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An analysis of the determinants of agricultural productivity of India

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Abstract: *the Indian agricultural sector plays a vital role both as a source of livelihood and as provider of raw material to the manufacturing sector. The productivity of Indian agriculture has seen continuous increase ever since the introduction of green revolution. The present study is an attempt to analyse this trend and find out the factors that contribute to the enhance level of productivity. The study has found that irrigation and consumption of pesticide have significant impact on the agricultural productivity. However, the use of fertiliser does not seem to have significant impact on the level of productivity. The result has been consistent both for food grain and commercial crops.*

Agriculture plays a vital role in the Indian economy, contributing significantly to the nation's GDP and providing employment to a large percentage of the population. With the population of 1.39 billion, India is second most populous country in the world. India faces unique challenges in ensuring food security and sustainable agricultural development. The importance of agriculture in an economy is recognised not only for the reason that it tends to feed the entire population of a country but also for the fact that agriculture correlates and interacts with all other sectors of the economy. It ensures food supply, transfer of manpower and surplus to the secondary sectors for capital formation and creation of additional purchasing power. Further, an adequate supply of food enables a country to escape from a hand-to-mouth existence and devote a larger amount of labour to the production of more sophisticated kinds of capital goods.

Agriculture, with its allied sectors, is the largest source of livelihood in India. As per the Economic Survey 2022-23, 65% of India's population lives in rural areas and 47% of the population is dependent on agriculture for livelihood, with 82% of farmers being small and marginal. It is the 7th largest country geographically in the world with 328 mha (Million Hectare)

area. India has about 160 mha of arable land, the second largest after the United States of America and experiences all 15 prominent climates with 46 out of 60 soil types that exist on the earth.

About 50% of its total geographical area is cultivated, which ranks it among the top users of land for agriculture. In the more geographically suitable Indo-Gangetic Plain (IGP) and the deltas of the eastern coast, the proportion of cultivated to the total geographical area often exceeds 90%. Indian agriculture, one of the oldest systems of the world, is diverse, heterogeneous, unorganized, and often subjected to vagaries at various phases from 'seed to market'. It is the critical sector of the economy for the sustainable and inclusive economic growth of the country. The sector engages 49.6% of the workforce, often seasonally, under-employed, and underpaid and accounts for about 17.8% share of India's Gross Domestic Product (GDP).

Many agro-based industries, such as textile, leather, sugar, tea, etc., are dependent on the agricultural sector. Agribusiness is contributing greatly to the national income of India. Therefore, it is said that agriculture is the backbone of the Indian economy. Agricultural exports constitute around a fifth of the total exports of the country.Therefore, the development of the agriculture sector has tremendous potentialto raise production and creation of infrastructure through horizontal and vertical linkages with the rest of the economy.

Since the introduction of economic planning in India, agricultural development has been receiving special emphasis. It was only after 1965, i.e., from the mid-period of the Third Plan, that special emphasis was laid on the development of the agricultural sector. Since then, a huge amount of funds has been allocated for the development and modernization of this agricultural sector every year, which helped to impart the growth in food grains production and in transforming India from a global food basket case to national self-sufficiency; the developments during the last decade suggest that a rethinking in this strategy pursued so far has been an unqualified success only in the case of a few crops like rice and wheat and that too only in regions well-endowed with irrigation coupled with the use of inputs like fertilisers.

Now, India is a global agricultural powerhouse. It is the world's largest producer of milk, pulses, and spices, and has the world's largest cattle herd (buffaloes), as well as the largest area under wheat, rice and cotton. It is the second largest producer of rice, wheat, cotton, sugarcane, farmed fish, sheep & goat meat, fruit, vegetables and tea. The country has some 195 m ha under

cultivation of which some 63 percent are rainfed (roughly 125m ha) while 37 percent are irrigated (70m ha). In addition, forests cover some 65m ha of India's land.

