GLOBAL JOURNAL OF BIO-SCIENCE AND BIOTECHNOLOGY

www.scienceandnature.org

IMPLICATIONS OF INTENSIVE FARMING ON TECHNICAL EFFICIENCY OF THE FARMS IN TAMIL NADU

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ABSTRACT
Most of the developing countries have used intensive agriculture on existing lands to meet their needs and India is no exception. It is viewed in many literatures that intensive agriculture has a negative influence over sustainability of resources as a result of reduction in efficiency. In this study, an attempt is made to estimate farm specific technical efficiency of the major intensive farming districts in Tamil Nadu a state of India during 1980 to 2010. Maximum likelihood analysis using stochastic frontier shows that the efficiency of both small and large farms were reduced in the recent decades due to inefficient usage of resources.

KEY WORDS: Stochastic Frontier, Composite Index, High Yielding Varieties.

INTRODUCTION

In India as a result of green revolution, increase in area under cultivation and productivity was noticed in almost all the crops. Intensive use of inorganic fertilizers and pesticides and extension of area under irrigation has been an important tool in the drive for increased crop production. Tamil Nadu which is one of the important agrarian state in India covering 4 per cent geographical area and 2.89 per cent of the gross area sown of the country, has attained rapid rate of growth in the agricultural sector. It is one among the leading states in the production of principal crops like paddy and sugarcane. With the limited gross area sown, higher productivity of many crops has been achieved by practicing intensive farming. Also growing population and income, increases the demand for agricultural products and with the no scope for expanding the existing land resources, (Deshpande and Bhende, 2003), the only option remained to increase agricultural production is through adoption of improved technology and efficient use of available resources. Measuring efficiency is the popular approach to understand the performance of farmers in mobilizing the resources. So this study attempts to measure the technical efficiency of farmers in different time periods using most common inputs such as chemical fertilizers, seeds, animal human and machine labour.

MATERIALS AND METHODS

For identifying the districts in Tamil Nadu which are practicing intensive farming, composite index is used. In this method, for each district a 'composite index' is constructed. The composite index comprised of the indicators such as net irrigated area by tube wells, area irrigated per tube well, area under high yielding varieties of rice and sugarcane, fertilizer consumption per hectare of net area sown and number of tractors used per net area sown. Based on the composite index, Cuddalore and Villupuram districts were choosen since these two districts holds first two ranks in intensive farming in the state. For the analysis, paddy crop was selected since it is the most water intensive, fertilizer demanding crop and almost all the area under its cultivation in the districts is occupied by high yielding varieties. For measuring the input use efficiency of the firm over the years, the study uses the farm level panel data compiled by Tamil Nadu Agricultural University, Coimbatore, under the scheme Cost of Cultivation of Principal crops, sponsored by the Directorate of Economics and Statistics (DES), Ministry of Agriculture, Government of India. The data collected for analysis was pertained to the year 1980 to 2008. To analyse whether intensive farming is technically efficient across farm size groups, stochastic frontier production function approach is used. Based on operational holding, farms were classified as large farms and small farms. Those farms which operate below 2.5 hectares of land are classified as small farms and those above it comes under the category of large farms. The stochastic frontier model is estimated using the computer program FRONTIER 4.1 written by Coelli (1996). The model can be represented as $Yi = f(Xi,^{\beta}) \exp^{(Ui-Vi)}$……(1) ; Where, Yi is the quantity of yield of i th farm with i ranging from 1,2…….n, Xi is the vector of input quantities, β is the vector of unknown parameters, Ui is the non negative random variation due to variation in education, extension, infrastructure and so on and assumed to account for technical inefficiency in production, Vi is the random variation in output due to factors outside the control of farmers. The stochastic frontier production function of the Cobb-Douglas type was specified to estimate the technical efficiencies for the individual farms which when linearised becomes

Ln Y= ln βo + β1 ln X1 + β2 ln X2 + β3 ln X3 + β4 ln X4 + β5 ln X5 + Ui – Vi, ……(2)

