An Econometric Analysis of Agricultural Production and Economic Growth in India

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Abstract

Agriculture continues to be the backbone of the Indian economy - this is hardly an extravagant statement. India is the world's second most populous country after China. India is the world's largest producer of jute, pulses, and milk and ranks as the second largest producer of wheat, rice, cotton, groundnut, sugarcane, and horticulture crops. In the present study, the interrelationships between agricultural production and economic growth were studied in an interdependent framework for economic growth keeping in view set policy guidelines for agricultural development in India. The econometric model is formulated with aggregate information available over the period of 1961 - 2017 (economic reforms to new India concept) and both static and Augmented Dickey - Fuller test (ADF) along with Johansen co-integration test and regression analysis were carried out to assess the performance of the set model. This study examined the agricultural production and its impact on economic growth in India. The study revealed that if there had been no increase in agricultural output (explanatory variables) in India, it would have negatively impacted the economic growth in India.

Keywords : **agriculture production, GDP, economic growth, regression model**

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Agriculture continues to be the backbone of the Indian economy - this is hardly an extravagant statement. With a population of 1.27 billion, India is the world's second most populous country after China. Over two - thirds of the country's population is directly dependent on agriculture (Kular & Brar, 2012). India is the world's largest producer of milk, pulses, and jute and ranks as the second largest producer of wheat, rice, cotton, groundnut, sugarcane, and horticulture crops. Agriculture and its allied sectors are the largest sources of livelihood, and these account for 23% of the GDP and employed 59% of the country's total workforce in 2016. According to World Bank Data 2018, India is the sixth largest economy by nominal GDP and third largest by purchasing power parity (PPP).

In more developing countries (MDC) like India, the agricultural sector, its growth, and agricultural production have been regarded as dominant prerequisites for economic growth. Several studies have been conducted, and we have considered the agricultural production as a dominant prerequisite. Since 1947, the agricultural sector has witnessed huge technological reforms, however, despite this fact, the farmers' standards of living did not improve (Bandaru, 2019). The government has also implemented the policy of regulated agricultural market, and a study on such a regulated agricultural market by Rehman (2015) found that the farmers had a positive perception towards the regulated markets. The idea behind implementing all the reforms was to increase agricultural

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production so as to make the country self-sufficient in agricultural production and also to generate employment opportunities in rural areas and increase the rural development so that the whole process will lead to economic growth. As per available data on rural development of India, it is essential to increase the agricultural production and generate employment opportunities in rural India. It will mean more adequate food supplies and will reduce the imports of the food items in the country. Moreover, when agricultural production will be in surplus, more foreign currency will be available for the development of the industrial and services sectors of the country. Inevitably, India's economic growth will increase. Consequently, the major improvements in the performance of the Indian economy can be initiated by agricultural development.

In the present study, we have attempted to ascertain the relationship of agriculture production with economic growth since 1961 - 2017 in India. The study is primarily based on the assumption that agriculture is of utmost importance in the Indian economy.

Review of Literature

In this section, a review of previous studies conducted in the field have been compiled to enable better understanding of the problems concerned with the objectives of the study.

Awokuse and Xie (2015) investigated the dynamic interaction between agriculture productivity and economic growth in general terms and examined the relationship between agriculture production and economic growth using time - series analysis of 15 developing and transition economies in Latin America, Asia, and Africa. All economic variables were used for export, agriculture value added per worker, real GDP per capita, population as proxy for labour, and gross capital formation per worker as proxy for capital taken from the World Bank development indicators and IMF for the period of 1971 to 2006. The study found that agriculture is a paramount factor for economic growth. The study suggested that the impact of trade openness was positive and favourable on GDP per capita.

Kannan and Sundaram (2011) discussed the trends and patterns in the growth of the crop sector at the national and state levels in India. The study also estimated crop output growth model for analyzing its determinants at the India level. The cropping pattern in India has undergone significant changes, with a significant shift from the cultivation of food grains to commercial crops. The study also revealed that crop output growth model indicated a positive relationship between dependent and explanatory variables. Mapfumo (2013) showed a positive relationship between GDP and other explanatory variables in the Zimbabwe economy.

