereas pulses and cotton exhibited fluctuating trends. The annual growth rates of major crops from 1991 to 2020 displayed significant fluctuations, with both positive and negative trends. Notably, in 2020, production rebounded, with jowar increasing by 37.07 per cent, bajra by 19.63 per cent, maize by 3.79 per cent, and wheat by 4.11 per cent, reflecting the sector's resilience. Furthermore, the double log linear regression analysis indicates that the relationship between cultivated area and crop output weakened post-LPG for food grains, rice, and wheat, while maize and pulses showed improvement.

(Key words: Production trends, yield trends, LPG reforms, green revolution, sustainable farming)

INTRODUCTION

India's agricultural sector has transitioned from traditional practices to modern, mechanized operations, necessitating a focus on enhancing productivity to boost production and address supply constraints. India's agriculture sector employs 54.6 per cent of its workforce, but its annual growth rate is low compared to manufacturing. Despite policy interventions, agriculture has lagged behind, highlighting the need for food security, employment generation, and income generation (Das, 2016). Abraham and Pingali (2021) stated that both price and non-price factors influenced supply response in agriculture, with output price and production factors providing incentives for market production. The growth of crops, driven by population growth and income growth, is crucial for ensuring the availability of diverse food groups. The green revolution improved wheat and rice productivity, ensuring food security, while pulses cultivation has shown stagnant yields and area under cultivation. Pulse availability decreases due to low productivity growth and population growth, leading to high price volatility and capita^{-1} availability dropping from 65 g day^{-1} in 1950s to 35 g day^{-1} in 2010. Food grain production in India experienced significant growth in 1979-80 due to favorable monsoon conditions and high-yielding varieties, while negative growth in 1999-2000 was attributed to droughts, input cost fluctuations, and policy constraints. Rice production experienced significant growth during the Green Revolution era (1969-70 over 1979-80), primarily due to high-yielding varieties, irrigation expansion, and fertilizer usage. However, negative growth periods (1999-2000 over 2000-2001) indicate vulnerability to climatic and economic shocks. Wheat production experienced 18.62 per cent growth post-Green Revolution (1969-70 over 1979-80), driven by high-yielding varieties, mechanization, and irrigated areas expansion, while negative growth phases in 1999-2000 over 2000-01 (-8.76 per cent) indicate market and climatic vulnerabilities (Kannan and Jeyanthi, 2025). The study by Kumar *et al*. (2022) showed that minor millets' production is decreasing due to cereal cultivation, pulses, and commercial cash crops, while productivity is increasing due to high-yielding varieties and new technology adoption in India, the largest cereal producer. Jeyanthi and Kannan (2024)

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highlighted India's low millet production over the past seven decades, highlighting the need for increased cultivation for food and nutritional security. Between 1951-1960 and 2011-20, India experienced a two-fold increase in jowar area cultivation and production, while bajra cultivation showed a decline while production and productivity increased. The study showed consistent growth in maize cultivation area, production, and productivity between 1951-1960 and 2011-20, with positive growth rates of 2.4, 8.5, and 3.6 times, respectively.

The pre-green revolution saw a significant decrease in jowar cultivation area, production, and productivity compared to the post-green revolution. Post-reform periods saw a significant decrease in jowar production compared to pre-reform periods, while bajra production increased significantly. The study showed a significant increase in jowar and bajra productivity, while millet cultivation area decreased from 42.53 million hectares to 28.06 million hectares, despite significant increase in average output and yield hectare^{-1}. Das (2016) indicated that agricultural total factor productivity (TFP) growth in India fluctuated between 1 per cent between 1981-1990 and 1.7 per cent between 2000-2008. The study reveals that post-reform growth in TFP was higher than pre-reform, with a decline in agricultural input usage and a rising trend in TFP contribution to output growth. India's agriculture sector employs 54.6 per cent of its workforce, but its annual growth rate is low compared to manufacturing. Despite policy interventions, agriculture has lagged behind, highlighting the need for food security, employment generation, and income generation. Kumari and Singh (2024) also highlighted significant role of wheat in reducing hunger and malnutrition, thereby promoting food security and achieving zero hunger. Wheat consumption in rural India increased due to nutritious cereal availability, with consistent cultivation area and yield from 2012-2021, but a drop in 2015 occurred. Since 2016, wheat production and yield have shown a rising trend of 0.33 per cent in area, 1.94 per cent in production and 1.61 per cent in yield with Uttar Pradesh showing the highest growth and Tripura the lowest. The average yield during the period was 3226.87 kg ha^{-1}, with production and areas of 98.25 million tones and 30.46 million hectares, respectively. The study revealed maximum instability in yield (5.26 per cent), followed by production (4.17 per cent) and area (2.41 per cent).

Many studies have explored India's agricultural growth, but few have examined the changes over seven decades in a detailed and structured way. While research has focused on the Green Revolution and policy changes, there is little work comparing crop production, productivity, and land use before and after economic reforms. Also, most studies do not fully explain how mechanisation, irrigation, and market changes have shaped long-term agricultural growth. This study fills the gap by providing a clear picture of how Indian agriculture has evolved, highlighting key trends and future challenges. With this back drop, this seven-decade study analyzed the performance and prospects of Indian agriculture using secondary data from various government sources. Specifically, it evaluated production and productivity trends and the overall performance of the agricultural sector before and after the new economic reforms to assess their impact.

