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Efficiencies of Rice Production in Union Territory of Pondicherry

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Abstract

The efficiency of paddy farms in the Union Territory of Pondicherry has been measured for the year 2005-06 using data envelopment analysis (DEA). It has revealed that about 12.62 per cent of the farmers who operate rice farms belong to the most efficient category (90-100 per cent) and 23.45 per cent belong to the least efficient group (less than 50 pr cent), with the mean technical efficiency of 64 per cent. The allocative efficiency measure has indicated that about 15.86 per cent of the farmers belong to the most efficient category and 21 per cent to the least efficient group, with the mean allocative efficiency of 76 per cent. This suggests that the farms on an average, produce only about two-thirds of the potential output level. Also, there is possibility to increase the output level by 36 per cent in the short-run. The mean allocative efficiency measure has indicated that the rice farmers could reduce the costs by about 24 per cent by adoption of appropriate technologies and management practices. The returns to scale co-efficient have been found fairly distributed, suggesting that there is no systematic pattern in farms being too big or too small. More than one-third of the farmers belong to the most efficient scale group (90-100 per cent) and 4.18 per cent operate the farms in the least scale efficient group. Most of the allocative inefficiency can be attributed to over-use of labour, fertilizers and chemicals and this situation warrants policy interventions. Concerted efforts are essential to bridge the gap between awareness level and adoption of technologies by strengthening the agricultural extension system.

Introduction

The demand for rice in India has been projected at 128 million tonnes by the year 2012 and it will require a production level of 3000 kg/ha, which is significantly higher than the present average yield of 1900 kg/ha. Rice is the main crop grown in the Union Territory of Pondicherry, and the growth of its production has accelerated from the negative growth of 2.46 per cent during the 1980s to the negative growth rate of 1.08 per cent during the 1990s. The average yield of paddy has been stagnated over the years at around 2000 kg/ha.

There is a considerable scope in raising the yield of rice even with the technologies currently on the shelf. The yield gap has been estimated to be around 40 per cent in rice cultivation in India. The quantum jump in rice yield is possible using semi-dwarf varieties that respond to increased use of fertilizers, pesticides, weedicides and a host of other chemicals along with the irrigation water. An integrated approach is necessary to remove the technological, infrastructural, social and policy-related constraints responsible for this productivity gap and in some cases, productivity decline. With this background, the measurement of farm-level efficiency in rice production in the Union Territory of Pondicherry was the first aim of this paper. Following that, the efficiency differentials across farms have been explained, which may help policymakers in identifying ways to improve efficiencies.

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Methodology

Technical Efficiency and Data Envelopment Analysis (DEA)

The Data Envelopment Analysis (DEA) is a non-parametric mathematical programming methodology

based on the works of Farrell (1957) and Fraser and Cordina (1999). It involves the use of linear programming to construct an efficiency frontier that provides a means by which all farms can be assessed in terms of relative efficiency. The constant returns to scale (CRS) assumption means that average productivity, denoted by output / input is not dependent on scale of production. However, the most general assumption that can be made in respect of returns to scale is that they are variables. It permits constant and increasing or decreasing returns to scale for different scale sizes. To allow for this possibility, variable returns to scale (VRS) that measure technical efficiency can be decomposed into pure technical efficiency and scale efficiency (SE) (Charnes *et al*., 1978). The VRS rating is obtained when control for the scale size of the Decision Making Unit (DMU) and SE measures the impact of scale size on the productivity of a DMU. The technical efficiency score (in both CRS and VRS models) of one implies full efficiency, and of less than one indicates technical inefficiency.

Consider the situation with 'n' farms or decision-making units (DMUs), each producing a single output by using 'm' different inputs. Let, Y_i be the output produced, X_i be the (m × 1) vector of inputs used by the i^{th} DMU, Y be the (1 × n) vector of outputs and X be the (m × n) matrix of inputs of all n DMUs in the sample.

The technical efficiency (TE) measure under constant returns to scale (CRS) was obtained by solving the DEA model given by Equation (1) (Banker *et al*., 1984):

$$\begin{aligned} &\text{Min } \theta_i^{CRS} \\ &\theta_i^{CRS}, \lambda \qquad \ldots(1) \\ \text{Subject to} \quad &Y_i \leq Y\lambda \\ &\theta_i^{CRS} X_i \geq X \end{aligned}$$

where, θ^{CRS} is a TE measure of the i^{th} DMU under constant returns to scale (CRS) and λ is an (n × 1) vector of weights attached to each of the efficient DMUs. A separate linear programming (LP) problem is solved to obtain the TE score for each of the n DMUs in the sample.

Data and Variables

Since rice is the main crop in the Union Territory of Pondicherry, 180 rice farmers were selected randomly across the four regions of the Union Territory. The data and information pertaining to the agricultural year 2005-06 were collected by personal interview method using a per-tested interview schedule.