Simsir (2012) observed the direct effects of agricultural credits on agricultural income and employment, and the study also supported that agricultural credit had an indirect effect on agricultural income due to the impact of agricultural credits on agricultural income and the impact of agricultural income on agricultural employment.

Cao and Birchenall (2013) observed that the role of agricultural production was the main determinant of China's post reform economic growth and sectoral reallocation. The study advocated a positive relationship between economic growth and reallocating workers in terms of agricultural productivity in China.

Awan and Anum (2014) conducted an analysis to examine the major determinants of agricultural sector and mutual relationship between agriculture economic development and gross development product. In this study, 31 observations were used since 1980 - 2010. The study considered agriculture growth and economic growth as economic variables. Data were taken World Bank and Meta data of Pakistan. The study showed a significant and positive relationship between agricultural growth and GDP growth. It was suggested that the agriculture growth was quite essential for economic growth of the country.

Oyakhilomen and Zibah (2014) proclaimed that the relationship between agricultural output and economic growth was positive in Nigeria. The study also established that the relationship was significant both in short run as well as long run.

Objectives of the Study

The main objectives of the study are :

- To examine how agricultural production contributes to the economic growth in India (1961 - 2017).
- To fit the linear regression growth model to find out the relationship between gross domestic product and the selected variables of agricultural production in India.

Data and Method of Analysis

The present study makes use of secondary data drawn from Economic Survey of India, World Bank reports, and RBI's *Handbook of Statistics* for the period of 1961 - 2017. The linear growth regression model is employed where GDP is a dependent variable and the explanatory variables are the major crops and factors which effect the economic growth of the country. Six major crops which are included in the model are wheat, rice, pulses, groundnut, sugarcane, and cotton (lint). The data analysis is done using Eviews -10 software.

(1) Model Specification : The study uses linear growth regression model. The gross domestic product (GDP) is a dependent variable and the six independent variables are the major crops such as wheat, rice, pulses, groundnut, sugarcane, and cotton (lint).

The model of linear regression is as follows :

$$GDP = á + â_1 Wheat + â_2 Rice + â_3 Pulses + â_4 Groundnut + â_5 Sugarcane + â_6 Cotton \text{ (Lint)} + u_t$$

where, *GDP* = is the gross domestic product and á = is a constant value, and $â_1$, $â_2$, $â_3$, $â_4$, $â_5$, and $â_6$ are parameters to be estimated. All explanatory variables : wheat, rice, pulses, groundnut, sugarcane, and cotton (lint) are the agricultural outputs, respectively.

(2) Variables Used in the Model :

(i) Dependent Variable - Gross Domestic Product : In a mixed economy, net foreign demand for domestic output is an important source of final spending. In the present study, the GDP at factor cost is taken as a proxy for economic growth which measures the total output in an economy. It measures how big the economy is and has been chosen as an important indicator in this case because it captures all the variables that concern economic performance. GDP measures the total production outputted in the selected period at prices of the same base year.

(ii) Independent Variables : The study analyzes the impact of all six explanatory variables on gross development product of India from1961 - 2017.

- **Wheat :** Wheat is a major food crop in India. In 2014 - 15, Uttar Pradesh was the largest wheat producing states in India. Uttar Pradesh produced 25220 million tonnes of wheat in 2014-15 and Punjab was the second largest wheat producing states in India. Punjab produced 15783 million tonnes of wheat in the same year.

- **Rice :** India is the largest rice producing country in the world after China. Rice contributes to more than 40% of the country's total food grain production. In India, rice is grown in 43.86 million ha, the production level is 104.80

million tonnes, and the productivity is about 2390 kg/ha (Ministry of Agriculture & Farmers Welfare, Department of Agriculture, Cooperation & Farmers Welfare, Directorate of Economics and Statistics, 2016).

