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Economics

THE ROLE OF INPUTS IN INDIAN AGRICULTURE: A POST REFORM ANALYSIS

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ABSTRACT This paper attempts to understand the role of inputs in agricultural production in pre and post reform India. In Indian agriculture, there is a clear demarcation between the pre and post economic reform period as far as agriculture is concerned. It is often felt that agriculture has been neglected after 1991 which has led to a marked slowdown. The major objective of this research paper is to study the effect of modern inputs on growth of agricultural output, for which the unrestricted form of Cobb-Douglas Production function has been used. The impact of economic reforms is measured by inserting a dummy variable. Chow test has been used to endogenously determine the structural break point. Secondary data for last 46 years from 1967-68 to 2012-13 is taken at All India level for purpose of analysis after checking for stationarity. In both pre reform and post reform India land is emerging as the most important input. It is interesting to observe that tractors, power tillers and fertilisers have emerged as the other significant determinants of agricultural output. The results may this indicate that the pattern of Indian agriculture is oriented towards capital use as compared to labour use.

KEYWORDS : Agricultural output, Input use, Cobb-Douglas Production function, Chow test, Stationarity, Dummy Variable, Economic reforms

I. INTRODUCTION

First, and foremost, agriculture is important in India for various reasons, both historical and economic. Historically, in the Kautiliya Arthasastra agriculture, cattle breeding and trade were grouped in a science called Varta. Chapter fourteen of the book two of Arthasastra in fact deals with the detailed role of the Sitadhyaksha or the Superintendent of agriculture. An even more ancient text on Indian agriculture is the Krishi-Parashara in which the theory of agriculture is explained in such a manner that the farmers would benefit by its application to agriculture. During British rulethe Satyagrah movement of Mahatma Gandhi finds its seeds in the revolt of Indigo farmers.

Pandit Deen Dayal Upadhyaya writing in the "Organiser" on January 29, 1962 emphasised that agriculture is the basis of all economic development and without it even industries cannot flourish. He divided the problems facing Indian agriculture into two categories – land reforms and land management (which related to the needs of the farmer in respect of actual farming operations). Dr. B. R. Ambedkar's thoughts on agriculture are of immense relevant in post reform India. In his article "Small holding in India and there remedies, (1917)" Dr Ambedkar stated that the productivity of land was related not only to the size of holding but also to factors like capital, labour and other inputs. He suggested provision of credit, water, seeds and fertiliser by the government as a measure to promote agricultural development. Thus, we can say that agriculture has always been the mainstay of Indian economy.Even in post reform India agriculture accounts for 15.4 percent of GDP (State of Indian Agriculture, 2017) and it contributes 54 percent to total employment (Census, 2011). Poor agricultural performance can have wide spread impact on the economy including rising prices, farmer distress and social upheaval. In this paper an attempt will be made to understand the role of modern inputs in agricultural production in pre and post reform India.

II. Review of Literature

In Indian agriculture, there is a clear demarcation between the pre and post economic reform period as far as agriculture is concerned. It is often felt that agriculture has been neglected after 1991 which has led to a marked slowdown.

There have been numerous studies which have compared the trends in growth of output and input use in pre and post reform India, some of which have been summarized below:

a. Trend in Output growth in Post Economic Reform Period

Murali & Vijay (2017) have identified two structural breaks in 1995-96 and 2004-05. They concluded that in the post reform period (1994-95 to 2004-05), there was a deceleration in Indian agriculture during which the total cropped area declined with the area under food grains showing absolute decline. In the following period 2004-05 to 2010-11 according to the authors there was a revival in agriculture and this coincided with a revival of the foodgrains economy.They argued that changes in the foodgrains sector are more important as compared to changes in Horticulture crops in influencing agricultural growth.

Prasad & Reddy(2017) aimed to analyze the status of Indian agriculture along with industry across seventeen states in pre and post reform period. They concluded that regional disparity in agriculture widened during post reform period(1990-91 to 2013-14). In addition during this period industry had become more important as compared to agriculture.

Chand (2014) analyzed the growth performance of Indian agriculture since 1995. He found that after 2004-05, there was a revival of growth in agriculture because of increase in agricultural productivity. Increased prices received by the farmers were a major factor for impressive performance of agriculture post 2004-05. He suggested that agricultural development strategy should be expanded to bring marketing in its fold to improve competition, reduce inefficiency and harness market innovations.

