

# Impact of Agricultural Inputs on Agricultural GDP in Indian Economy

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**How to cite this paper:** Reddy, T.K. and Dutta, M. (2018) Impact of Agricultural Inputs on Agricultural GDP in Indian Economy. *Theoretical Economics Letters*, 8, 1840-1853.

<https://doi.org/10.4236/tel.2018.810121>

**Received:** April 9, 2018

**Accepted:** June 18, 2018

**Published:** June 21, 2018

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## Abstract

The paper aims to investigate the impact of Agricultural inputs on Agricultural Gross Domestic Product in Indian Economy using A Simple Regression Analysis for the period 1980-1981 to 2015-2016. Agricultural GDP is taken as the dependent variable and independent variables are taken as fertilizers, net irrigated area, pesticides, electricity, rainfall and usage of HYV seeds. The study reveals that the variables like fertilizers and net irrigated area are not statistically significant, which means they do not have a significant impact on agricultural GDP during the time period 1980-1981 to 2015-2016. The study further reveals that the variables like pesticides, electricity, rainfall and seeds are statistically significant and it is inferred that these variables have a significant impact on agricultural GDP during the aforementioned data period. The authors opine that the government can intervene in the working of the agricultural sector both from input side as well as from output side. The study highlights that the Reviving public sector investment is critical due to its multiplier effect on the overall GCF in the sector. Thus, there is a need to formulate a long-term perspective plan for rural infrastructure that focuses on infrastructural projects that have the highest total impact and strongest linkages.

## Keywords

Net Irrigated Area, Fertilizers, Electricity, Rainfall, Agricultural GDP, Public Investment

## 1. Introduction

Indian Economy is mainly agrarian in nature and economy is rural centric. Being the largest industry in the country, in 1972-1973 nearly 73.9 percent of working population was engaged in agriculture and allied activities, and this percentage fell to 64.8 percent in 1993-1994 and 48.9 percent in 2011-2012 [1].

During the period 2011-2014 agriculture provided employment to 43 percent of the male workers and 60 percent of the female workers. Moreover it provides raw materials to our leading industries such as Cotton Textile, Jute, Sugar, Vanaspati Industries that are of basic importance to the national economy. The proportion of agricultural goods which are exported, amount to near about the total amount of our exports. Thus agriculture is an extremely important part of our economic structure. The average rate of growth of agricultural production in India during 1951-2006 has been around 3.0 percent per annum which is considerably lower as compared to that of 5.3 percent in China, 4.4 percent in Pakistan and 4.1 percent in Indonesia. In the post-green revolution period annual growth rate (1967-1968 to 2013-2014) was to the extent of 2.4 percent per annum. The growth rates of agriculture and allied sectors have been fluctuating: 1.5% in 2012-2013, 5.6% in 2013-2014, -0.2% in 2014-2015, 0.7% in 2015-2016, and 4.9% in 2016-2017. The uncertainty in growth in agriculture is because 50% of agriculture is dependent on rainfall [2].

From 53.1 percent in 1950-1951, the share of agriculture and allied activities includes forestry and logging and fishing in GDP at factor cost declined to 29.6 percent in 1990-1991 and further to 13.9 percent in 2013-2014 (at 2004-2005 prices). According to the new series with 2011-2012 as the base year the share of agriculture and allied activities in Gross Value Added (GVA) at basic prices was 16.5 percent in 2014-2015 and then fell to 15.4 percent in 2015-2016. Gross Capital Formation (GCF) in agriculture as a proportion of total GCF has declined during the post-reform period. It was declined from 9.9 percent in 1990-1991 to 8.6 percent (at 1993-1994 price) in 2011-2012 (2011-2012 price) and further fell to 7.8 percent in 2015-2016 [2].