MATERIALS AND METHODS

The study examined the performance and prospects of Indian agriculture from 1950-51 to 2020-21 using secondary data obtained from the Directorate of Economics and Statistics, Ministry of Agriculture, Department of Cooperation and Farmers' Welfare (Anonymous, 2022). Data on the area, production, and productivity of major food crops such as rice, wheat, pulses, and nutrient cereals, as well as commercial crops like oilseeds, sugarcane, cotton, and jute, including the percentage of irrigated area, cropping intensity, and irrigation intensity, were compiled from the Ministry of Agriculture and Farmers' Welfare for the period 1950-2021. The study recorded and analysed the performance and prospects of these major crops over the past seven decades. Besides, the study incorporated statistical tools such as decadal mean, annual growth rate, and the double log linear regression model for analytical purposes. The mean production and productivity performance, along with the annual growth rate of major food and commercial crops in India from 1950-51 to 2020-21, were examined. Additionally, the double log linear regression model was applied to assess the effects of new economic reforms on various agricultural metrics by comparing the period before and after their implementation in India. Based on the statistical relationships identified in the data, the overall regression model can be expressed as:

$$ln\ Y = á + â_0\ ln\ X_1 + â_1\ ln\ X_2 + â_2\ ln\ X_3 + â_3\ ln\ X_4 + â_4\ ln\ X_5 + â_5\ ln\ X_6 + â_6\ ln\ X_7 + å$$

where: X_1 – Area under food grains, X_2 – Area under rice, X_3 – Area under wheat, X_4 – Area under pulses, X_5 – Area under jowar, X_6 – Area under bajra, X_7 – Area under maize.

RESULTS AND DISCUSSION

For assessing the performance of Indian agricultural sector, it is necessary to discuss the production and productivity trends over the past seven decades in Indian agriculture. However, increase in agricultural production and productivity depends, to a large extent, on the availability of water, inputs such as seed, fertilizers, finance and relevant technology. The present section is devoted to such study. For the purposes of the analysis the entire table can be conveniently divided into two parts namely overall performance of Indian agricultural sector and the period up to the new economic reforms and after the new economic reforms for analyzing the impact created by new economic reforms on Indian agricultural sector.

Area under cultivation of major crops in India

Table 1 shows the area under cultivation of various crops in India during the last seven decades from 1950-51

to 2020-21. The table includes various crops such as rice, wheat, pulses, jowar, bajra, maize, coarse cereals, total food grain, oilseeds, sugarcane, cotton, and jute. The area under cultivation for both rice and wheat had consistently increased over the years, with rice increased from 30.81 million hectares in 1950-51 to 45.77 million hectares in 2020-21, and wheat increased from 9.75 million hectares to 31.13 million hectares during the same period. The area under cultivation for pulses had shown fluctuating trends, first increased from 19.09 million hectares in 1950-51 to 24.66 million hectares in 1990-91, then decreased to 20.35 million hectares in 2000-01 and again increased to 28.78 million hectares in 2020-21. While maize had shown steady increased from 3.16 million hectares in 1950-51 to 9.89 million hectares in 2020-21, jowar and bajra had shown significant decline. Jowar decreased from 15.57 million hectares in 1950-51 to 4.38 million hectares in 2020-21, and bajra decreased from 9.02 million hectares to 7.65 million hectares during the same period.

The total area under food grain cultivation had shown a mix of growth and stagnation and cultivation increased from 97.32 million hectares in 1950-51 to 129.80 million hectares in 2020-21, with some fluctuations in between. Oilseeds and cotton had shown significant increase, with oilseeds cultivation raised from 10.73 million hectares to 28.83 million hectares and cotton from 5.88 million hectares to 13.29 million hectares. Sugarcane cultivation had also increased from 1.71 million hectares to 4.85 million hectares. However, Jute cultivation declined from 0.57 million hectares in 1950-51 to 0.66 million hectares in 2020-21. It suggests shift in agricultural practices, policy influences, and market demands over the years. Kalaiarasi *et al*., (2024) reported that there were significant regional disparities in agricultural efficiency, with Odisha (0.44%), Andhra Pradesh (0.40%), and Gujarat (0.34%) exhibiting higher Compound Annual Growth Rates (CAGR). The authors identified irrigation infrastructure, crop productivity, and access to agricultural credit as key determinants of efficiency. They observed that states had better irrigation facilities and improved crop yields tend to perform more efficiently in agricultural production. The study emphasized the need for region-specific agricultural policies to bridge the efficiency gap, ensuring food security, poverty reduction, and economic growth.