Where β o is the intercept, X1= Animal labour (hrs/ha), X2 is human labour (human days/ha), X3= Machine labour (hrs/ha), X4= Seeds (kg/ha), X5= NPK (kg/ha), Ui

= Non negative random variable and Vi = Random error (not under the control of farmer)

RESULTS & DISCUSSION

Stochastic Frontier Estimates for Small Farms

According to the availability of data for all the variables in the districts, 544 farms representing small land holdings growing paddy were selected. Before getting into the estimates of technical efficiency, the mean input and output details of paddy crop for different time periods are analysed and given in Table 1.

TABLE 1: Mean Level of Input Use and Output for Small Farms

S.No	Particulars	1980 to 1990	1991 to 2000	2001 to 2005	1980 to 2005
1	Area (ha)	1.14	1.18	1.16	1.16
2	Yield(kg/ha)	3783	3871	4141	3916
3	Animal Labour (hrs/ha)	234	128	80	144
4	Human Labour (man daya/ha)	1868	1579	1134	1541
5	Machine Labour (hrs/ha)	249	326	321	303
6	Seed (kg/ha)	126	113	236	148
7	NPK (kg/ha)	225	534	292	388

Source: Author,s estimation from secondary data

From the Table 1, it is observed that the average occupational area of the small farms during the first time period was 1.14 ha. It slowly gets increased in the two decades and in the last decade it was 1.16 ha. Production and thereby productivity of the crops shows a remarkable rise in the last three decades due to intensive farming. The yield obtained in last three decades was higher than the state average yield. The mobilization of labourers from agricultural to non agricultural areas resulted in unavailability of labour for agricultural practices and mechanization reduced the animal labour usage dramatically. Thus both human and ab nnimal labour usage in agriculture gets declined in all the three decades. Machine labour usage peaked during 1991-2000 and then in the last decade it slowly declined to 321 hrs from 326 hrs for a crop year. Quantity of NPK used per hectare was first increased to a maximum of 534 kg/ha during 1991-2000 and then declined to 292 kg/ha in 2001 to 2010. But still it was higher than the government recommended rate of 200 kg/ha. Seeds are the only input where the usage gets increased from 126 kg/ha to 236 kg/ha. The average rate of seeds applied per hectare was twice higher than the recommended rate. Thus to analyse the efficiency in the usage of resources, stochastic frontier production function was used. In view of getting higher yield, generally farmers applied more fertilizers than what is recommended. From the Table 2 it could be seen that in the first time period the use of human and animal labour hours have positive impact on output, however, the estimated coefficients were not statistically different from zero. Quantity of NPK used in the production process has a significant influence over the output at one per cent confident level. The output elasticity with respect to NPK was 0.11. A high value of gamma (0.76) indicates the presence of significant inefficiencies in the production of the crop. In other words, about 76 per cent of the difference between the observed and the frontier output was mainly due to inefficient use of resources, which are under the control of the sample farms. These findings corroborate the observations made by Battese and Coelli (1995), Datta and Joshi (1992), Jayaram et al. (1992) and Rama Rao et al. (2003)

TABLE 2: Maximum Likelihood Estimates for Small Farms

S.No	Particulars	Coefficient		
		(1980-1990)	(1991-2000)	(2001-2008)
1	Constant	*** 6.978 (13.03)	***9.128 (20.20)	***8.387 (34.22)
2	Animal labor	0.0631 (1.414)	0.0048 (0.192)	0.017 (1.419)
3	Human labour	0.0868 (1.025)	0.0098 (0.462)	-0.0077 (-0.505)
4	Machine labour	-0.0159 (-1.063)	0.0079 (0.323)	**0.0329 (2.363)
5	Seeds	-0.0068 (-0.122)	***-0.1913 (-3.375)	0.035 (0.643)
6	NPK	**0.1127 (2.639)	0.0613 (1.408)	-0.014b(-0.447)
7	Sigma squared	***0.1256 (4.673)	***1.714 (11.31)	***0.2836b(7.081)
8	Gamma	***0.7614 (6.521)	***0.9999 (3162)	***0.9936 (112.1)
9	Log Likelihood	-5.375	-269	-21.08