The new economic policies followed by successive governments have brought about a serious crisis in Indian agriculture. The impact of falling prices of agricultural produce, declining per capita income, the decrease in the per capita consumption of food grains and increasing poverty in rural India have culminated in the crisis. The crisis in agriculture is also caused by the policy of shifting cultivation from traditional crops like Rice and Maize etc., to capital-intensive commercial crops. The proportion of area under cultivation between food crops and nonfood crops has recorded a change from 74:26 in 1950-1951 to 80:20 in 1980-1981 and then again reversed to 77:23 in 1990-1991 and then finally to 73:27 in 2013-2014. It clearly reflects a shift in area from non-food crops to food crops in the country. The main reason behind this shift is cultivation of food crops, now-a-days has become very much remunerative and productive due to the introduction of new technology in Indian agriculture. Inadequate finance, untimely finance and inconsistent or contradictory policies of the government have aggravated farmer's problems severely [3]. Agricultural production has been directly supported by subsidies to farm inputs such as fertilizers and irrigation in many developing countries, such as India. These policies generally benefit large farmers more than smallholders [4]. The growth in the productivity has been stagnant in recent years, resulting in a significant decline in the income of

farmers. Agricultural growth contributes to economic growth through a forward linkage effect (agriculture providing food and raw materials to non-agricultural production), a backward linkage effect (agriculture consuming industrial products such as insecticide or tractors), inter-sectoral transfers (agriculture contributes taxes and cheap labor to other sectors), and foreign exchange through agricultural exports [5]. At the outset, the paper aims to investigate the impact of Agricultural inputs on Agricultural Gross Domestic Product in Indian Economy. Agricultural sector is largely state controlled which resulted in widespread inefficiencies and distortions. Subsidies on inputs have helped a lot to secure food sufficiency, yet it has many negative impacts. It results in over use of inputs as inputs cost doesn't represent adequate market costs, farmers are unable to respond to market signals. They continue to use skewed mix of inputs as costs are borne by the government.

The present study discusses the impact of Agricultural inputs on Agricultural GDP in Indian economy for the period 1980-1981 to 2015-2016. It has also estimated the statistical significance of different inputs taken for study on Agricultural GDP. The present study contributes to the existing knowledge base on Indian Agriculture in a way that it estimates the impact of Agricultural inputs on Agricultural GDP using a simple regression analysis. For the purpose of the study only secondary data is taken for the period 1980-1981 to 2015-2016. So all the limitations of secondary data are found in the study. The results are particularly pertinent when considering economic growth prospects for countries where a majority of labor force still depend upon agriculture.

The rest of the paper is organized as follows. The chapter gives the present progress of Agricultural sector in Indian economy in terms of yield of principal crops and India's position in world agriculture. The third chapter deals with trends in Agricultural inputs for the study period. The fourth chapter is about Impact of Agricultural inputs on Agricultural GSDP. The fifth chapter is about policy implications and conclusions

### **1.1. Objectives of the Study**

- 1) To study the progress of Agricultural Sector in terms of production and productivity of Indian Economy in comparison with other economies across the world
- 2) To study the trends in Agricultural inputs used since 1980-81.
- 3) To study the impact of various agricultural inputs on Agricultural GDP growth rate of the Indian Economy.

### **1.2. Literature Review**

According to NCAER Kharif Outlook Report [6] the slow or negative agricultural growth momentum in the recent years signifies that despite the sharp decline in rainfall, agriculture sector in India is yet to be completely weather-proof. The study further reveals that the advancements in farming practices and technology have limited the impact of adverse impact of monsoon failure on agricultural

production. The study highlights that timely intervention by the government through formulation and effective implementation of crop contingency plans helped to mitigate the drought losses, but not fully. Bardhan [7] counter argues that the green revolution may not help in raising agricultural employment.

The Green Revolution in Asia was partly driven by intensive irrigation. In fact, only 4 percent of crop area in Africa is irrigated, versus 34 percent in Asia. Another factor that makes the Sub-Saharan African context different is the underdevelopment of infrastructure, which hinders market access and leads to high transportation costs. As a consequence, several geographically separate revolutions will have to take place across Sub-Saharan Africa [8]. Schultz (1964) stressed the importance of making inputs available to farmers (and increasing the capacity of industry to supply these inputs), generating new locally specific knowledge, and improving education about new seeds and technologies via extension services.

Garg *et al.* [9] state that the adoption of HYV of crops have helped in increasing income proportionate to the percentage of adoption in all groups of farmers with the adoption of HYV, the additional income per hectare has accounted for more than double the expenditure. It is also observed that technology is neutral to the size of the farm and it tends to reduce the disparities between the various groups of farms.