Output growth of major crops in India

The Table 2 shows the output growth of major crops in million tons over different years from 1950-51 to 2020-21. There was steady increase in rice output from 20.58 million tons in 1950-51 to 124.37 million tons in 2020-21, showcasing significant growth over the decades. Wheat production saw a substantial rise, increased from 6.46 million tons in 1950-51 to 109.59 million tons in 2020-21, more than a 17-fold increased. Pulses had shown inconsistent growth. Output started at 8.41 million tons and rose to 25.46 million tons by 2020-21, but there were years (like 1970-71 to 1980-81) where production decreased. Jowar's output peaked in 1980-81 with 10.43 million tons and had declined to 4.81 million tons in 2020-21, indicating a significant drop over the decades. Bajra's output increased initially but normalized around 10 million tons over the last two decades, with minor fluctuations. Maize production had shown strong growth from 1.73 million tons in 1950-51 to 31.65 million tons in 2020-21, indicating its increasing importance. Coarse cereals also experienced growth, from 15.38 million tons in 1950-51 to 51.32 million tons by 2020-21. The total food grain output had consistently increased from 50.82 million tons to 310.74 million tons, reflecting enhancement in agricultural productivity. Oilseed production had increased from 5.16 million tons to 35.95 million tons, demonstrating growth though it remains significantly lower than the primary grains. Sugarcane cultivation had increased from 57.05 million tons in 1950-51 to 405.40 million tons. This crop had shown the most significant growth in absolute terms. Cotton production had also grown from 3.04 million tons to 35.25 million tons over the period, although growth had been modest compared to other crops. Jute output fluctuated over the years and ended at 9.35 million tons, showing less growth in comparison to other crops.

The trends in Table 2 enable us for understanding agricultural development, food security, and economic planning in the respective regions involved in crop production. Strategic initiatives can be formulated to enhance growth in crops that stagnated or decreased in output. The study by Kumar *et al*. (2022) shows that minor millets' production decreased due to cereal cultivation, pulses, and commercial cash crops, while productivity increased due to high-yielding varieties and new technology adoption in India, the largest cereal producer. Manipur, Meghalaya, and Nagaland people in northeastern India rely on minor millets as their staple food, providing energy, nutrition, and essential minerals. However, cultivation area had decreased from 2447 thousand hectares to 458 thousand hectares due to overcultivation of major cereals, pulses, and cash crops. Overcultivation of major cereals, pulses, and cash crops led to a reduction of 81 per cent of cultivation area. The cultivation area of minor millets decreased by 42 per cent from 1990-91 to 1999-00, 42 per cent from 2000-01 to 2009-10, and 43 per cent from 2010-11 to 2019-20. Minor millets production decreased by 48 per cent from 1990-91 to 1999-00, 35 per cent from 2000-01 to 2009-10, and 16 per cent from 2010-11 to 2019-20. The study revealed a significant increase in minor millet productivity from 486 kg hectare^{-1} to 809 kg hectare^{-1} from 1990-91 to 2019-20, largely due to the availability of high-yielding varieties and new cultivation techniques. The study showed that minor millets' cultivation area decreased by 5.13 per cent annually due to cereal, pulse, and cash crop expansion, while production decreased by 3.30 per cent due to shifting cultivation areas. Minor millets' productivity increased by 1.92 per cent annually due to the availability of high-yielding, pest and disease-resistant varieties, and improved cultivation practices.

Productivity of major crops in India

The Table 3 shows the productivity (in kilograms/ hectare, kg ha^{-1}) of various major crops in India over a span of several decades, from 1950-51 to 2020-21. Productivity of rice was observed to be a steady increase over the decades from 668 kg ha^{-1} to 2717 kg ha^{-1} between 1950-51 and 2020-21. It shows that the productivity of rice has more than quadrupled since 1950. The productivity of wheat significantly increased over the decades, especially between the 1960s and 2000s. It was observed that productivity increased from 663 kg ha^{-1} to 3521 kg ha^{-1} during 1950-51 to 2020-21 by witnessing increase in productivity of wheat more than five times. An overall upward trend of 441 kg ha^{-1} in 1950-51 to 885 kg ha^{-1} in 2020-21 was observed in case of pulses, but it was less compared to cereals. Whereas in Jowar, productivity increased with a fluctuation of 353 kg ha^{-1} in 1950-51 and it increased to 1099 kg ha^{-1} in 2020-21 by witnessing tripled in productivity of Jowar in India. The productivity of Bajra also showed overall growth with some fluctuations and was 288 kg ha^{-1} in 1950-51 and it increased to 1420 kg ha^{-1} in 2020-21 by witnessing strong increase particularly noted in recent decades. In maize, it was observed that a strong increasing trend of 547 kg ha^{-1} in 1950-51 to 3199 kg ha^{-1} in 2020-21 by witnessing six-fold growth. There had been a steady increase of coarse cereals was observed over the decades in India. It was recorded as 408 kg ha^{-1} in 1950-51 and it increased to 2128 kg ha^{-1} in 2020-21 by witnessing the productivity increased more than five-fold. There was significant increase in total food grain over the years. It was 522 kg ha^{-1} in 1950-51 and it increased to to 2394 kg ha^{-1} in 2020-21 by witnessing the productivity increase of almost five times in India agriculture during the past seven decades.