On the whole, Indian agriculture does not show high efficiency or productivity, though there has been an improvement since independence. While there has been improvement in certain areas, overall efficiency and productivity remain relatively low. Several obstacles have hindered the sector's growth, preventing it from reaching its full potential and meeting the increasing demands of a growing population.

Review of Literature:

Kumar and Mittal (2006) examined the sustainability issue of the Indian crop productivity from 1971 to 2000. A sustainable farming system is a system in which natural resources are managed in a way that potential yield and the resources stock do not decrease over time. To compute the TFP indices for crops they have applied the Divisia-Tornqvist index. The study has found that the initial high productivity growth during 1980s has slowed down. Thus the new technology introduced under green revolution has temporary effect on productivity, but in longrun it has negative effect on soil health, water level etc.

Sinha et al. (2016) focus on the shrinking net sown area and changing land use patterns in the state of Bihar, India. The research aims to understand the factors and consequences associated with the decrease in agricultural land and its impact on food security and rural livelihoods. Rapid urbanisation, expanding population, depleting water level, fragmentation of land have been mainly responsible for the rapidly declining net sown area. This has specifically become a cause of concern in the agriclimatic zone-III. Flood-prone areas in zone-I and zone-II have also seen a decrease in net sown area due to the risk of crop damage. Rapidly declining area under agriculture is likely to have detrimental effect on rural employment and livelihood, food security.

Dholakia and Dholakia (1993) estimated the sources of growth of Indian agriculture for three sub-periods during 1950-51 to 1988-89. It also estimated the contribution of adverse weather conditions and intensity of resource use to total factor productivity growth (TFPG). The TFPG basically indicates the level of technological advancement which has been brought about by green revolution. Using seeds which have higher yield potential, applying higher doses of

fertiliser and expanding irrigation facility have been the components of this technological advancement. This TFPG has been seen to be the main source of growth in agricultural productivity in India.

Singh (2000) focuses on the environmental consequences of agricultural development in the state of Haryana, India, particularly in the context of the Green Revolution. The Green Revolution refers to the period of intensive agricultural development that took place in the 1960s and 1970s, aiming to increase crop yields and food production. The study highlights both positive and negative environmental impacts resulting from the agricultural development in Haryana. On the positive side, the Green Revolution led to a significant increase in crop productivity, enabling the state to achieve self-sufficiency in food production. This had a positive impact on food security and alleviated poverty among rural communities. It also resulted in adverse environmental consequences. The study emphasizes the need for sustainable agricultural practices, such as the promotion of organic farming, efficient water management, and biodiversity conservation, to mitigate the environmental impacts of agricultural development.

Shindagimath (2015) examines the impact of irrigation on land use change in the Bellary district of India through a geographical analysis. While higher level of irrigation leads to an expansion of area under cultivation, it has also negatively affected the total availability of water for other purposes. Development of irrigation infrastructure enables the farmers to cultivate even the barren land and the shift from rain fed agriculture to irrigated agriculture has increased the level of certainty. However, over exploitation of water has led to unsustainability of this farming because of the receding water table. The study has suggested focusing on developing infrastructure which can rejuvenate the ground water to make sustainable use of water.

Tanhampoar and Mahmoudi (2018) investigated the empirical model to evaluate the productivity growth in agriculture sector. The result has found that average factor production growth rate is -0.72 percent and its share in value added is also negative -19.6 percent while it has estimated to be 33.8 percent in fourth development plan. The value-added growth in agriculture sector has achieved by the effective capital role in agriculture low. Labour productivity growth does not have positive effect on the value-added growth.

Raju et al., (2014) focused on analysing the pattern and trends in labor utilization within the Indian agriculture sector. By using National Sample Survey Organization's (NSSO) 66th round survey on employment and unemployment conducted during 2009-10 they have found the vulnerabilities faced by farmers and agricultural labourers. They have suggested skill development, improving access to credit and markets, and creating alternative employment opportunities outside of agriculture to facilitate the transition of labor from the agricultural sector to other sectors of the economy.