↳ **Pulses :** Pulses are an important commodity, are rich in proteins, and are leguminous crops. Pulses being rich in protein complement the cereals substantially for the pre-dominantly vegetarian population of the country. Pulses can be produced with a minimum use of resources and are mostly cultivated in rainfed areas as these do not require intensive irrigation facility. In comparison with other crops and vegetables, pulses are grown in the fields left after satisfying the demand for cereal/cash crops.

↳ **Groundnut :** The production of groundnut is mostly useful for edible oil production in India. According to Kharif crop statistics, the groundnut production volume amounted to about 7.6 million tonnes in 2017. The production dropped in 2018, and the figure was 6.2 million tonnes. With respect to India, Gujarat state is the top state, with 27.87% of total groundnut production in India, though the other states like Maharashtra, Rajasthan, Orissa, Madhya Pradesh, Uttar Pradesh, and West Bengal are the important groundnut producing states in India.

↳ **Sugarcane :** The cultivation of sugarcane in India dates back to the Vedic period. Broadly, there are two distinct agro - climate regions of sugarcane cultivation in India like tropical and subtropical. Sugarcane is a widely grown crop of India. It has the scientific name *"Saccharum Officinarum".* Maharashtra, Tamil Nadu, and Uttar Pradesh are the most important states with respect to production and cultivation of sugarcane in India.

↳ **Cotton (Lint) :** Gujarat is the leading cotton producing state in India followed by Maharashtra, Andhra Pradesh, Punjab, Madhya Pradesh, and Haryana, etc. Cotton (lint) is known as it is separated from seed. India is the first country at the global level to commercialize cotton hybrids. India is the second largest cotton producer after China.

Analysis and Results

The data analysis is done using Eviews - 10 software. The data under the study is a time series data, therefore, first the stationarity of the data series is tested through the unit root method using Augmented Dickey - Fuller test (ADF). The ADF test is applied on all the variables under the study. The test hypothesis for the unit root ADF test is as under :

↳ **Null Hypothesis : H_0 :** ä = 0 (i.e., there is a unit root or time series is non - stationary).

↳ **Alternative Hypothesis : H_1 :** ä < 0 (the time series is stationary).

The test results reveal that at the *I*(0) levels, the absolute value of the ADF test is lower than the absolute critical value at 90% level of confidence for all the variables under the study. This gives enough ground for not rejecting the null hypothesis, meaning that the data series under the study are non - stationary. This violates the basic assumption of the time series. In time series analysis, estimating a linear equation or developing a model on non - stationary data may yield spurious results. Therefore, to check whether the model is spurious or not, the model is estimated with the original non - stationary data, assuming that the data will be stationary at the first difference level. A simple check is applied that if the *R* square value is greater than the Durbin - Watson value, then it may suggest that the model is spurious. If the *R* square value is less than the Durbin - Watson value, then the model in not spurious and can be used for further testing and analysis. The result of estimation at *I*(0) level indicates that the value of Durbin - Watson is 2.043188, which is higher than the *R* square value of 0.402339, and

Table 1. Summary of Unit Root ADF Test Results

Variables	Variable Description	ADF Test	Order of Integration	Decision	Level of Significance
GDP	Gross Domestic Product	-9.937713	1	Stationary	1%
X_1	Wheat	-10.86169	1	Stationary	1%
X_2	Rice	-8.272001	1	Stationary	1%
X_3	Pulses	-10.47521	1	Stationary	1%
X_4	Groundnut	-10.60421	1	Stationary	1%
X_5	Sugarcane	-10.48128	1	Stationary	1%
X_6	Cotton Lint	-6.860111	1	Stationary	1%

also, the *F* - statistic prob value is 0.0001. This indicates that the model is not spurious and cannot be outrightly rejected.

The model estimation at *I*(0) level indicates that the model is not spurious and cannot be outrightly rejected, but the basic assumption of stationarity of data is violated, therefore, the unit root ADF test is applied at the *I*(1) level to check whether the data is stationary at *I*(1) level or not including the intercept. The summary result of the unit root ADF test applied to all the variables under the study is displayed in Table 1.