Apart from the food crops, the commercial crops also showed a upward trend with fluctuations during the study period of 1950-51 to 2020-21. For instance, the productivity of oilseeds was observed to be increase from 481 kg ha^{-1} to 1247 kg ha^{-1} in 2020-21. In the case of sugarcane, there was remarkable growth with very high productivity was observed in the above mentioned periods. Between 1950-51 and 2020-21, it was recorded as 33422 kg ha^{-1} to 83566 kg ha^{-1} by witnessing more than doubled in productivity growth. For cotton, it was observed that an increase of 88 kg ha^{-1} to 451 kg ha^{-1} between 1950-51 and 2020-21 with overall increase but with notable fluctuations. There was steady and significant increase in productivity was observed in jute at 1043 kg ha^{-1} to 2542 kg ha^{-1} during 1950-51 to 2020-21. Overall, the data in Table 3 illustrate substantial growth in crop productivity in India from 1950 to 2021, particularly for staple foods like rice and wheat, due in part to advancements in agricultural practices, technology, and the introduction of high-yielding varieties. However, crops like pulses and cotton showed more inconsistent trends, indicating the complexity of agricultural productivity influenced by various factors, including climate, market demand, and farming practices.

Area under irrigation of major crops in India

From the data in Table 4, stated that irrigation for major crops in different years increased from 31.70 per cent to 64.97 per cent over the period from 1950-51 to 2019-20, with a notable increase in the later years. Irrigation for wheat showed an upward trend as well. It started at 33.99 per cent in 1950-51 and rose to 95.76 per cent in 2019-20, with some fluctuations in between. The irrigation percentage for pulses increased from 9.43 per cent in 1950-51 to 23.10 per cent in 2019-20, but the pace of increase was slower than other crops. Irrigation for Jowar increased from 2.98 per cent in 1950-51 to 11.10 per cent in 2019-20, showing steady growth over the years. The irrigation per centage for Bajra rose from 3.45 per cent in 1950-51 to 15.20 per cent in 2019-20, with fluctuations in between. The irrigation for maize increased from 11.35 per cent in 1950-51 to 29.30 per cent in 2019-20. Irrigation for sugarcane had shown a steady increase, from 67.33 per cent in 1950-51 to 96.46 per cent in 2019-20. The percentage of irrigation for cotton initially increased, from 8.22 per cent in 1950-51 to 35.80 per cent in 2019-20, with fluctuations in between. The overall irrigation percentage for food grains had shown an upward trend, with a notable increased from 18.10 per cent in 1950-51 to 56.96 per cent in 2019-20. By and large, most of the crops had shown an increase in irrigation per centages over the years, indicating a shift towards more water-intensive agriculture practices.

Selected category of land use and cropping and irrigation intensity

The Table 5 provides detailed statistics on land use and cropping and irrigation intensity across different years from 1950-51 to 2019-20, measured in million hectares. Both the net area sown and total cropped area have generally increased over the decades, reflecting an increase in agricultural production. It was observed at 118.75 million hectares to 139.90 million hectares and 131.89 million hectares to 211.36 million hectares respectively during 1950-51 to 2019.20. The net area sown showed fluctuations, with some years slightly lower than others for instance 141.34 in 2000-01 and 141.37 in 2010-11, indicating potential shifts in agricultural practices or land use policies. The cropping intensity had shown a steady rise, especially notable from 1970-71 onward. The biggest jump in cropping intensity occurred between 2010-11 and 2019-20, from 140.15 million hectares to 151.08 million hectares, indicating advancements in farming practices or increased use of multiple cropping systems. Irrigation intensity also showed a consistent upward trend, particularly from the 2000s onward, suggesting improvements in irrigation infrastructure and management. The data showcases a broad trend of increasing agricultural productivity and higher cropping and irrigation intensity over the decades, reflecting advancements in agricultural technology and practices, and possibly reflecting policy changes aimed at enhancing food security and sustainability in agricultural practices.

A similar finding also revealed that land configuration and nutrient management significantly

influenced soil fertility, quality, and nutrient uptake by maize. Ghodpage *et al*. (2023) examined the effects of different land configurations and nutrient application strategies during the *kharif* season of 2017-18 at EAD Farm, College of Agriculture, Nagpur. Their study indicated that nitrogen and phosphorus uptake by maize increased by 29.63 per cent and 19.66 per cent, respectively, when 125 per cent RDF was applied alongside ridges and furrows with in situ green sunhemp, compared to 75 per cent RDF with a flatbed. Furthermore, nitrogen content in the soil improved from 9.66 per cent to 14.52 per cent under balanced nutrient management, while phosphorus content increased between 12.45 per cent and 30.09 per cent. The highest grain yield (58.88 q ha^{-1}) was recorded under 125 per cent RDF with ridges and furrows, whereas the lowest (45.30 q ha^{-1}) was observed under 75 per cent RDF with a flatbed. The highest protein content (10.89%) was also reported under 125 per cent RDF with ridges and furrows and in situ green sunhemp. Additionally, calcium and magnesium content in maize grain was highest (0.417% and 0.257%, respectively) under higher doses of NPK and in situ green sunhemp. The study recommended adopting ridge and furrow systems integrated with green manure to improve nutrient uptake and to enhance maize productivity.