Ishwar C. Dhingra [10] has points out that the improved strains of seeds are essential for increasing agricultural production. Unless the farmer has good seeds of suitable varieties, he cannot get the best out of other inputs, such as irrigation, fertilizers, insecticides and machinery. With HYV seeds, it becomes possible for the farmer to take to intensive agriculture because of the resultant high yield and good economic returns.

### 1.3. Research GAP

The earlier review of literatures focuses on the role of agricultural inputs and the consequences for countries processes of structural change. The results of the few studies that have been carried out in India have been conflicting. There is therefore a gap in literature as far as a study on the effects of agricultural inputs on agricultural GDP in India is concerned. This study therefore sought to fill this research gap by answering one question: What is the relationship between agricultural inputs and agricultural GDP in Indian Economy?

### 1.4. Methodology

The study has used secondary data from different data sources like RBI, Hand Book of Statistics on Indian Economy, Economic Surveys, Agricultural Statistics at a glance and FAOSTAT etc for analysis. A simple regression analysis has been used here to establish relationship between agriculture GDP growth and growth in various inputs required in production process. The paper uses the data for variables such as fertilizer consumption, net irrigated area, pesticides consump-

tion, electricity consumption and HYV seeds consumption.

$$\text{Agriculture GDP} = \beta_1 + \beta_2 \text{ fertilizers} + \beta_3 \text{ netirrigatedarea} + \beta_4 \text{ pesticides} + \beta_5 \text{ electricity} + \beta_6 \text{ rainfall} + \beta_7 \text{ seeds} + \mu.$$

The Agriculture GDP growth rate is taken as the dependent variable and growth in fertilizers, net irrigated area, pesticides, electricity, rainfall and HYV seeds are taken as independent variables.

$\beta_1$  = Constant term (When value of all the independent variables are zero, the value of agriculture GDP).

$\beta_2$  = Unit/% change in agriculture GDP due to 1 unit/% increase in fertilizers.

$\beta_3$  = Unit/% change in agriculture GDP due to 1 unit/% increase in net irrigated area.

$\beta_4$  = Unit/% change in agriculture GDP due to 1 unit/% increase in pesticides.

$\beta_5$  = Unit/% change in agriculture GDP due to 1 unit/% increase in electricity.

$\beta_6$  = Unit/% change in agriculture GDP due to 1 unit/% increase in rainfall.

$\beta_7$  = Unit/% change in agriculture GDP due to 1 unit/% increase in seeds.

Here  $\mu$  represents all the other variables that have not been included as independent variables due to unavailability of data in the given period. Our methodology will involve the minimization of the error term in order to avoid omitted variable bias.

Error term basically shows the presence of all those variables that has not been taken due to reasons like unavailability of data etc, but they have an impact on the dependent variable. So as a researcher, in order to avoid spurious regression, we should reduce the error term by taking as many variables as control variables, which in turn will give us accurate and unbiased results. Here in our paper we have dealt with the error term by taking as many control variables that impacts the dependent variable (Agriculture GDP) , which will improve our prediction, reduce our error term and make it close to zero and avoid the problem of omitted variable bias, as mentioned earlier.

## 2. Progress of Agricultural Sector in Indian Economy

**Table 1** provides information on the total population in the country and various categories agricultural workers depend on agricultural sector since 1951. According to the Census of 1951, the population of the country was 361.1 million. Since then, in a period of 60 years the population of the country has increased by more than 850 million. It is clear from the above table that the rate of growth of population during 1951-1961 was 1.96 percent per annum and further increased to 2.20 percent per annum during 1961-1971. The 1991 census also indicates that the annual rate of growth of population during the 1980s was 2.16 percent. The annual rate of growth rate of population has come down to 1.97 percent during 1991-2001 and further fell to 1.50 percent during 2001-2011. The proportion of rural population to the total population has shown a declining trend since 1951. The proportion of rural population to the total population has been decreased from 82.7 percent in 1951 to 68.9 percent in 2011. Total workers have