Gulati &Jain (2014) emphasized that true inclusiveness of Indian growth model can come only when agricultural performance improves. They analyzed the agri-growth performance since economic reforms and concluded that it was much lesser than target in the period and also fluctuated a lot. They found that rationalizing subsidies will not only help divert budgetary support towards higher return investment but also ensure appropriate use of resources, particularly fertilizers. High agricultural input subsidies according to them result in inefficient resource allocation, crowding out of public sector investment and degradation of the environment.

Bhalla & Singh(2012)evaluated the performance of crop production, crop diversification and geographical spread of agricultural growth during 1962 – 2008. They also analyzed the factors which cause inter regional variations in land and labour productivity. According to them 1990-93 to 2005-08 was characterised by a slowdown in agricultural growth as well as in the growth rate of agricultural worker productivity. The low agricultural productivity states were Bihar, MP, Maharashtra and eastern U P. They suggested that this problem can be remedied by expanding per worker cultivable land, by promoting more intensive use of land resources, improving education and skill level of the rural labour force, development of rural infrastructure and agricultural marketing. Bhalla (2007) identified the factors influencing agricultural growth since independence. The main factor responsible for increasing agricultural growth after the mid sixties were Implementation of land reforms, large planned investments in irrigation and other rural infrastructure, research and development in agriculture, extension services and introduction of a positive price policy. He observed that there was significant deceleration in agricultural growth after the liberalization of Indian economy. The new challenges before Indian agriculture were to increase its competitiveness through large investment in new technology and rural infrastructure.

b. Trends in use of modern Inputs in Post Economic Reform Period
Gupta & Singh (2017) have analyzed the availability and consumption pattern of major farm inputs. They concluded that the distribution of HYVs seeds mainly of Cereals, Oilseeds and Pulses increased over the years. The area under irrigation grew maximum in case of Rice, Wheat, Pulses, Sugarcane and Coarse Cereals between 1990-91 to 2014-15. Mechanization grew significantly 2004-05 and 2015-16 but the share of agriculture in total power consumption has fallen. According to them major enabling factors for improving farm sector performance were high remuneration, sustainable income and infrastructure. They blamed inadequacy of use of farm inputs and technology for low agricultural productivity.

Bathla et al (2017) examined the composition and trends in public spending by social and economic categories, including subsidies on electricity, fertilisers, irrigation, and credit from 1981–82 to 2013–14 for 17 states of India. They found that expenditure on fertiliser and irrigation subsidies contribute more to agricultural productivity as compared to Credit and power subsidies. Input subsidies entail a high cost to the government, but they incentivisefarmers to increase their use of inputs through lower prices.

Chand &Pavithra (2015) analyzed imbalance in the use of fertilizer in India from 1971-72 to 2013-14. They stated that traditional view required using Nitrogen, Phosphorus and potassium in the ratio 4:2:1. In August 1992 the pricing and distribution of potassic and phosphatic fertilizers were decontrolled. This led to the reversal of the pre reform trend of decreasing use of Nitrogenous fertilizer.

Sharma (2011) in his study of fertilizer use from 1950-51 to 2009-10 suggested that modern inputs such as improved seeds, irrigation and chemical fertilizers have played an important role in agricultural development in the country. However, their low efficiency is one of the major reasons for decelerating growth in Indian agriculture. He suggested that improvement in input use efficiency is essential for accelerating agricultural growth.

Haque(2006)examined resource use efficiency in Indian agriculture form 1981-82 to 2003-04 which broadly include technical efficiency, allocative efficiency and environmental efficiency. According to him a farmer's access to technology, credit, market and other infrastructure and policy support, along with risk perception and risk management capacity under erratic weather and price situations determine his farm efficiency. He emphasized the importance of appropriate risk management for stabilising farm income.

III. Objectives and Methodology

The major objective this research paper is to study the effect of modern inputs on growth of agricultural output, for which the unrestricted form of Cobb-Douglas Production function has been used.The impact of economic reforms is measured by inserting a dummy variable in the equation.

Secondary data for last 46 years from 1967-68 to 2012-13 is taken at All India level for purpose of analysis.