Annual growth rate estimation of India's major crops production

The Table 6 presents the annual growth rates of production (in tonnes) for various major crops in India over a period spanning from 1991 to 2020. Each row represents a specific year, and each column corresponds to a particular crop. The crops listed include food grains, rice, wheat, nutri cereals, jowar (sorghum), bajra (pearl millet), maize, and pulses. The data shows fluctuations in production growth rates over time for each crop, influenced by various factors such as weather conditions, government policies, technological advancements, and market demand. Some crops exhibited more consistent growth patterns over the years, while others showed greater variability. Especially, the growth rates for food grains vary over the years, with fluctuations ranging from as high as 12.61 per cent in 2001 to as low as -16.70 per cent in 2003. This indicates significant volatility in food grain production over time. Rice production showed both positive and negative growth rates. For example, there was a notable increase of 18.32 per cent in 2001 and a decrease of -19.92 per cent in 2003. These fluctuations suggested variability in rice production trends. Wheat production also exhibited fluctuations, with growth rates ranging from 8.55 per cent in 1996 to -13.89 per cent in 2003. However, the overall trend seems to be more stable compared to some other crops. Besides, nutri cereals production demonstrates both positive and negative growth rates, with significant fluctuations. For instance, there was an increase of 40.78 per cent in 1993 and a decrease of -20.66 per cent in 1996, indicating notable variability in nuts production. Jowar production has experienced considerable fluctuations in growth rates. There was a substantial increase of 58.15 per cent in 1993 and a significant decrease of -39.43 per cent in 2016, suggesting significant changes in jowar production over time. Bajra production also showed significant variability in growth rates. For example, there was an increase of 90.15 per cent in 1993 and a decrease of -72.07 per cent in 1998, indicating notable fluctuations in bajra production. Maize production exhibited substantial fluctuations in growth rates. There was a significant increase of 293.50 per cent in 1997 and a decrease of -16.95 per cent in 2000, suggesting considerable changes in maize production levels over time. Pulse production demonstrates significant variability in growth rates. For instance, there was an increase of 10.89 per cent in 1991 and a decrease of -17.06 per cent in 2003, indicating notable fluctuations in pulse production trends. These analyses indicate that each crop had its own unique production dynamics, influenced by various factors such as weather conditions, market demand, government policies, and technological advancements.

The annual growth rates of major crops in India exhibit diverse trends and fluctuations over the years. Food grains, including rice and wheat, demonstrate varying growth rates, with notable fluctuations observed from year to year. Nutri cereals, jowar, bajra, maize, and pulses also showcase significant variability in their growth patterns. Notably, in 2020, there was a resurgence in production for most crops, with positive growth rates recorded across the board. Nuts experienced a substantial growth rate of 10.89 per cent, while jowar saw a remarkable increase of 37.07 per cent. Bajra, maize, and wheat also demonstrated notable growth rates of 19.63 per cent, 3.79 per cent, and 4.11 per cent respectively. These growth rates reflect the resilience of India's agricultural sector amidst challenges, highlighting the importance of monitoring and adapting to dynamic agricultural dynamics. A study conducted by Singh and Singh (2023) examined the impact of different rice residue management practices and varying nitrogen application levels on wheat productivity and quality. The field study, conducted at the Student's Research Farm, Khalsa College, Amritsar, during the *rabi* season of 2021, utilized a split-plot design with 15 treatment combinations. The main plot treatments included three residue management techniques—burning, removal, and incorporation with a decomposer—while the subplot treatments comprised five nitrogen levels ranging from control to 125 per cent of the recommended dose. The study revealed that wheat grown under residue incorporation with a decomposer exhibited significantly higher growth parameters, yield attributes, and overall productivity compared to residue removal and burning methods. The highest grain yield of 50.23 q ha^{-1} was recorded under decomposer-based residue incorporation, which outperformed residue removal (48.32 q ha^{-1}) and burning (44.32 q ha^{-1}). Growth indicators such as plant height (108.03 cm), leaf area index (3.73), and dry matter accumulation (9.3 g $plant^{-1}$) also peaked under decomposer treatment. Furthermore, the 125 per cent recommended nitrogen dose led to the highest values for protein content in grain (10.93 per cent) and straw (2.62 per cent), reinforcing

the importance of optimized nitrogen application. The authors concluded that integrating rice residue decomposition with adequate nitrogen fertilization significantly enhanced wheat productivity and quality. The hypothetical question for the present study is the implementation of the new economic reforms such as Liberalization, Privatization, and Globalization (LPG) policy in India has not led to a statistically significant change in the relationship between the area of production (in ha) and crop production (in tonnes), suggesting that agricultural productivity remains consistent irrespective of the policy shifts.