The summary of the unit root ADF test as shown in Table 1 indicates that all the variables under the study have become stationary at the *I*(1) order of integration at the 1% level of significance. Therefore, from the test results, it is concluded that the all the variables are stationary at *I*(0) level and can be used for the time series analysis and for estimating the model.

The variable under the study is non - stationary at the *I* (0) level, and becomes stationary at *I*(1) level, therefore, it becomes necessary to perform the cointegration test to establish a long run relationship. To check whether the variables are cointegrated or not, the Johansen cointegration test (JCT) Max-Eigen statistic is applied. The test hypothesis for the JCT test is as under :

- **Null Hypothesis : H_0 :** There is no cointegrating equation.
- **Alternative Hypothesis : H_1 :** H_0 is not true.

The series are stationary at *I*(0) level without log. Therefore, as per the JCT test requirement, the cointegration test is performed on the data without taking the log transformation of the original data. The decision criteria for the JCT test is that, if the value of trace and max statistics is greater than the 5% critical value, the null is rejected, meaning that the series are cointegrated. The test results of JCT Max - Eigen statistics are displayed in the Table 2.

As can be inferred from the Table 2, the JCT test output max - Eigen statistic value in the first row (None*) is 64.41464, which is greater than the corresponding 0.05 critical value 46.23142 and the corresponding Prob.** value is 0.0002, which is much lower than the 0.05 value. This indicates that there exists sufficient evidence to reject the null hypothesis, meaning that there is a co-integrated equation and also that there is cointegration among the variables. Further, the second row (At most 1*) max - Eigen value of 44.43171 is also greater than the 0.05 critical value (40.077457) and the prob value 0.0152 is less than 0.05, which indicates that we can reject the null hypothesis. The null hypothesis for At most 1* is : There is at most one cointegration equation and rejecting the null means that there is more than at most one cointegrating equation. Further, the third row (At most 2*) max - Eigen value (27.27031) is less than the 0.05 critical value (33.87687) and the Prob value is also insignificant. This indicates that we cannot reject the null hypothesis. The null for Atmost 2* is: There are at most two cointegration equations, and not rejecting the null means that there exist at most two cointegrating variables at the 0.05 level. Since the variables are cointegrated, we can estimate both short run and long run models.

Table 2. Johansen Cointegration Test

Unrestricted Cointegration Rank Test (Maximum Eigen Value)				
Hypothesized No. of CE(s)	**Eigen value**	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.****
None *	0.689998	64.41464	46.23142	0.0002
At most 1*	0.554184	44.43171	40.07757	0.0152
At most 2	0.390931	27.27031	33.87687	0.2492
At most 3	0.297869	19.44993	27.58434	0.3805
At most 4	0.215226	13.32977	21.13162	0.4223
At most 5	0.072898	4.163021	14.2646	0.8418
At most 6	0.025277	1.408089	3.841466	0.2354

Max - Eigen value test indicates 2 cointegrating variables at the 0.05 level.

* denotes rejection of the hypothesis at the 0.05 level.

** MacKinnon-Haug-Michelis (1999) *p* - values

To estimate the long run and short run relationships, the GDP is set as the dependent variable and the rest of the variables are defined as the explanatory variables including the error term. Since the unit root ADF test results indicate that all the series under the study are stationary at the first difference level with intercept, the long run estimates are computed using the first difference. The results of the estimating equation are displayed in the Table 3.