**Table 1.** Population and agricultural workers (In Millions).

Year	Total Population	Average Annual Exponential	Rural Population	Total workers	Agricultural Workers		
					Cultivators	Agricultural Laborers	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1951	361.1	1.25	298.6 (82.7)	139.5	69.9 (71.9)	27.3 (28.1)	97.2 (69.7)
1961	439.2	1.96	360.3 (82.0)	188.7	99.6 (76.0)	31.5 (24.0)	131.1 (69.5)
1971	548.2	2.20	439.0 (80.1)	180.4	78.2 (62.2)	47.5 (37.8)	125.7 (69.7)
1981	683.3	2.22	525.6 (76.9)	244.6	92.5 (62.5)	55.5 (37.5)	148.0 (60.5)
1991	846.4	2.16	630.6 (74.5)	314.1	110.7 (59.7)	74.6 (40.3)	185.3 (59.0)
2001	1028.7	1.97	742.6 (72.2)	402.2	127.3 (54.4)	106.8 (45.6)	234.1 (58.2)
2011	1210.8	1.50	833.7 (68.9)	481.9	118.8 (45.1)	144.3 (54.9)	263.1 (54.6)

Source: Registrar General of India. Note: (1) Figures within parentheses in col.4 are percentages to the total population; (2) Figures within parentheses in col.6 and 7 are percentages to col.8; (3) Figures within parentheses in col.8 are percentage share of Agricultural workers in Total Workers.

been increased substantially from 135.9 m million in 1951 to 481.9 million in 2011. The dependence on agriculture is brought out by the fact that out of total workers 263.1 million has been engaged in (54.6 percent) has been engaged in Agriculture and allied activities in 2011.

In **Table 1**, the working force in the agricultural sector was distributed into cultivators and agricultural laborers. During the year 2011 there are 118.8 million cultivators and 144.3 million Agricultural Laborers across the country. It can be seen from the table the proportion of cultivators in the total Agricultural workers has declined from 71.9% in 1951 to 45.1% in 2011, while the proportion of agricultural laborers has increased from 28.1% in 1951 to 54.8% in 2011. It clearly reflects that quite a few people have actually moved from being cultivators to being agricultural laborers. 2011 Census results show a fall of about 9 million in cultivators and an increase of about 38 million in agricultural laborers.

**Table 2** provides information on yield per hectare of major crops in India since 1950-1951. Yield per hectare of all food grains has increased by more than three-and-a-half times from 552 kgs per hectare in 1950-1951 to 2016kgs per hectare in 2015-2016. Wheat has been recorded most significant increase since 1950-1951 with its yield increasing from 655 kgs per hectare in 1950-1951 to 3093 kgs per hectare in 2015-2016. Productivity of rice has also increased from 1950-1951 to 2404 kgs per hectare in 2015-2016. Jowar and bajra recorded much slower rates of growth in productivity. Productivity in pulses has shown much disappointing trend. The productivity of maize and cotton has been increased

**Table 2.** Yield per hectare of major crops (Kgs per hectare).

Crop	1950-51	1960-61	1980-81	1990-91	2000-01	2014-15	2015-16
Rice	668	1013	1336	1740	1901	2390	2404
Wheat	655	851	1630	2281	2708	2872	3093
Jowar	353	533	660	814	764	953	-
Bajra	288	286	458	658	688	1272	-
Maize	547	926	1159	1518	1822	2557	-
Pulses	441	539	473	578	544	744	652
Total Food grains	552	710	1023	1380	1626	2070	2056
Oilseeds	481	507	532	771	810	1037	968
Cotton	88	125	152	225	190	461	432
Jute	1043	1049	1245	1833	2026	2627	-

Sources: (1) Various Economic Surveys; (2) RBI, Hand Book of Statistics on Indian Economy 2015-16.

substantially due to the adoption of hybrid maize varieties and Bt cotton in recent years. It is clear from the above table that the productivity of Maize rose from 547 kgs per hectare in 1950-1951 to 2557 kgs per hectare in 2014-2015. It is also observed from the above table that the average yield per hectare of pulses has grown by less than one percent annually on an average since the 1950s. The productivity of jute has also increased from 1043 kgs per hectare in 1950-1951 to 2627 kgs per hectare in 2014-2015. Moreover, the target in respect of production of oilseeds was marginally exceeded but there were shortfall in realizing targets in except of sugarcane, jute, cotton etc.

**Table 3** shows the India's position in the world agriculture in 2014. India has occupied seventh rank in terms of both in total area and land area in the world in 2014. India is the seventh largest country in the world with a total area of 329 million hectares. India is now the largest jute and pulses producer in the world and the second largest producer of Groundnut, sugarcane, tea and Cotton lint. As India is the largest consumer of these products, the quantity of exports varies depend on size of the crop and demand. But it is also a leading consumer. So although it exports these products the quantities will vary depending on the size of the crop and demand. India is the third largest producer of Tobacco manufactured products, Rapeseed and total cereals in 2014.