India's major crops production during pre and post liberalization era

The results of the double log linear regression analysis in Table 7 suggest that the relationship between the area of production and crop production changed significantly across different crop varieties before and after the implementation of the LPG policy in 1991. The coefficients, F-test values, and R^2 values indicated that the strength and significance of these relationships generally weakened post-LPG, particularly for food grains, where the coefficient declined from 5.473 to 3.504, accompanied by a sharp reduction in the F-test value from 73.297 to 9.767 and a decrease in R^2 from 0.724 to 0.259, implying a weaker correlation between the area of production and output. Similarly, rice, which initially showed a very strong positive relationship with an R^2 value of 0.886 and a coefficient of 3.731 before LPG, experienced a slight decline in post-LPG, with the coefficient decreasing to 3.476 and the R^2 value dropping to 0.319, reflecting a reduced strength in the relationship. Likewise, wheat, despite maintaining an overall strong correlation, saw a decrease in its coefficient from 2.336 to 2.174 after LPG, while the F-test, though still high at 268.787, was significantly lower than its pre-LPG value of 913.115, suggesting a slightly weaker relationship. On the other hand, maize and pulses exhibited an improvement in their relationship post-LPG, indicating a positive impact of the policy on these specific crops, possibly due to technological advancements, policy incentives, or shifts in demand and cropping patterns. The findings further reveal that nutrient cereals, jowar, bajra, maize, and pulses showed varying relationships before LPG, with some strengthening, weakening, or even changing direction after its implementation, suggesting that the policy had a differentiated impact across crop varieties. Moreover, the statistical significance of most coefficients at the 1 per cent level provides strong evidence against the null hypothesis, reinforcing the reliability of the observed changes. Therefore, the study advocates that while food grains, rice, and wheat exhibited a stronger production relationship before the LPG policy, the impact of the reforms led to diverse effects on India's agricultural sector, with some crops benefiting while others experienced a decline in production responsiveness to the area of cultivation. These findings highlight the complexity of agricultural transformations under economic liberalization, emphasizing the need for policy interventions personalized to support sustainable growth across different crop categories. The study by Malathi *et al*. (2016) found significant growth in millet production from 1950-51 to 2011-12, primarily due to increased yield hectare^{-1}. Millets are crucial cereals in developing Asia and Africa's semi-arid tropics, particularly in India, Nigeria, and Niger, ensuring food and nutrition security. India, the world's largest producer of millets, experienced a reduction in its millet's contribution to total foodgrain production from 22.17 per cent in 1950-51 to 6.94 per cent in 2011-12. The study shows a significant decline in millet crop area from 1950-51 to 2011-12, primarily due to increased cultivation of major cereal crops like rice and wheat, and globalization of agriculture, primarily affecting the area under millets. Millets production had significantly increased over the last 60 years, possibly due to increased demand from public distribution systems and increased awareness about their health benefits. Another study by Yamuna *et al*. (2024) showed a significant decline in cultivation area and production, especially in major millets like sorghum and finger millet, with a CAGR of -2.51 per cent and -1.84 per cent respectively. The study predicts further decline in area and production for millet cultivation in the next decade, with a potential reversal in increasing yield. It emphasizes the nutritional importance of millets in climate-resilient agriculture. The declining cultivation area and production of major millets like sorghum in -2.51 per cent in area and -1.44 per cent in production annum^{-1} and finger millet in -1.84 per cent in area and -0.49 per cent in production annum^{-1} pose a challenge to India's food security, while the study showed a positive trajectory in millet yield (1.09 per cent to 2.47 per cent).

This study examined the performance and prospects of Indian agriculture by analyzing trends in cultivation, production, productivity, and irrigation of major crops over seven decades. The study highlighted a substantial increase in rice and wheat cultivation, whereas crops like jowar and bajra had seen a decline. Overall, output and productivity improved, particularly for maize, oilseeds, sugarcane, and cotton. However, pulses and certain commercial crops had shown inconsistent trends, reflecting variations in agricultural performance across different crop categories. Changes in land use, cropping patterns, and irrigation intensity highlighted the evolving nature of Indian agriculture. The increase in irrigated areas and shifts in crop choices indicated the sector's adaptation to policy changes, technological advancements, and market demands. However, disparities in growth among different crops suggest the need for targeted interventions to ensure balanced agricultural development.

The study also evaluated the impact of economic reforms, particularly the 1991 LPG policy, on agricultural growth. While food grains, rice, and wheat showed a weakening correlation between cultivated area and production post-reform, crops like maize and pulses benefited from improved productivity and market responsiveness. These findings underline the complex

transformations within the agricultural sector and the importance of policies that support sustainable growth and resilience in the face of economic and environmental challenges. Based on the findings, the following recommendations are proposed to enhance agricultural growth, address declining crop trends, and improve overall productivity and sustainability in Indian agriculture.

1. Expanding and modernising irrigation infrastructure, including micro-irrigation techniques like drip and sprinkler systems, will optimise water use and support sustainable crop production.

2. Promoting the cultivation of high-yield and climate-resilient crops can help mitigate risks associated with declining crops like jowar and bajra while ensuring food security.

3. Encouraging balanced fertiliser use, organic farming, and soil testing practices will enhance soil fertility and long-term productivity.

4. Developing better storage, transportation, and processing facilities will help to reduce post-harvest losses and improve farmers' access to markets.

5. Strengthening agricultural research on high-yield varieties, pest-resistant crops, and sustainable farming techniques will help address productivity challenges.

6. Implementing policies that support climate-smart agriculture, such as drought-resistant crops and improved weather forecasting systems, will help mitigate the impact of climate change on farming.