Note : Figures in parenthesis indicates T ratio

***- significant at 1 per cent confident level ** - significant at 5 per cent confident level

In the second time period, with the exception of seeds all the variables used in the model have expected signs. The quantity of NPK used which is significant in the first time period turns out to be statistically insignificant and had the negative influence over yield. The ratio of the variance of the farm specific TE to the total variance of output showed that more than 99 per cent of the difference between the observed and the frontier output is mainly due to factors

which were under the control of the farmers. In the third time period, the empirical results derived through maximum likelihood techniques shows that the estimated elasticity coefficient for machine labour use is statistically significant at the 1 per cent level. The elasticity coefficient for other inputs was not statistically significant.

Frequency Distribution of Technical Efficiency for Small farms

The frequency distribution of estimated technical efficiency for the sample households by time period are given in Table 3.

TABLE 3: Technical Efficiency of Small Farms in Different Time Periods

S.No	Particulars	First Time period	Second Time period	Third Time period
1	<70	16	64	43
2	70-80	26	21	25
3	80- 90	45	9	18
4	>90	14	7	13
	Mean TE	0.79	0.62	0.70

Source: Authors estimation from secondary data

In the first time period the estimated TE ranged between 0.42 to 0.93 and nearly 60 per cent of the farms were operating at the technical efficiency range of above 80 per cent. The mean TE range of 0.79 for all the farms indicates that the output can be raised by 21 per cent by following efficient crop management practices without having to increase the level of application of inputs. In the second time period, sample farms realized only 62 per cent of their potential output. It has to be noted that this is the time period wherein maximum number of sample farms (more than 64 per cent) realized less than 70 per cent of the potential output due to inefficient use of resources. The frequency distribution of estimated technical efficiency for the third time period shows that nearly 70 per cent of the farms realized less than 80 per cent of the potential production. It is interesting to note that 13 per cent of the farmers are operating near the frontier or harvesting 90 per cent or more of the potential output .Thus in case of small farms the percentage of farms attained higher level of efficiency with the minimal amount of seeds and fertilizers was more in first period, when compared to later decades. During second and third periods, the usage of resources especially NPK and seeds was more but not significant, which meant the usage of those inputs were higher than the recommended rate and hence excess usage doesn't contribute to yield.

Stochastic Frontier Estimates for Large Farms

To estimate the technical efficiency of large farms, 170 holdings representing all the blocks of the districts were collected from the data. The average input usage of large farms is analyzed for the three decades and given in the Table 4.

TABLE 4: Average Level of Input Use and Output for Large Farms

S.No	Particulars	1980 to 1990	1991 to 2000	2001 to 2008	1980 to 2008
1	Area (ha)	4.86	5	5.5	5
2	Yield(kg/ha)	4025	3459	3501	3662
3	Animal Labour (hrs/ha)	181	66	43	97
4	Human Labour (man daya/ha)	1689	1234	1056	1308
5	Machine Labour (hrs/ha)	201	255	197	208
6	Seed (kg/ha)	111	112	117	111
7	NPK (kg/ha)	286	367	208	301

Source: Authors estimation from secondary data

It shows that the average area of large farms gets increased in the last three decades from 4.8 to 5.5 ha. The average yield though decreased in second time period, gets improved in 2001 to 2008. The animal labour usage, human labour hours, machine operation hours and NPK application used for crop production all gets decreased during the last three decades. Seeds applied per hectare increased in the last three decades to a tune of 6 kg per hectare. From the Table 5, it could be observed that in case of large farms during the first time period, only one variable namely NPK was found to influence the paddy output. The other variables were not found to be significant. It could be seen that as much as 60 per cent of the difference between the observed and the potential (frontier) output is due to inefficient use of resources which are at the disposal of the farmers. In the second time period the estimated elasticity coefficients for animal labour, human labour and machine labour was statistically significant at 1 per cent confident level. The elasticity coefficient for seeds and NPK was not statistically significant. A high value of gamma (0.99) indicates that about 99 per cent of the difference between the observed and the frontier output was mainly due to inefficient use of resources which are under the control of the sample farmers.