A comparison of Area, Production and productivity levels of various crops in Indian agriculture with other countries is presented in the above **Table 4**. It is observed from the above table that there were wider differences among various countries on the figures related to area, production and productivity of various crops. India accounted for percent of the total area.

It is quite evident from the above table that with respect to paddy production, China produces around 28% of the world paddy and India lies just below it producing 21.19% of the world paddy. India ranks second after China in the world paddy production. It is in a higher rank than Indonesia, Brazil and even

**Table 3.** India's position in world agriculture in 2014.

Item	India	World	%share	India's Rank	Next to
1) Total Area (Million Hectares)	329	13467	2.4	Seventh	Russian federation, Canada, USA, China, Brazil, Australia
a) Land Area	297	13009	2.3	Seventh	Russian federation, China, USA, Canada, Brazil, Australia
b) Available Land	156	1417	11.0	Second	USA
2) Crop Production (Million Tonnes)					
a) Total Cereals	295	2819	10.5	Third	China, USA
b) Total Pulses	20	78	25.8	First	-
c) Oilseeds					
Groundnut (in shell)	07	44	14.9	Second	China
Rapeseed	08	74	10.7	Third	Canada, China
d) Commercial Crops					
Sugarcane	352	1884	18.7	Second	Brazil
Tea	1.21	5.56	21.7	Second	China
Coffee (green)	0.30	8.79	3.5	Sixth	Brazil, Vietnam, Indonesia, Columbia, Ethiopia
Jute & Jute like Fibres	2.07	3.65	56.8	First	
Cotton Lint	6.19	26.16	23.7	Second	China
Tobacco Unmanufactured	0.72	7.18	10.0	Third	China, Brazil

Source: Agricultural Statistics at a glance 2016, P.254.

**Table 4.** Area production and yield of principal crops in various countries in 2014. (Area-"000" hectares, production-"000" Tonnes, Yield-Kg/Hectare).

Country	Area	production	Yield	Production (%)
<b>1. Paddy</b>				
World	163,000	741,000	4546	100.00
China	30,300	207,000	6832	27.94
India	43,900	157,000	3576	21.19
Indonesia	13,800	70,800	5130	9.55
Bangladesh	11,300	52,300	4628	7.06
Thailand	10,700	32,600	3047	4.40
Myanmar	6790	26,400	3888	3.56
Philippines	4740	19,000	4009	2.56
Brazil	2341	12,200	5212	1.65
Japan	1575	10,500	6667	1.42
<b>2. Wheat</b>				
World	220,000	729,000	3314	100.00
China	24,100	157,000	6515	21.54
India	30,500	95,900	3144	13.16
USA	18,800	55,100	2931	7.56
<b>3. Maize</b>				
World	185,000	1,040,000	5622	100.00

**Continued**

USA	33,600	361,000	10,744	34.71
China	37,100	216,000	5822	20.77
Brazil	15,400	79,900	5188	7.68
Argentina	4837	33,100	6844	3.18
Ukraine	4627	28,500	6160	2.74
India	9258	23,700	2560	2.28
<b>4. Pulses</b>				
World	85,191	77,473	909	100.00
India	30,309	19,980	659	25.79
Myanmar	4203	5977	1422	7.72
Canada	2870	5828	2031	7.52
China	2379	4101	1724	5.29
<b>5. Sugarcane</b>				
World	27,100	1,880,000	69,373	100.00
Brazil	10,400	736,000	70,769	39.15
India	5012	352,000	70,231	18.72
China	1760	126,000	71,573	6.70
<b>6. Groundnut(in shell)</b>				
World	26,500	43,900	1657	100.00
China	4604	16,500	3584	37.59
India	4685	6557	1400	14.94
<b>7. Tobacco Unmanufactured</b>				
World	3964	7177	1811	100.00
China	1463	2995	2047	41.74
Brazil	416	862	2074	12.02
India	433	721	1666	10.04
USA	153	398	2596	5.54

Source: FAOSTAT (as on 26-12-2016).