Bhalla and Roy (1988) underscore the importance of addressing mis-specification in farm productivity analysis. The problems in data collection, exclusion of many variables and choice of incorrect functional forms are some of the factors that lead to distortion between measured and actual productivity. Addressing these issues at the earliest can only lead to accuracy and reliability of productivity analysis in the agricultural sector.

Chadha (1961) has implications for agricultural policies aimed at enhancing productivity and promoting sustainable rural development. The farm size and productivity debate has been revisited in this study and the finding has supported small farmers to be more productive. However the major issues faced by these farmers are access to resources, training and extension services, marketability of their product etc. The study underscores the need for nuanced policies and interventions to support small-scale farmers and improve their productivity.

Roy (2017**)** has reiterated the findings of many other literatures and found that the relation between farm size and productivity is inverse in India. He pointed out that there is no other source of employment for poor villagers. So, they prefer to cultivate their own land which is small in size. When villagers cultivate their own land, they put in all their efforts and life into it. But that is not the case with large farms. Large farm owners are rich. They have many other sources of earning. So, they appoint outside people to cultivate their own land. These outside people do not cultivate those lands by putting in all their efforts because they will get the wages at the same rate irrespective of the productivity. So large farms have low productivity and small farms have

high productivity in India. He again highlighted the need of addressing the issues faced by small farmers in India.

Chand and Kumar (2011) concluded that Productivity performance, measured by the growth in TFP, has shown a considerable variation across crops and regions. Wheat has enjoyed the highest benefit of technological breakthroughs throughout during the past three decades with its TFP growth close to 2%. Rice lags far behind wheat, while maize has achieved an annual TFP growth of around 0.67%. The major cereals, namely wheat, paddy and maize have experienced a lower growth in TFP after mid-1990s. Despite lot of claims about hybrid sorghum, its TFP has shown a decline during 1995 to 2005.

The objective of the study

The objectives of the present study are

1. The first objective of the study is to analyse the trends in agricultural productivity from 1980 to 2018.

2. Second objective of the study is to identity the Factors Affecting Agricultural Productivity both for food grains and commercial crops.

Methodology

In order to study the trends of production, inputs and productivity in food grain as well as in commercial crops, secondary data has been used in this study. The data has been collected from the Handbook of Statistics on Indian Economy of Reserve Bank of India (RBI). Here the times series data (from 1980 to 2018) pertaining to net sown area of land, consumption of fertilizer, irrigated area of land, use of pesticides, and total food grain production has been collected.

Methods for analysis

The main method used in this study will be OLS regression. OLS regression is a statistical method that can be used to estimate the relationship between two or more variables. In this study, OLS regression will be used to estimate the relationship between agricultural productivity and a set of explanatory variables, such as irrigation, fertilizer use, and pesticide use.

