



Agricultural Productivity Growth in India

Amarnath Tripathi¹ and A. R. Prasad²

Introduction

Considering the importance of agricultural productivity growth and technology for raising the standard of living, it is not surprising that agricultural productivity growth and technology analyses receive substantial attention from the economic and political communities of developing countries.

The case of Indian agricultural performance was impressive. The food production and increases in productivity are essential for meeting the growing demands for food in the future. There is widespread opinion that this growing demand can be met by increased use of inputs or increases in agricultural productivity. Productivity growth of agriculture in India over the past four decades was the result of a combination of factors such as new incentives to farmers offered by the government who considered them as autonomous economic agents, and physical factors such as land, labour, capital (in the form of machines, working animals, irrigation system, and so on), and intermediate inputs such as fertilizer. Indian agricultural growth has been less dependent on the conventional inputs of capital³. Capital was computed as the sum of the value of agricultural machinery, farm equipment and tools, transport equipment in farm business, land improvements, investments in private and public irrigation, and farm houses in Indian agriculture. As the growth of agriculture increases the importance of conventional inputs of capital becomes lesser in

¹ Research Scholar, Department of Economics, BHU, Varanasi, amarnathtripathibhu@gmail.com

² Reader, Department of Economics, Banaras Hindu University, Varanasi, anubhuti_prasad@rediffmail.com

³. Conventional input of capital means traditional practices of farming.

comparison to modern inputs of capital. Since mid 1960s, a package of modern inputs of capital such as high yield variety seeds, chemical fertilizers, tractor etc. has been continuously used with increasing trend in Indian agriculture. This was main cause of the remarkable growth in output of agriculture during 1970s and 1980s decades.

This paper is aimed at analyzing the impact of some production variables (input) on agricultural productivity growth (output) in Indian agriculture from 1969-70 to 2005-06. The question here is whether or not these different variables have an impact on agricultural production.

The remainder of the paper is organized as follows: Section II gives a brief overview of the growth of agricultural production in India. Section III explains the methodology used; results of the Cobb Douglas models and interpretations are given in Section IV, and conclusions are presented in Section V.

The growth of Agricultural Production

Agricultural growth is one of the main facets of India's economic development and national food sufficiency policies. Tables (1a & 1b) show the growth rate of agricultural economy by sector and different crop wise. The aggregate agricultural output increased annually at 2.01 percent during 1970s, at 2.86 percent during 1980s and 2.62 percent during reforms period. The growth rate of aggregate agricultural output turned up 3.29 percent during the initial years of reforms, which was 0.43 percentage point higher than the previous period. Disaggregating of agriculture into sub sectors shows that fisheries was the main sources of the acceleration in growth rate of agricultural output in the initial years of reforms. However, the situation of agriculture turned adverse during post-WTO period and this covered all the sub sectors of agriculture. The growth rates in output of all crops decelerated from 2.93 percent to 1.57 percent. The livestock declined from 4.21 percent to 3.40 percent. The fisheries declined from 7.48 percent to 3.25 percent. Only, forestry witnessed a sharp increase from 0.09 percent to 1.82 percent.

The crop sector, which forms largest segment of agriculture, showed poorest growth during post-WTO period in comparison to all other periods. Further, within crop sector, all crops except sugar showed declining trend between initial years of reforms and post-WTO period. This deceleration is very high in Cereals, Cereals, Pulses, Oilseeds, and Drugs & Narcotics. The growth rate turned negative in the case of pulses.

These growth rates are lower than the growth rate of rural population. Thus, the clear implication of this growth trends is that the per capita output in agriculture is declining. This seems to be one of the causes for rising disparity between rural and urban areas in India.

Methodology

The Cobb-Douglas equation was used to analyze the impact of some production variables on agricultural productivity growth.