7. Ensuring stable and favourable agricultural policies, including fair pricing mechanisms and input subsidies, will encourage sustainable growth in the sector.

Table 1. Area under cultivation of major crops in India (million hectares)

Crops	1950-51	1960-61	1970-71	1980-81	1990-91	2000-01	2010-11	2020-21
Rice	30.81	34.13	37.59	40.15	42.69	44.71	42.86	45.77
Wheat	9.75	12.93	18.24	22.28	24.17	25.73	29.07	31.13
Pulses	19.09	23.56	22.54	22.46	24.66	20.35	26.40	28.78
Jowar	15.57	18.41	18.61	15.81	14.36	9.86	7.38	4.38
Bajra	9.02	11.47	12.91	11.66	10.48	9.83	9.61	7.65
Maize	3.16	4.41	5.85	6.01	5.90	6.61	8.55	9.89
Coarse cereals	37.67	44.96	45.95	41.78	36.32	30.26	28.34	24.12
Total food grain	97.32	115.58	124.32	126.67	127.84	121.05	126.67	129.80
Oilseeds	10.73	13.77	16.64	17.60	24.15	22.77	27.22	28.83
Sugarcane	1.71	2.42	2.62	2.67	3.69	4.32	4.88	4.85
Cotton	5.88	7.61	7.61	7.82	7.44	8.53	11.24	13.29
Jute	0.57	0.90	1.08	1.30	1.02	1.02	0.87	0.66

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

Table 2. Output growth of major crops in India (million tons)

Crops	1950-51	1960-61	1970-71	1980-81	1990-91	2000-01	2010-11	2020-21
Rice	20.58	34.58	42.22	53.63	74.29	84.98	95.98	124.37
Wheat	6.46	11.00	23.83	36.31	55.14	69.68	86.87	109.59
Pulses	8.41	12.70	11.82	10.63	14.26	11.08	18.24	25.46
Jowar	5.50	9.81	8.11	10.43	11.68	7.53	7.00	4.81
Bajra	2.60	3.28	8.03	5.34	6.89	6.76	10.37	10.86
Maize	1.73	4.08	7.49	6.96	8.96	12.04	21.73	31.65
Coarse cereals	15.38	23.74	27.29	29.02	32.70	31.08	43.40	51.32
Total food grain	50.82	82.02	108.42	129.59	176.39	196.81	244.49	310.74
Oilseeds	5.16	6.98	9.63	9.37	18.61	18.44	32.48	35.95
Sugarcane	57.05	110.00	126.37	154.25	241.05	295.96	342.38	405.40
Cotton	3.04	5.60	4.76	7.01	9.84	9.52	33.00	35.25
Jute	3.31	5.26	6.19	8.16	9.23	10.56	10.62	9.35

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

Table 3. Productivity of major crops in India (kg ha^{-1})

Crops	1950-51	1960-61	1970-71	1980-81	1990-91	2000-01	2010-11	2020-21
Rice	668	1013	1123	1336	1740	1901	2239	2717
Wheat	663	851	1307	1630	2281	2708	2988	3521
Pulses	441	539	524	473	578	544	691	885
Jowar	353	533	466	660	814	764	949	1099
Bajra	288	286	622	458	658	688	1079	1420
Maize	547	925	1279	1159	1518	1822	2542	3199
Coarse cereals	408	522	665	695	900	1027	1531	2128
Total food grain	522	710	872	1023	1380	1626	1930	2394
Oilseeds	481	507	579	532	771	810	1193	12.47
Sugarcane	33422	45549	48322	57844	65395	68578	70091	83566
Cotton	88	125	106	152	225	190	499	451
Jute	1043	1049	1032	1130	1634	1868	2197	2542

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

Table 4. Area under irrigation of major crops in India (%)

Crops	1950-51	1960-61	1970-71	1980-81	1990-91	2000-01	2010-11	2019-20
Rice	31.70	36.77	38.36	40.67	45.55	54.37	58.80	64.97
Wheat	33.99	32.74	54.25	69.98	81.14	88.37	91.51	95.76
Pulses	9.43	8.02	8.75	8.95	10.48	12.64	14.91	23.10
Jowar	2.98	3.55	3.64	4.68	5.62	8.33	8.70	11.10
Bajra	3.45	2.79	3.98	5.53	5.10	7.81	10.17	15.20
Maize	11.35	12.63	15.86	20.14	19.72	21.79	24.41	29.30
Total food grain	18.10	19.09	24.11	29.66	35.07	43.70	48.15	56.96
Sugarcane	67.33	69.26	72.38	81.26	86.97	92.17	92.83	96.46
Cotton	8.22	12.71	17.34	27.28	32.94	32.22	32.84	35.80

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

Table 5. Selected category of land use and cropping and irrigation intensity (million hectares)