Japan, which roughly produces around 2% of the world paddy. Now taking about wheat, we can say that India produces around 13% of world wheat, which ranks just below China, which produces around 225 of world wheat. India ranks higher than even USA, which produces only around 8% of the world wheat. Coming to maize, USA ranks highest in the production of maize, producing 35% of world maize, followed by China, Brazil, Argentina, Ukraine and India. India ranks 6<sup>th</sup> in the production of maize, producing 2.28% of world maize. Now speaking about pulses, India ranks in the production of pulses, producing around 26% of world pulses, followed by Myanmar, Canada and China. In terms of sugarcane, India ranks second after Brazil, producing 39% of the world sugarcane, followed by China. With respect to groundnut, India lies second after China producing around 15% of world groundnut. Coming to unmanufactured tobacco, India ranks third, producing around 10% of the world tobacco, fol-

lowed by USA. In terms of area wise cultivation of paddy, China covers an area of around 19% of the world paddy cultivation area. India ranks second with an area of around 27%. In terms of cultivation of wheat, China covers an area of around 11% of the world wheat cultivation area. India ranks second with an area of around 27%. In terms of cultivation of maize, USA covers an area of around 18% of the world maize cultivation area. India ranks second with an area of around 5%. In terms of cultivation of pulses India ranks first, covering an area of 35.5% of the total world cultivation of pulses. In terms of cultivation of sugarcane India ranks second after Brazil, covering an area of 18.49% of the total world cultivation of pulses. In terms of cultivation of groundnut India ranks second after China, covering an area of 17.67% of the total world cultivation of groundnut. In terms of cultivation of tobacco India ranks third after China and Brazil, covering an area of 11% of the total world cultivation of tobacco.

### 3. Trends in Agricultural Inputs

The agricultural growth that India has experienced since independence is an outcome of efforts to ensure availability and use of high-quality seeds of high-yielding varieties; fertilizers; irrigation; pesticides; farm machinery and equipment; electricity and agricultural credit. Foremost among the agricultural inputs credited for revolutionizing the agricultural sector are improved seeds and planting materials.

Since independence, a huge amount of investment was made for the development of irrigation projects. In 1950-1951 about 20.9 million hectares of land were irrigated which accounted to only 18 percent of the total cropped area. Water and soil are the most important factors on which agriculture is based.

As a result of introduction of different sources of irrigation, irrigation potential of the country has increased from 81.1 million hectares in 1991-1992 to 108.2 million hectares in March 2011 (Economic Survey 2010-2011).

The availability of irrigation at critical periods of crop growth is a major factor which determines the quality of crop produce. About 42 million hectares of land in India has assured irrigation facilities. The rest of the agricultural land mainly depends on monsoon or rainfall.

The use of fertilizers in Indian agriculture has received a boost after the initiation of high-Yielding Varieties Program in 1966. The consumption of fertilizers has been increased from 66,000 tonnes in 1952-1953 to 125.46 lakh tones in 1990-1991 and in 2014-2015 stood at 255.76 lakh tonnes. India was emerged as the second largest consumer of fertilizers after China. But the imbalanced nutrient use coupled with neglect of organic matter has resulted in nutrition deficiencies in Indian soils. The average fertilizers consumption in India has increased from 69.84 kg per hectare in 1991-1992 to 128.08 kg per hectare in 2014-2015. In the early 1950s the consumption of pesticides was negligible but in mid 1960s the use of pesticides increased considerably. The pesticides consumption in 1970-1971 stood at about 24.3 thousand tones and it rose to 57.4 thousand tonnes in 2014-2015.

#### 4. Empirical Analysis and Results:

Source	Sum of squares	Degrees of freedom	Mean sum of squares	Number of observations = 36
Model	412.003823	6	68.6673039	F (6, 29) = 6.05
Residual	329.219234	29	11.3523874	Probability > F = 0.0003
Total	741.223057	35	21.1778016	R-squared = 0.5558

  

GDP	Coefficient	Std Error	t value	Pvalue
Fertilizers	-0.0125068	0.0449754	-0.28	0.0783
Net irrigated area	0.000156	0.0004561	0.34	0.0735
Pesticides	-0.0781709	0.0648877	-1.20	0.0238
Electricity	-0.0000741	0.0000838	-0.88	0.0384
Rainfall	0.0430007	0.0076602	5.61	0.000
Seeds	0.0269377	0.0171984	1.57	0.0128
constant	-33.85378	16.66425	-2.03	0.051

$$\text{GDP} = -33.85 - 0.0125\text{fertilizers} + 0.00015\text{net irrigated area} - 0.078\text{pesticides} - 0.000074\text{electricity} + 0.043\text{rainfall} + 0.026\text{seeds} + \mu$$

The model is overall statistically significant ( $P < 0.05$ ).