Production function in general form can be written as:

$$Y = F(X_i) \quad (1)$$

where Y is production output and X_i are measured physical production factor inputs. Eq.(1) of production function in log form is:

$$\log_e Y = \beta_0 + \beta_1 \log_e X_1 + \beta_2 \log_e X_2 + \beta_3 \log_e X_3 + \dots \beta_n \log_e X_n + \varepsilon \quad (2)$$

$$\log Y = \beta_0 + \sum_i^n (\beta_i \log X_i) \quad (3)$$

where X_i denote production factors and ε is the residual of the regression. In our analysis the agricultural production function (Cobb-Douglas) is specified as follows:

$$\log_e (\text{GVAO}) = \beta_0 + \beta_1 \log_e (\text{Labour}) + \beta_2 \log_e (\text{land}) + \beta_3 \log_e (\text{capital}) + \varepsilon \quad (4)$$

$$\log_e (\text{GVAO}) = \beta_0 + \beta_1 \log_e (L) + \beta_2 \log_e (M) + \beta_3 \log_e (K) + \varepsilon \quad (5)$$

where $GVAO$ is gross value of agricultural output; L is agricultural labor force; K is capital input; M is agricultural land; The coefficients β_i ($i = 1, 2, 3$) are the elasticities of the respective variables with respect to agricultural production, with the assumption that $\beta_i > 0$.

Period of the Study

The period from 1969-70 to 2005-06 is selected in this study because Indian agriculture has shown remarkable growth after introduction of Green Revolution technologies in the late 1960s.

Sources and description of data used in estimating the production function

The data used in this study were country level agricultural output and inputs for estimating the Cobb-Douglas production function of Indian agriculture from 1969-70 to 2005-06. Most previous studies on Indian agriculture used gross value of

agricultural output (GVAO) as the total value of agricultural production. GVAO is defined as the sum of the total value of production from farming, forestry, livestock, and fishery. The sum of output of all products of farming, livestock, forestry, and fishery equals to GVAO and is expressed at 1999-2000 prices. The data on GVAO were taken from the National Account Statistics (Back series 1950 to 2000, and 2007) published from Central Statistical Organization, Government of India.

Labour, land, and capital are considered the three main inputs in agricultural production. Labour input is measured as workforce involved in agriculture. The data of workforce in agriculture is given in Agricultural Statistics at a Glance (2007) published from Directorate of Economics and Statistics, Ministry of Agriculture, Government of India only for census year. This series was interpolated for making time series data.

Land input refers to the net cultivated area and is measured by net sown area. The data were taken from Agricultural Statistics at a Glance (2007).

Capital stock of a country is broadly referred to as that part of national wealth which is reproducible; it consists of all resources which contribute to the production of goods and services. Capital is measured in terms of net fixed capital stock in agriculture and data related to net fixed capital stock are taken from National Account Statistics. This capital stock measure includes agricultural machinery, farm equipment and tools, transport equipment in farm business, land improvements, investments in private and public irrigation, and farm houses.

Estimated Results and Interpretation

Results for the Cobb-Douglas estimates are reported below in Tables 2, 3, & 4.

The estimated agricultural production function for Indian agriculture based on data during 1969-70 to 2005-06, can be expressed in the following mathematical form:

$$\text{Log}_e(\text{VOA}) = -2.40 + 1.98 \text{Log}_e(\text{NSA}) + 1.06 \text{Log}_e(\text{labr}) + 0.15 \text{Log}_e(\text{cptl})$$

$$(1.546808) \quad (.3178849) \quad (0.1164384) \quad (0.1487931)$$

From the above equation, we can see that in Indian agriculture during 1969-70 to 2004-05, the output elasticities of land, labour, and capital were 1.98, 1.06, and .15

respectively. If $\alpha = 1.98$, and the land input increases to about 1 percent, then the gross value of agricultural output increases 1.98 percent. Similarly, $\beta = 1.06$, and $\gamma = .15$ can be interpreted in the same way. The sum (α , γ , and β) gives information about the returns to scale, that is, response of output to a proportionate change in the input, in our case adding the three output elasticities we obtain 3.19, which gives the value of the returns to scale parameter. As we can see the sum is greater than 1, thus there are an increasing returns to scale. As is evident, over the period of the study, the Indian agriculture is characterized by increasing returns to scale doubling the inputs will more than double the output.