Crops	Net area sown	Total cropped area	Area more than once	Net irrigated area	Gross irrigated area	Area irrigated more than once	Cropping intensity	Irrigation intensity
1950-51	118.75	131.89	13.15	20.85	22.56	1.71	111.07	108.2
1960-61	133.20	152.77	19.57	24.66	27.98	3.32	114.69	113.46
1970-71	140.86	165.79	24.93	31.10	38.20	7.09	117.70	122.83
1980-81	140.29	172.63	32.34	38.72	49.78	11.06	123.05	128.56
1990-91	142.87	185.74	42.87	48.02	63.20	15.18	130.01	131.61
2000-01	141.34	185.34	44.00	55.20	76.19	20.98	131.13	138.03
2010-11	141.37	198.13	56.76	63.87	89.32	25.45	140.15	139.85
2019-20	139.90	211.36	71.46	75.46	112.23	36.77	151.08	148.73

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

Table 6. Annual growth rate estimation of India's major crops – production (in tonnes)

Year	Food grains	Rice	Wheat	Nutri cereals	Jowar	Bajara	Maize	Pulses
1991	3.13	0.98	10.61	-5.93	-9.46	3.61	-7.15	10.89
1992	-4.54	0.52	1.00	-20.52	-30.65	-32.22	-10.04	-15.71
1993	6.59	-2.44	2.73	40.78	58.15	90.15	23.95	6.66
1994	2.13	4.31	-3.64	6.17	22.29	-7.62	0.73	8.04
1995	3.93	1.88	9.91	-3.05	-21.38	44.06	-7.50	5.56
1996	0.52	5.65	8.55	-20.66	-27.17	-39.41	-4.60	-3.98
1997	3.68	-0.98	4.52	12.20	45.29	293.50	-0.46	9.10
1998	0.40	0.89	0.88	1.74	-16.05	-72.07	21.85	-7.62
1999	2.14	5.32	2.80	-8.12	-23.03	-11.56	3.53	5.37
2000	3.04	4.18	7.13	-3.22	3.09	-16.95	3.23	-9.99
2001	12.61	18.32	5.96	19.22	7.42	43.22	7.98	-0.45
2002	2.04	1.69	4.93	-2.03	-0.92	7.81	-10.54	-0.07
2003	-16.70	-19.92	-13.89	-14.05	-19.24	-18.34	-3.13	-17.06
2004	0.16	-5.15	-0.84	12.64	-11.64	46.26	13.83	11.52
2005	0.79	-2.18	-1.49	7.66	-3.85	17.31	17.69	18.50
2006	5.16	10.42	1.03	1.82	5.39	-3.15	3.81	1.90
2007	1.92	5.46	5.06	-9.79	7.04	-30.47	0.80	-4.76
2008	5.81	8.53	-2.76	21.46	18.36	53.15	13.40	0.68
2009	1.60	2.58	2.69	-1.74	-8.58	-10.83	4.06	-1.29
2010	0.38	-4.57	6.58	-1.09	-6.29	-22.68	10.73	3.24
2011	4.27	-3.23	7.67	8.39	-3.45	16.65	10.14	25.19
2012	0.84	0.07	1.47	4.92	13.26	17.62	-2.25	-6.82
2013	2.02	-0.24	8.07	-6.58	-3.12	-4.79	-7.90	6.94
2014	2.22	1.28	1.02	3.05	-7.36	-10.02	11.49	12.64
2015	0.19	1.02	-6.24	11.27	28.54	13.75	7.09	5.09
2016	2.88	8.78	6.24	-11.24	-39.43	-22.18	3.87	-10.53
2017	3.80	2.86	2.78	1.11	-17.51	5.19	6.76	20.68
2018	3.60	2.79	1.38	7.31	5.03	-5.34	11.00	8.70
2019	0.07	3.30	3.73	-8.32	-27.50	-5.97	-3.58	-12.00
2020	4.31	2.05	4.11	10.89	37.07	19.63	3.79	3.65

Source: Author's estimation

Table 7. Regression results of India's major crops during pre and post liberalization era

Crop	Before LPG				After LPG			
Varieties	â	t	F (sig)	R^2	â	t	F (sig)	R^2
Food grains	5.473	8.561***	73.297	0.724	3.504	3.125***	9.767	0.259
	(0.639)		0.01		(1.121)		0.04	
Rice	3.731	14.75***	217.574	0.886	3.476	3.618***	13.091	0.319
	(0.253)		0.01		(0.961)		0.01	
Wheat	2.336	30.218***	913.115	0.970	2.174	16.395***	268.787	0.906
	(0.077)		0.01		(0.133)		0.01	
Nuts	-0.647	-1.988**	3.954	0.124	-0.978	-4.988***	24.879	0.470
	(0.325)		0.06		(0.196)		0.01	
Jowar	-0.752	-1.901*	3.616	0.114	0.886	13.845***	191.673	0.873
	(0.396)		0.07		(0.064)		0.01	
Bajara	1.272	1.454	2.114	0.070	-0.657	-1.340	1.795	0.060
	(0.874)		0.157		(0.49)		0.19	
Maize	1.681	6.961***	48.458	0.634	2.273	27.301***	745.344	0.964
	(0.241)		0.01		(0.083)		0.01	
Pulses	1.498	3.249***	10.559	0.274	2.068	13.449***	180.873	0.866
	(0.461)		0.01		(0.154)		0.01	

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