Equations for regression

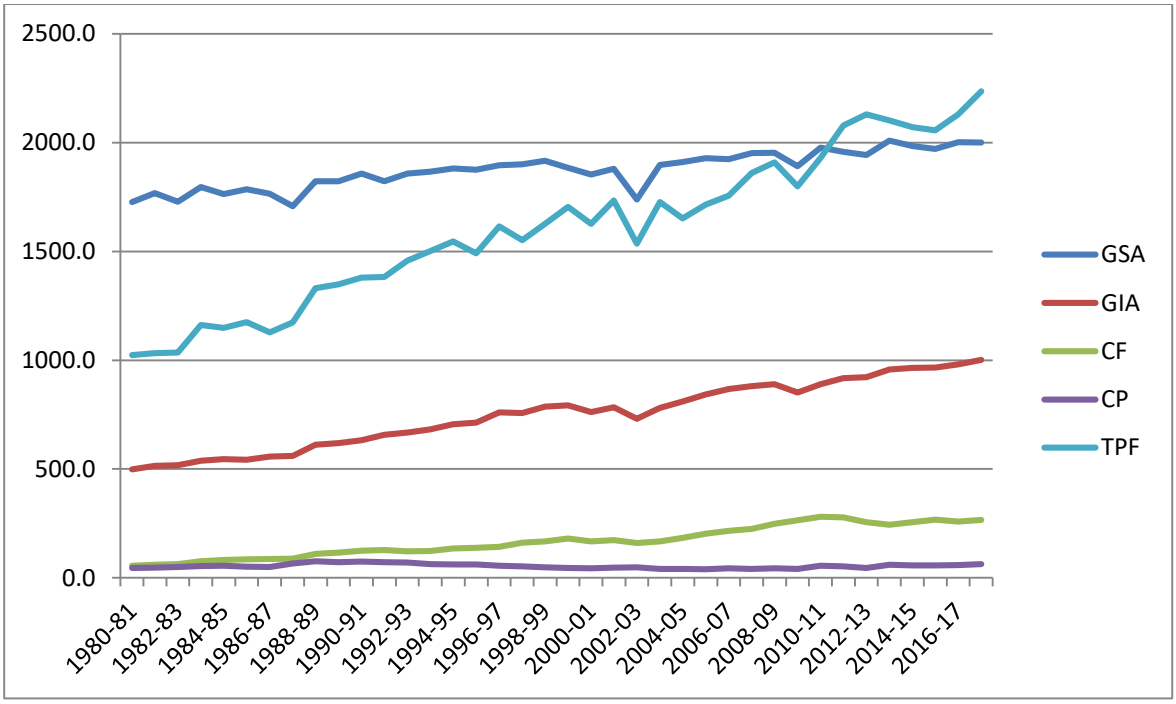
The particular regression model that has been used in this study can be written as:

$$TPF_t = \beta_0 + \beta_1 GIA_t + \beta_2 CF_t + \beta_3 CP_t + e_t$$

$$TPCM_t = \beta_0 + \beta_1 GIA_t + \beta_2 CF_t + \beta_3 CP_t + e_t$$

- TPF is the total productivity of food grains, which is a measure of the efficiency with which inputs are used to produce output.
- TPCM is the total productivity of commercial crops, which is a measure of the efficiency with which inputs are used to produce output.
- GIA is the gross irrigated area, which is a measure of the amount of land that is irrigated.
- CF is the fertilizer consumption, which is a measure of the amount of fertilizer that is used.
- CP is the Consumption of pesticides, which is a measure of the amount of pesticides used.

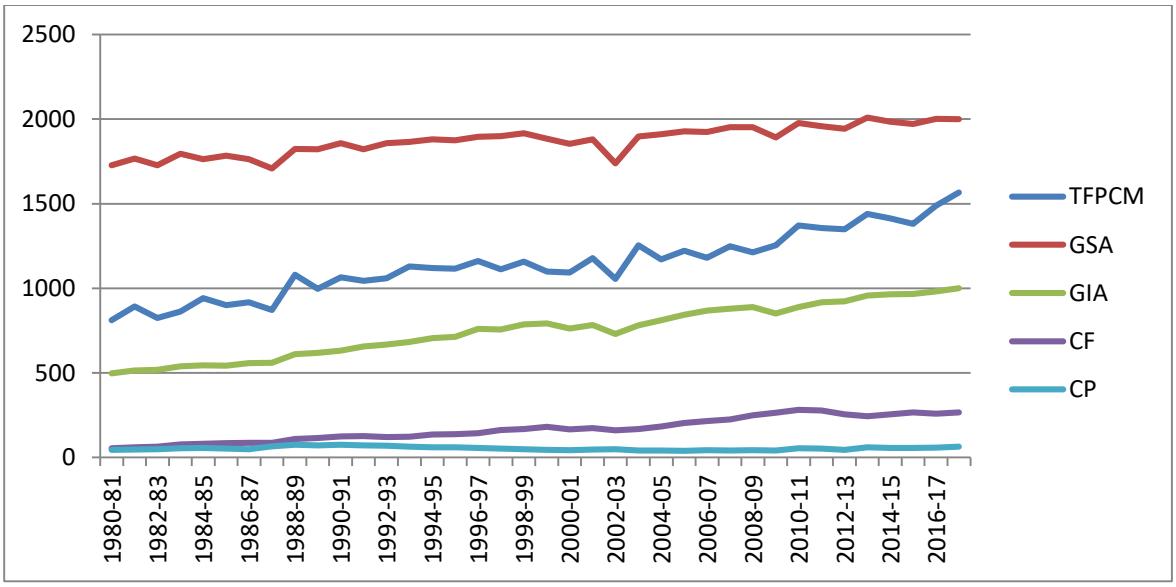
Trend of Food Grain Productivity and different Inputs:



Source: Handbook of Statistic on Indian Economy, RBI

As can be seen from the trend line, all the variables have an increasing trend. Gross sown area refers to the amount of land devoted for agriculture and it is not likely to affect per hectare output or productivity. Similarly, the productivity of commercial crops has also been increased significantly and this has been shown in the figure below.

Trend of Commercial Crops Productivity and Different Inputs:



Source: Handbook of Statistic on Indian Economy, RBI

Regression Results for Food Grains:

Dependent Variable	Explanatory Variable	Coefficient	P-Value	R-square
TFP	CP	2.182979	0.010	0.9818
	CF	.5665871	0.251	
	GIA	2.04569	0.000	
	Constant	-143.9221	0.171	

As can be seen from the above results, the consumption of pesticide has significant impact on the productivity level of food grains. An increase in the one thousand ton of pesticide at the national level leads to 2.18 kg increase in food grain output per hectare. Similarly, the level of irrigation also has significant impact on the productivity level. If the irrigation facility is extended to one million hectare of land then the output per hectare increases by 2.04 kilogram. However, the fertiliser consumption does not have significant impact on the productivity of food grains. The r-square of the above regression is very high and it shows that around 98 per cent of variation in the dependent variable can be explained by the explanatory variables included within the regression model.

Regression Results for Commercial Crops:

Dependent Variable	Explanatory Variable	Coefficient	P-Value	R-square
TPCM	CP	3.135911	0.000	0.9483
	CF	.0276495	0.951	
	GIA	1.239916	0.000	
	Constant	39.12565	0.682	

As can be seen from the above results, the consumption of pesticide has significant impact on the productivity level of commercial crops as well. An increase in the one thousand ton of pesticide at the national level leads to 3.13 kg increase in output of commercial crops per hectare. Thus,

the impact of pesticide consumption is higher in case of commercial crops as compared to food grains. Similarly, the level of irrigation also has significant impact on the productivity level. If the irrigation facility is extended to one million hectare of land then the output per hectare increases by 1.23 kilogram. The coefficient of irrigation is smaller than the food grain regression, because commercial crops need less water and food grains, like rice, need higher amount of water. However, the fertiliser consumption does not have significant impact on the productivity of commercial crops as well. The r-square of the above regression is very high and it shows that around 95 per cent of variation in the dependent variable can be explained by the explanatory variables included within the regression model.

Conclusion:

The present study has highlighted the trend of different variables associated with the Indian agricultural sector and also attempted to highlight the impact of different inputs on the level of productivity. The study is comprehensive as it includes both food grain as well as commercial crops. By taking the annual data for the period 1980 to 2018, the study has clearly shown that the consumption of all inputs has steadily increased and also the level of productivity has shown an upward trend. Both the crops have been highly responsive to the level of irrigation and consumption of pesticides. The consumption of fertiliser has been seen to have insignificant impact on the per hectare output. Thus, in order to increase the level of productivity affirmative action should be taken to increase the area under irrigation and also reduce the destructive role of pests in destroying the crops. Since higher dose of pesticide can be detrimental to human health, environment friendly measures should be taken to reduce the crop loss caused by pests.

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