From a purely statistical viewpoint, the estimated regression line fits the data quite well. The R^2 value of 0.99 means that 99 percent of the variation in the (logarithmic of) gross value of agricultural output is explained by the (logarithmic of) land, labour, and capital. For adjusted R^2 the relation is 99 percent. This shows the statistical dependence of the (logarithmic of) gross value of agricultural output on the (logarithmic of) labour, land and capital. α , and β are statistically significant at the 5 percent level and γ is not significant. The dw-statistic is equal to 1.411, it is greater than the value of d_L and less than d_U . This situation is inconclusive about autocorrelation.

In summary, the analysis shows that land, labour, and capital are positively related to output.

The positive and significant elasticities of labour can be explained by the fact that in India labour forces shifts among sectors have been phenomenal.

Land played a significantly positive role in determining agricultural output in India. Net sown area continued to expand at about 0.02 percent per year throughout the reference period. The growth rate of net sown area was 0.14 percent for 1970s but this is decreased to -0.35 percent per year in post-WTO period. Thus, it is one of the main reasons of slowdown of agricultural growth during post-WTO period. It is not possible to increase net sown area due to inelastic nature of land but through intensive agriculture, proper irrigation facilities and multiple cropping gross sown areas can be increased.

Capital is expected to have positive influence on agricultural productivity. Capital grew by an average of 2.83 percent per year during 1969-70 to 2005-06. The rapid expansion in the use of these inputs took place at the same time that new technology became widely available.

Conclusion

In this research we analyzed the impact of some production variables (input) on the agricultural productivity growth (output) in India from 1969-70 to 2005-06

using Cobb-Douglas model. The results of estimations led to the conclusion that labor, capital and land significantly impacted agricultural productivity growth.

Table (1a): Average Annual Growth Rates of Crops, Livestock, Forestry, Fisheries and Aggregate Output in India

Period	Crop	Livestock	Forestry	Fisheries	Aggregate
1969-70 to 1979-80	1.79	3.56	-0.13	3.03	2.01
1980-81 to 1990-91	2.43	4.65	-0.006	5.58	2.86
1991-92 to 2005-06	2.28	3.49	1.58	4.06	2.62
1991-92 to 1995-96	2.93	4.21	0.09	7.48	3.29
1996-97 to 2005-06	1.57	3.40	1.82	3.25	2.10
1969-70 to 2005-06	2.57	4.06	0.1	4.53	2.82

Note: Annual compound growth rates have calculated by using linear log model

Table (1b): Average Annual Growth Rate of All Categories of Crops in India (1969-70 to 2005-06)

Name of all Categories of Crops	1969-70 to 1979-80	1980-81 to 1990-91	1991-92 to 2005-06	1991-92 to 1995-96	1996-97 to 2005-06	1969-70 to 2005-06
Cereals	2.34	3.03	1.05	2.16	0.12	2.4
Corse Cereals	0.98	0.70	0.53	0.37	0.39	0.52
Pulses	-0.32	1.91	0.43	1.05	-0.32	0.85
Oilseeds	0.40	5.47	0.76	3.89	0.57	3.16
Sugar	1.54	2.62	4.18	2.72	3.25	3.17
Fibers	2.38	2.67	1.62	5.77	2.28	2.5
Drugs & Narcotics	3.85	2.41	2.69	1.58	0.20	2.81
Fruits & Vegetables	3.27	2.3	4.3	5.5	2.43	3.52
Condiments & Spices	3.29	4.43	4.95	4.59	5.06	4.15

Others	0.10	-0.29	2.33	0.62	3.19	1.52
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Note: Annual compound growth rates have calculated by using linear log model

Table (2): Model Summary

Model	Adjusted R ²	Std. error of the estimate
1	.989	.03023

Predictors (Constant), LNL, LNM, LNK, Dependent Variable LNGVAO

Table (3): Analysis of Variance (ANOVA)

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	3.10531529	3	1.0351051	1132.43	.000
Residual	.029249712	32	.000914053		
Total	3.134565	35			

Predictors (Constant), LNL, LNM, LNK, Dependent Variable LNGVAO

Table (4): Coefficients

Variables	Coeff.	Std. Err.	t- Value	Adj- R ²	DW- Stat.
Cons.	-2.390	1.546808	-1.55		
nsa	1.976*	.3178849	6.22	.989	1.41
labr	1.061*	.1164384	9.12		
cptl	.148	.0908932	1.64		

Dependent Variable LNGVAO

* Significant at 5 percent level

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