Table 3. Results of Long Run Estimates

Dependent Variable : *D(GDP)*

Method : Least Squares

Sample (Adjusted) : 1962 - 2017

Included Observations : 56 after adjustments

Variables	**Coefficient**	**Std Error**	***t*-statistics**	**Prob.**
C	0.094635	0.350581	0.269937	0.7884
$D(X_1)$ Wheat	-0.198774	0.112983	-1.759316	0.0849**
$D(X_2)$ Rice	0.168731	0.067308	2.506848	0.0156*
$D(X_3)$ Pulses	0.762573	0.252091	3.024988	0.004*
$D(X_4)$ Groundnut	0.124474	0.213485	0.583059	0.5626
$D(X_5)$ Sugarcane	0.003498	0.013585	0.257501	0.7979
$D(X_6)$ Cotton Lint	-0.332291	0.176711	-1.880421	0.0661*
U	1.074881	0.148692	7.2289	0.0000
R-Squared	0.715294	Mean dependent var		0.06152
Adjusted *R*-Squared	0.673774	Durbin - Watson Stat		2.070529
S.E. of regression	2.335235			
F-statistic	17.22785			
Prob (*F* - statistic)	0.000000			

Note. *Significant at the 5% level.

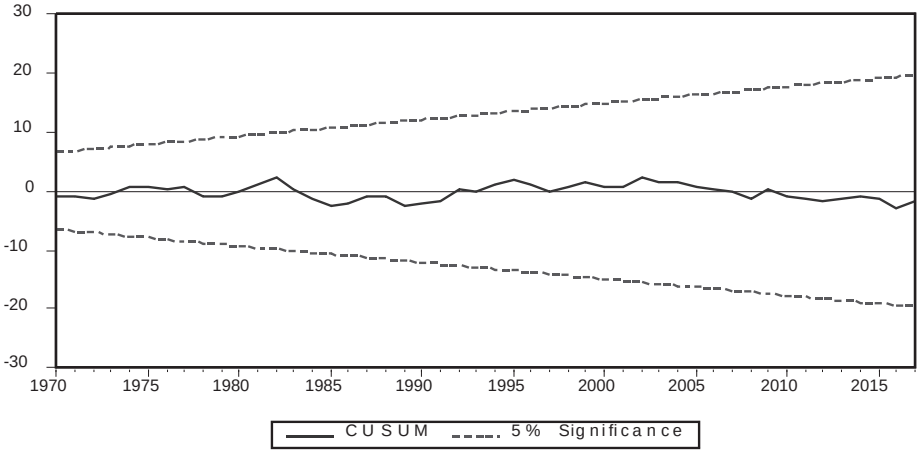
Note. **Significant at the 10% level.

The output of long run estimates displayed in Table 3 reflects that out of the total six variables, four variables are significant. However, the individual effect of the independent variables - wheat, rice, pulses, and cotton lint is found to be statistically significant, which means that these four variables have a significant effect on the dependent variable - GDP. However, the two independent variables - groundnut and sugarcane do not have a statistically significant effect on the dependent variable - GDP at the individual level. The result of Prob (*F* - statistics) is 0.00000, which indicates that individually, the variables may not contribute significantly, but together they have a long run effect on the dependent variable - GDP. The *R* - squared value is 0.715294 and the adjusted *R* - squared value is 0.673774, which indicates that 67.37% variation in the dependent variable is caused by the independent variable, including *U* (the error term). The Durbin - Watson statistic is 2.070529, which shows that there is no autocorrelation among the variables.

The coefficient result shows that there is a positive and significant relationship between GDP and rice production ; for every 1% increase in rice production, the GDP increases by 16.87% on an average. This may be because India is the second largest producer of rice in the world. The coefficient result for pulses also indicates a positive and significant relationship. However, the result indicates a negative but significant relationship for wheat and cotton lint. As far as the other two variables - groundnut and sugarcane are concerned, the result shows the positive coefficient, but insignificant relationship.

To check the serial correlation, the Breusch - Godfrey serial correlation LM test is used. The model is further tested for the residuals. The *p* - value corresponding to the Obs**R* - square value is 0.113, which is higher than 0.05, which means that the null hypothesis for the test - that the residuals are not serially correlated - cannot be rejected, which means that there is serial correlation in the model. To check heteroskedasticity, the Breusch - Pagan - Godfrey test is applied. The prob chi - square value corresponding to the Obs**R* - square value is 0.3281, which is much higher than the value of 0.05, which means that the null hypothesis for the test that the residuals are not heteroskedastic cannot be rejected, which means that the residual is not heteroskedastic but is homoscedastic, which is again a good sign for the model. To test whether the residuals are normally distributed or not, the Jarque - Bera test is applied. The test results indicate that the probability value of Jarque - Bera is 0.470067, which is much higher than the value of 0.05, meaning that the null hypothesis for the test that the residuals are normally distributed cannot be rejected, meaning that the residuals are normally distributed, which again is a good sign for accepting the model. The long - run stability of the model is tested through CUMSUM test at the 5% level of significance, and the output of the result is as depicted in Figure 1.