Results and Discussion

The summary statistics of rice farmers have been presented in Table 1. The results implied that there was a difference in input usage and output realization. It was also matched with the states that grow rice in modified ways and it revealed considerable potential of further increase in rice yield in this Union Territory.

Table 1. Summary statistics of variables

(ha)

Variables	Means value	Minimum value	Maximum value
Output (kg)	4185	2115	5210
Seed (kg)	80	60	105
Labour (human-days)	422	342	545
Fertilizer (Rs)	4100	2800	4325
Chemicals (Rs)	3800	3215	4221
Irrigation (No.)	15	12	19
Capital (Rs)	4950	3520	5983

Note: Capital represents the value of machinery and animal power used in rice cultivation.

The results of DEA, technical, allocative and scale efficiencies have been presented in Table 2. The average technical efficiency score was found to be 0.64. This suggests that the average farm was producing only about two-thirds of the potential output level (i.e. 4185 kg/ha). It also indicates that there is possibility to increase the output level by 36 per cent in the short-run. The mean allocative efficiency score was found as 0.76, which indicated that rice farmers could reduce the costs by about 24 per cent (Rs 4736) by adopting appropriate technologies and management practices. The average scale efficiency score of 0.94 indicated that there was a scope for increasing the yield of the rice farms to obtain the frontier output.

The frequency distribution of technical, allocative and scale efficiency measures for rice farms has been presented in Table 3. A perusal of Table 3 reveals that about 12.62 per cent of the rice farmers belonged to the most efficient category (90-100 per cent) and 23.45 per cent to the least efficient group (less than 50 per

Table 2. Technical, allocative and scale efficiency measures for rice farms in Pondicherry

Parameters	Technical efficiency	Allocative efficiency	Scale efficiency
Mean	0.64	0.76	0.94
Standard deviation	0.19	0.12	0.08
Minimum	0.36	0.29	0.48
Maximum	1.00	1.00	1.00
IRS (%)	-	-	54.48
DRS (%)	-	-	39.15
CRS (%)	-	-	6.37

Table 3. Frequency distribution of technical, allocative and scale efficiency measures for rice farms in Pondicherry

(in per cent)

Frequency level	Technical efficiency	Allocative efficiency	Scale efficiency
< 50	23.45	21.00	4.18
50-60	21.69	21.52	12.58
60-70	18.42	16.85	10.18
70-80	13.96	12.42	18.52
80-90	09.86	12.35	15.89
90-100	12.62	15.86	38.65

cent), with a mean technical efficiency of 64 per cent. The allocative efficiency measures indicated that about 15.86 per cent of the farmers belonged to the most efficient category and 21 per cent to the least efficient group, with the mean allocative efficiency of 76 per cent.

The returns to scale co-efficient were fairly distributed, suggesting that there was no systematic pattern in farms being too big or too small, since the scale efficiency results only reflected the farm size in the sample. More than one-third of the farmers (38.65 per cent) belonged to the most efficient scale group (90-100 per cent) and 4.18 per cent of the farmers operated in the least scale efficiency group.

Allocative efficiency was further investigated to identify the over-use and under-use of input along with the input levels. The systematic over-use of inputs has been shown in Table 4, wherein a ratio greater than unity indicated the over-use of that input. It was found that there was considerable over-use of labour, fertilizers and chemicals. Agriculture was considered as a subsidiary occupation, which resulted in over-use of labour. The over-use of fertilizers was not surprising, since the rice farmers apply fertilizers which is one and a half times of the recommended level, so much so that the Union Territory of Pondicherry is the number one in the fertilizer consuming states of the country. It may be due to single window input delivery system of agricultural inputs at subsidized rates by the Government of Pondicherry.

Table 4. Ratio of optimal and existing use of inputs

Variables	Input ratio	Overuse farms (%)
Seed (kg)	0.95	-
Labour (humandays)	1.12	45.02
Fertilizer (Rs)	1.38	48.56
Chemicals (Rs)	1.10	52.12
Irrigation (No.)	0.94	-
Capital (Rs)	0.84	-

Conclusions

The study has used data envelopment analysis (DEA) to measure the efficiency of paddy farms in the Union Territory of Pondicherry. The results have indicated the mean technical efficiency as 64 per cent, mean allocative efficiency as 76 per cent and mean scale efficiency as 94 per cent. This suggests that the average farm is producing only about two-thirds of the potential output level (i.e., 4185 kg/ha). Also, there is potential to increase the output level by 36 per cent

(1025 kg/ha) in a short-run. The mean allocative efficiency measure has indicated that the rice farmers could reduce the costs by about 24 per cent (Rs 4736) by adopting appropriate technologies and management practices. Most of the allocative inefficiency can be attributed to over-use of labour, fertilizers and chemicals and this situation warrants policy revisions. Concerted efforts are essential to bridge the gap between awareness and adoption of technologies by strengthening the agricultural extension system.

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