R Square value is 0.5558, which means 55.58% of the variation in agricultural GDP is explained by the above mentioned independent variables.

The variables like fertilizers and net irrigated area are not statistically significant, which means they do not have a significant impact on agricultural GDP during the time period 1980-1981 to 2015-2016. The study further reveals that the variables like pesticides, electricity, rainfall and seeds are statistically significant and it is inferred that these variables have a significant impact on agricultural GDP during the aforementioned data period. Pesticides and electricity have a negative relationship with agricultural GDP. Rainfall and seeds have a positive impact on agricultural GDP. Due to 1% increase in pesticides use, agricultural GDP decreases by 0.078% and due to 1% increase in electricity, agricultural GDP decreases by 0.000074%. Again due to 1% increase in rainfall, GDP increases by 0.043% and due to 1% increase in seeds use, agricultural GDP increases by 0.026%. The error term accounts for the 45% variation in agricultural GDP that is not explained by the above taken independent variables.

#### 5. Robustness Tests

**Table 5** shows that, all the VIF values of the variables are within the threshold level of 1 - 10. So we can conclude, by saying that, there exists no Multicollinearity in the regression model. There is no linear relationship between the independent variables.

Next we apply the Breuch Pagan BP test to check for Heteroscedasticity in our regression model. Our analysis shows that our test statistic has a P value less

**Table 5.** Values for Variance inflation factor (VIF) for Agriculture GDP.

Variables	Variance inflation factor (VIF)
Fertilizers	1.201
Net irrigated area	1.309
Pesticides	1.216
Electricity	1.177
Rainfall	2.673
Seeds	2.033

than 0.05, and then we can conclude by saying that there is no presence of heteroscedasticity, or unequal variance in our model.

Further we apply Durbin Watson DW test to check for autocorrelation in our model. Our analysis shows that DW test value is nearly 2, which signifies there is no presence of autocorrelation.

So, all the three tests act as a robustness check for our regression model. So we can say that our regression results are accurate and unbiased.

## 6. Policy Implications & Conclusions

From the above discussion that it can be concluded that the variables like fertilizers and net irrigated area are not statistically significant, which means they do not have a significant impact on agricultural GDP during the time period 1980-1981 to 2015-2016 (**Appendix**). The study further reveals that the variables like pesticides, electricity, rainfall and seeds are statistically significant and it is inferred that these variables have a significant impact on agricultural GDP during the aforementioned data period. Pesticides and electricity have a negative relationship with agricultural GDP. Rainfall and seeds have a positive impact on agricultural GDP.

The government can intervene in the working of the agricultural sector both from input side as well as from output side. The government can directly supply the inputs like water, irrigation, power, seeds and fertilizers in adequate quantity at subsidized price. The government can also support the producers of agricultural commodities by ensuring reasonable price through procurement policy and minimum support policies. Market stabilization, price stabilization and supply of inputs shall be treated as the responsibilities of the government. Apart from the concerns related to food security and poverty alleviation government involvement is essential for creating exportable surplus through adequate investment on infrastructure, irrigation, agricultural research and extension etc.

The government of India and many state governments have been investing huge amount on major and medium irrigation projects since 1951, but the beneficiaries of these projects have not been asked to pay for it. Even the running cost of these projects is not being met by the payment made by the users of these projects. The government has to regulate the consumption of ground water levels and registering of pump sets should be made compulsory on the part of the

farming community. Water shed projects as well as construction of minor irrigation and maintenance of age-old water resources shall be placed in the hands of farming community. Investment on water resource development especially the conservation and consolidation of traditional water resources should receive immediate attention.