Figure 1. CUSUM Chart of the Data



The Figure 1 reflects that the plotted line, which is the cumulative sum of deviation, is fluctuating randomly around the central line located at zero, and also, it is well within the control limits (dotted line), which indicates that the model is almost stable in the long run and within the controllable limits.

Hence, from the above test, we conclude that the model is a long run stable model and does not suffer from serial correlation, heteroskedasticity, or not normally distributed residual problem. However, the estimating equation results are not very promising as far as it relates to the explanatory power of the independent variables as only four out of six variables have shown a significant effect, and that too, in the short run. This may be because of the fact that the GDP is also affected by the variables other than the variables used in the present model. So, there exists scope for future research by conducting similar studies with more number of variables.

Suggestions for Policy Makers

The empirical findings of the study reveal that agricultural production has a direct effect on agricultural income and employment, and on the other hand, it also shows that economic growth has a direct relationship with agricultural production in the Indian perspective. The study demonstrates a positive relationship between the dependent variable : gross domestic product (GDP) and the selected six independent variables in the Indian economy. The study emphasizes that if there is no increase in agricultural production in India, then it has a negative impact on Indian economic growth. Inspite of the various steps taken up by the GoI from 1961 - 2017 to enhance the agricultural output in India, the agricultural sector is facing major problems in India. In order to completely remove the agricultural issues, the following can be considered in the policy making :

- It is the need of hour to make an effective plan for awareness among the farmers about Zero Budget Natural Farming education. The study suggests to build effective grassroots institutions to implement the ZBNF methods all over the country. It will bring about transformation in the Indian agriculture sector.

- Opportunities for informal learning need to be made more available at village level organizations (VLOs). Agricultural production and farm income in India are frequently affected by natural disasters such as droughts, floods, cyclones, storms, cloudbursts, landslides, and earthquakes.

- Susceptibility of Indian agriculture to these disasters is compounded by the outbreak of epidemics and man-made disasters such as fire, sale of spurious seeds, replacing the use of fertilizers and pesticides by ZBNF adoption.

- It is the need of the hour to find out the feasibility of insurance adoption regarding the advantages and disadvantages of the newly introduced scheme - Pradhan Mantri Fasal Bima Yojana (previously NAIS).

- It is important to examine the evident implications for the choice of crops, crop productivities, variety of yields, variety of seeds and availability of HYV and GM seeds, e-NAM, APMCs for the benefit of especially the small and marginal farmers for farm credit.

- A rethink on the minimum support price (MSP) process is required. It is again a major problem in India as the farmers face this condition irrespective of crop failure or bumper harvest as there has been a sharp fall in the market prices of crops like pulses, onion, potato, oilseeds, cotton, and maize. The farmers have suffered huge loss of income from 1961 - 2017 due to this.

- There is a need to make proper plans for linking the rivers for resolving irrigation issues as well as to resolve the flood and drought issues in India. The study advocates for quick execution for linkage of the rivers as soon as possible.

Limitations of the Study and Scope for Further Research

The study is limited because it used secondary data drawn from various sources (as discussed) for the selected duration of the study. The data relating to agricultural production of six major crops were collected on the basis of the available sources. The study is further limited due to the selection of only six crops and ascertaining their impact on economic growth in the last more than five decades. Despite its limitations, the present study provides an opportunity to farmers, researchers, traders, and policymakers for proper impactful execution of the agricultural policies for enhancement of the agricultural output in India.

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