During the third time period, only one variable namely seed was found to influence the paddy output. As much as 92 per cent of the difference between the observed and the potential (frontier) output is due to inefficient use of resources which are at the disposal of the farmers.

TABLE 5 : Maximum Likelihood Estimates for Large Farms (1980-1990)

S.No	Particulars	Coefficient		
		1980 to 1990	1991 to 2000	2001 to 2008
1	Constant	***7.547 (8.653)	***7.955 (42.86)	***4.819 (10.27)
2	Animal labor	0.024 (0.807)	***0.057 (13.3)	-0.036 (-0.924)
3	Human labour	-0.031 (-0.298)	***0.026 (49.7)	-0.060 (-0.886)
4	Machine labour	0.035 (1.595)	***-0.0468 (-27.2)	0.025 (0.341)
5	Seeds	0.024 (0.286)	-0.049 (-0.963)	***0.784 (8.708)
6	NPK	*0.128 (2.022)	0.027 (0.039)	0.089 (0.708)
7	Sigma squared	**0.057 (2.875)	***0.340 (56.8)	***0.386 (3.497)
8	Gamma	*0.595 (2.303)	***0.999 (1014)	***0.921 (15.97)
9	Log Likelihood	14.49	-19.59	-19.75

Note : Figures in parenthesis indicates T ratio

***- significant at 1 per cent confident level ** - significant at 5 per cent confident level

Frequency Distribution of Technical Efficiency for Large Farms

The frequency distribution of estimated technical efficiency for the large farmers across the time period is given in Table 6.

TABLE 6 : Technical Efficiency of Large Farms in Different Time Periods (percentage)

S.No	Particulars	First Time period	Second Time period	Third Time period
1	<70	2	37	53
2	70-80	3	16	27
3	80 - 90	67	24	18
4	>90	28	24	2
	Mean TE	0.86	0.72	0.68

Source: Authors estimation from secondary data

In the first time period, it is interesting to note that more than 95 per cent of the farms are operating near the frontier or realized more than 80 per cent of the output as against 5 per cent of the farmers realized less 80 per cent of the potential output. The mean technical efficiency of production at this stage is 86 per cent. In the second time period, about 95 per cent of the farms attained more than 80 per cent of the potential production. The mean technical efficiency of production achieved by the farms at this stage is 72 per cent. In the third time period, about 53 per cent of the farms attained less than 70 per cent of the potential production and only 20 per cent of the farms achieved higher technical efficiency of more than 80 per cent. The mean technical efficiency of production achieved by the farms is 68 per cent. In case of large farms, over the decades, percentage of farms achieving higher technical efficiency of above 80 per cent gets decreased and hence the mean efficiency level also gets reduced. Similarly, yield also gets declined compared to first time period. Thus there is an immediate need to bridge the gap between the actual realized and the potential output with the given technology by using available resources more efficiently.

SUMMARY & CONCLUSION

Using panel data, the technical efficiency of farmers involved in paddy production was analysed with the help of stochastic frontier production in Cuddalore and Villupuram district of Tamil Nadu, a south Indian state. The results of the analysis shows that seeds and NPK have significant positive influence over yield when the dosage applied doesn't deviate much to the recommended dosage. Over dosage of inputs leads to insignificant or negative influence over yield. Frequency distribution of technical efficiency shows that more number of small farms has attained higher technical efficiency when compared to large farms. Thus this study has proved the Schultz hypothesis (1964) that poor people in developing countries are much better in using the resources. The study concludes that intensive farming though improves the yield, resulted in inefficient usage of resources. The gap between the actual realized and the potential output can be improved by efficient usage of resources.

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