The variables used for this purpose are defined below:

Table: 1 Variables and Descriptions

Variables	Descriptions
Agricultural Output	Total value of Output from Crops (Agriculture) at Constant Prices (2004-05) in rupees crores.(VOA)
Land	Gross Cropped Area in million hectares. (GCA)
Fertilizers	Consumption of Total Chemical Fertilizers in Agriculture (N+ P + K) in thousand tones (FERT)
Tractors	Sale of Tractors in Agriculture in Thousand. (TRACT)
Power tillers	Sale of Power tillers in Agriculture in Thousand. (POT)
Electricity	Electricity Consumption for Agricultural purpose in Giga watt hours. (ELEC) This has been taken as proxy for irrigation as the agricultural power consumption reflects the use of ground water for irrigation purpose.
Labour	The agricultural workforce in millions has been calculated by the authors on the basis of NSS report no. 554, 68th round. (LAB)

Sources:
1. National Accounts Statistics, Sources and Methods (2012), CSO, Government of India.
2. NSS Report No. 554,(68th Round), Employment and Unemployment Situation in India.
3. Agriculture Statistics At a Glance, published by Directorate of Economics and Statistics, Department of Agriculture and Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare.

The following tools and techniques have been used for analysis:
a. Chow test has been used to endogenously determine the structural break point.

The time series have been checked for stationarity in order to avoid the problem of spurious or nonsense regression. The Augmented Dickey Fuller (ADF) test has been used for this purpose.

b. There are many alternative methods to test for co integration but in this paper the Johansen Maximum Likelihood Test for Co integrationhas been used. As mention before the series are known to be non –stationary at level and they are stationary at same difference (first difference). In Eviews 8 under co integration test specification we have allowed for linear deterministic trend in data. (Intercept no trend in co integrating equation)

c. To examine the short run analysis the (Vector ErrorCorrection Model)VECM model is used. The error correction term (ECT) tells us the speed with which our model returns to equilibrium following an exogenous shock. It should be negatively signed, indicating a move back towards equilibrium; a positive sign indicates movement away from equilibrium. The coefficient should lie between 0 and 1, 0 suggesting no adjustment one time period later, 1 indicates full adjustment.(Alezzee,2014)

d. An unrestricted form of the Cobb-Douglas Production Function has been used which is specified as

Where,

$$\text{Ln (VOA)} = \beta_0 + \beta_1 \text{Ln(GCA)} + \beta_2 \text{Ln(FERT)} + \beta_3 \text{Ln(TRACT)} + \beta_4 \text{Ln(POT)} + \beta_5 \text{Ln(ELEC)} + \beta_6 \text{Ln(LAB)} + \beta_7 (D_t) + u_t$$

Ln denotes Natural logarithm

β_0 = Intercept

$\beta_{i;\ i=1,2,....,7}$ = Slope Coefficients

D_t = Intercept Dummy Variable

u_t = Residual term

IV. Results and Discussion

a. The Chow Test

The Chow break point test in E-views8 was used to determine the structural break. The null hypothesis of no breakpoint at 1991-92 was rejected based on a p-value of 0.019

b. Test for Stationarity

The results of the ADF test in E-views for stationarity are summarized in the following table:

Table 2: Results of Unit Root Test

Variables	At Level (intercept)	At Level (Trend and Intercept)	At First Difference (Intercept)	At First Difference (Trend and Intercept)
Value of output from agriculture	0.209	-6.746*	-7.453*	-7.390*
Gross Cropped Area	-1.422	-5.548*	-12.411*	-12.321*

Electricity	-2.677	-2.119	-2.412	-5.930*
Fertilizer	-2.875	-1.450	-4.870*	-5.401*
Power tiller	-0.036	-2.623	-7.069*	-7.038*
Tractor	-1.089	-3.744*	-5.933*	-5.851*
Labour	-2.110	-3.375	-4.931*	-4.835*

* Reject Null Hypothesis (Unit Root) at 5 percent level

The above table shows that some variables are not stationary at level. Therefore, the time series is differenced once to check if it is integrated. The results show all the variables are integrated of the order I(1). As such the problem of spurious regression does not arise.

a. Johansen Maximum Likelihood Test for Co integration
As all the variables are I(1), the Johansen co integration test can be performed for this. The VECM lag length was first selected which is shown in the table below:

Note: * indicates lag order selected by the criterion, LR: sequential modified LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion The notion of an information criterion is to provide a measure of information that strikes a balance between this measure of goodness of fit and parsimonious specification of the model (Ayalew et al 2012). Although many alternative criteria are there, AIC information criteria we chosen for optimal lag length. Many studies like Liew (2004) have proved superiority of AIC and FPE over others. Lag three is used for test of co integration analysis.