The policy of cheap input can be justified in the initial phases of development and that to when the beneficiaries belong to low-income groups. The policy of providing free power to all the farming community will also have severe consequences like decline of ground water due to over utilization of groundwater. The government has to regulate the consumption of ground water levels and registering of pump sets should be made compulsory on the part of the farming community. Water shed projects as well as construction of minor irrigation and maintenance of age-old water resources shall be placed in the hands of farming community.

Government has to expand the agricultural research and extension activity and the peasants are to be prepared to face future challenges in scientific manner. Reviving public sector investment is critical due to its multiplier effect on the overall GCF in the sector. Thus, there is a need to formulate a long-term perspective plan for rural infrastructure that focuses on infrastructural projects that have the highest total impact and strongest linkages.

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**Appendix: All Units Are % Growth Rates**

Year	Fertilizers %	Seeds%	Net Irrigated Area%	Pesticides%	Electricity%	Rainfall%	GDP%
1980	0.0993	0.0172	0.0460	0.0444	0.0059	-0.0274	12.9
1981	0.0534	-0.0334	0.0046	0.0638	-0.0116	-0.1349	4.6
1982	0.2070	0.0692	0.0309	0.1000	0.0234	0.3051	-0.3
1983	0.0650	0.0781	0.0047	0.0182	0.1495	-0.1415	10.1
1984	0.0320	0.1347	-0.0066	-0.0714	0.1175	-0.0318	1.6
1985	0.0202	0.0149	0.0168	-0.0385	0.2571	-0.0752	0.3
1986	0.0161	0.0084	0.0076	0.3380	0.1978	0.0061	-0.4
1987	0.2568	0.0089	0.0759	0.1344	0.1024	0.4125	-1.6
1988	0.0478	0.0042	0.0120	-0.0513	0.1332	-0.1591	15.6
1989	0.0845	0.0011	0.0283	0.0417	0.1422	0.0568	1.2
1990	0.0145	0.0070	0.0384	-0.0383	0.1637	-0.1481	4
1991	-0.0452	0.0492	0.0086	-0.0186	0.0815	0.0041	-2
1992	0.0175	0.0310	0.0207	-0.1009	0.1164	0.0890	6.7
1993	0.0969	0.0588	0.0323	-0.0360	0.1217	0.1054	3.3
1994	0.0231	0.0613	0.0076	-0.0016	0.0811	-0.1008	4.7
1995	0.0311	0.0482	0.0320	-0.0841	-0.0200	0.0387	-0.7
1996	0.1314	0.0753	0.0018	-0.0690	0.0860	-0.0083	9.9
1997	0.0377	0.0784	0.0403	-0.0590	0.0652	0.0170	-2.6
1998	0.0757	0.0354	0.0017	-0.0602	-0.0644	-0.0848	6.3
1999	-0.0757	-0.0194	-0.0404	-0.0567	-0.0682	-0.0341	2.7
2000	0.0393	0.0641	0.0314	0.0789	-0.0361	-0.0142	0
2001	-0.0729	0.0679	-0.0534	0.0272	0.0344	-0.1029	6
2002	0.0438	0.1077	0.0586	-0.1511	0.0308	0.2471	-6.6
2003	0.0952	0.1075	0.0381	-0.0080	0.0168	-0.1580	9
2004	0.1055	0.0540	0.0271	-0.0221	0.0196	0.1293	0.2
2005	0.0645	0.2230	0.0313	0.0438	0.0967	0.0172	5.1
2006	0.0424	0.1551	0.0071	0.0511	0.0521	0.0604	4.2
2007	0.1036	0.2053	0.0071	0.0053	0.0345	-0.0692	5.8
2008	0.0633	0.1914	-0.0267	-0.0465	0.1087	-0.2045	0.1
2009	0.0618	0.0787	0.0278	0.3281	0.0576	0.3049	0.8
2010	-0.0118	0.0631	0.0320	-0.0461	0.1154	-0.0109	8.6
2011	-0.0811	0.0630	0.0087	-0.1389	0.0461	-0.0861	5
2012	-0.0413	-0.0384	0.0277	0.3214	-0.0220	0.1382	1.4
2013	0.0447	0.0057	-0.0135	-0.0486	0.0113	-0.1661	4.2
2014	-0.0214	-0.0029	0.0068	0.0253	-0.0056	-0.0203	-0.2
2015	-1.0000	-1.0000	-1.0000	-1.0000	-1.0000	-1.0000	1.1