Results of the two test statistics for co integration are given below:

Table 3: Var Lag Order Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	245.8047	NA	3.54e-14	-11.10720	-10.82049	-11.00147
1	512.4889	434.1370*	1.46e-18*	-21.23204	-18.93838*	-20.38621*
2	547.5537	45.66586	3.36e-18	-20.58389	-16.28329	-18.99796
3	613.8022	64.70782	2.56e-18	-21.38615*	-15.07860	-19.06012

Table 4(a):Trace Statistics

Hypothesized No. of CE(s)	Eigenvalue	TraceStatistic	0.05Critical Value	Prob.**
None *	0.934465	310.3538	125.6154	0.0000
At most 1 *	0.907169	195.8969	95.75366	0.0000
At most 2 *	0.528446	96.06401	69.81889	0.0001
At most 3 *	0.477745	64.49174	47.85613	0.0007
At most 4 *	0.398436	37.20853	29.79707	0.0058
At most 5 *	0.312681	15.86318	15.49471	0.0440
At most 6	0.002734	0.114999	3.841466	0.7345

* denotes rejection of the hypothesis at the 0.05 level

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

Trace test indicates 6 co integrating equ(s) at the 0.05 level.This co integrating equation means that 6 linear combination exist between the variables that force these indices to have a relationship over the entire 46 year time period, despite potential deviation from equilibrium levels in the short-term.

Table 4(b): Maximum Eigen Statistics

Hypothesized No. of CE(s)	Eigen value	Max-Eigen Statistic	0.05Critical Value	Prob.**
None *	0.934465	114.4569	46.23142	0.0000
At most 1 *	0.907169	99.83289	40.07757	0.0000
At most 2	0.528446	31.57227	33.87687	0.0919
At most 3	0.477745	27.28320	27.58434	0.0546
At most 4 *	0.398436	21.34536	21.13162	0.0467
At most 5 *	0.312681	15.74818	14.26460	0.0289
At most 6	0.002734	0.114999	3.841466	0.7345

* denotes rejection of the hypothesis at the 0.05 level

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

The Maximum Eigenvalue Test shows 2 co integrating equations at the 5% level. Therefore these two tests confirm a co integrating relationship over the 46 year time period.

Above table the no of co integrating relation are shown by r the maximum no of co integrating relation can be k-1 where kis the no of endogenous variables.

As seen above the trace statistics and maximum Eigen value statistics are yielding conflicting result. Johansen and Juselius(1990) state that in such a case after examining the co integrating vector the choice should be based on the interpretability of the co integrating relationship.

a. Vector Error Correction Model(VECM)
TheVECM specification can apply only to a co integrated series. Therefore in the previous section the result of the Johansen co integration test are shown:

Table 5: ECM Short Run Results

Independent Variables	Coefficients (t-values)
Constant	0.0456 (2.71)
Δ LnTRACT	0.116 (1.649)
ΔLnPOT	-0.074 (-1.493)
Δ LnLAB	-0.103 (-0.169)
Δ LnGCA	-0.482 (-0.696)
Δ LnFERT	-0.191(-1.372)
Δ LnELEC	0.016 (0.128)
Δ ECM	-0.0185 (-0.093)

Note: ΔLnVOA is dependent Variable
R-Squared=0.396
Adjusted R-Squared= 0.258
S.E. of Equation= 0.056
F-statistics = 2.875[Probability of F-Stat=0.014]
Log likelihood = 68.953
Durbin Watson Statistics =2.383

Short Run equation shows that the previous periods deviation from long run equilibrium is corrected in the current periods as an adjustment speed of -0.0185 (adjustment coefficient).

A percentage change in Power tillers, Labour, Gross cropped area and fertilizersare associated with -0.074, -0.103, -0.482, -0.1907 respectively decrease in Agricultural value of output on ceteris Paribas in short run. A percentage change in Tractor and Electricity are associated with 0.116 and 0.016 respectively increase in Agricultural value of outputon ceteris Paribas in short run.

The short-run dynamics are analysed by estimating a vector error correction model (VECM) to check for the presence of overshooting phenomenon. The VECM measure the speed of adjustments to its long-run equilibrium after a temporary shock. The main feature of the ECM (Error Correction Model) is its capability to correct for any disequilibrium that may shock the system from time to time. The error correction term picks up such disequilibrium and guidesthe variables of the system back to equilibrium. When the coefficient of the error correction term of the relevant variable in the VECM is negative and statistically significant, it provides the evidence of overshooting. Because, the negative sign of the ECT implies reduction in the value of the variable over the horizon to return to its long run equilibrium.(Khundrakpam and Das,2011; Ahmed, 2001)

e. Relation between agricultural output and inputs
As discussed in the section on methodology the unrestricted form of the Cobb-Douglas production has been used here:

Model 1 describes the results without the use of dummy variable.

Model 2 discusses the result when dummy variable has been introduced for pre and post reform period based on the break point endogenously determined by chow test.

Table 6(a): Model (without dummy variable)

Model	Adjusted R2	Std. error of the Estimate	DW- Stat.
1	0.9823	0.046	1.460

Table 6 (b): Coefficients

Variables	Coefficients	Std. Error	t- Value	Prob. Value
CONS.	3.067	2.200	1.393	0.171
LnGCA	0.999	0.391	2.552	0.014
LnFERT	0.140	0.065	2.151	0.037
LnTRACT	0.114	0.050	2.250	0.030
LnPOT	0.108	0.020	5.419	0.000
LnELEC	-0.048	0.040	-1.202	0.236
LnLAB	0.254	0.294	0.864	0.392

The C-D production function can be expressed as:

LnVOA = 3.06+ 0.99(LnGCA) + 0.14(LnFERT) + 0.11(LnTRACT) + 0.10(LnPOT) - 0.04(LnELEC) + 0.25(LnLAB)

In the above table land, fertilizer, tractor, and power tillers are significant at 1 percent level. The Adjusted R2 is 0.98 which means that 98 percent of the variation in output (logarithm) is explained by the logarithm of above inputs. The problem of autocorrelation does not seem to be there judging by the Durbin-Watson statistics.

However, the above analysis will not be able to give a complete picture because there have been structural changes in the Indian economy during 1967-68 to 2012-13. In order to better understand the difference between the pre reform and post reform scenario of agricultural output an intercept dummy has been used. We have used 0 for pre reform (1967-68 to 1990-91) and 1 for post reform period (1991-92 to 2012-13).

These results are summarized in the table below:

Table 7(a): Model (with intercept dummy)

Model	Adjusted R2	Std. error of the Estimate	DW- Stat.
2	0.982105	0.047	1.462

Table 7(b): Coefficients

Variables	Coefficients	Std. Error	t- Value	Prob. Value
CONS.	3.50	2.316	1.51	0.13
LnGCA	0.977	0.395	2.46	0.01
LnFERT	0.169	0.079	2.13	0.03
LnTRACT	0.111	0.051	2.17	0.03
LnPOT	0.100	0.024	4.16	0.0002
LnELEC	-0.067	0.049	-1.35	0.183
LnLAB	0.199	0.308	0.64	0.52
Dt	0.025	0.039	0.65	0.51

The C-D production function can be expressed as:
LnVOA = 3.50 + 0.97(LnGCA) + 0.16(LnFERT) + 0.11(LnTRACT) + 0.10(LnPOT) - 0.067(LnELEC) + 0.19 (LnLAB) + 0.025(Dt)

When we insert the intercept dummy the Adjusted R2 has decline in a minute way.

In the model twoland, fertilizer, tractor and power tillers are significant at the 1 percent level. This means that as in the first model (without dummy) electricity (proxy for irrigation)and labour are not significant. The Durbin Watson statistics shows that there is no problem of autocorrelation.

When we look at β values, we find that the elasticity is greatest in the case of land in both the models. In model 2 the coefficient of intercept dummy is 0.025 which means that intercept increased by 0.025 in the second period as compared to first. The coefficient of intercept dummy is also not significant.

V. CONCLUSION

In both pre reform and post reform India land is emerging as the most important input. It is interesting to observe that tractors, power tillers and fertilisers have emerged as the other significant determinants of agricultural output. In this paper the secondary data is taken from 1967-68 which means after the inception of green revolution. The results may thus indicate that the pattern of Indian agriculture is oriented towards capital use as compared to labour use in the years following inception of new technology.

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