Economic efficiency of paddy cultivated farmers in Raichur district of Karnataka (India)

Abstract

Chemical fertilizers have played a vital role in the success of India's Green Revolution and consequent self-reliance in foodgrain production. The increase in fertilizer consumption has contributed significantly to sustainable production of foodgrains in the country. Hence, in order to realize the need based targets of agricultural production, in the study area to find out the technically, allocative and economic efficient or inefficient in production of paddy. The result pertaining to this aspect was based on the primary data collected through survey method from paddy cultivated farmers 60 farmers in Raichur district during 2015-16. For paddy cultivation among small farmers results of technical, allocative and economic efficiency were indicated that 36.67 per cent, 16.67 per cent and 10 per cent of small farmers had efficiency scores above 0.9 in production of paddy, about 26.67 per cent and 16.67 per cent of the farmers were technically efficient with score ranges between 0.7-0.8 and 0.8-0.9. Similarly in large farmers 33.33 per cent, 26.67 per cent and 10 per cent of technical, allocative and economic efficiency scores above 0.9 in production of paddy. It is clear that most of the small and large farmers were economically inefficient, however still there is scope to utilise the available resources for paddy cultivation farmers in the study area.

Key words: Allocative efficiency, Cultivation, Economic efficiency and Technically efficiency.

INTRODUCTION

Agricultural sector plays an important role in economic development of developing countries. In India, this sector occupies a predominant position in the economy. It contributes about 13.9 per cent to the national income of the country for the year 2015-16 and sustains two-thirds population of India. It is the single largest sector providing employment to the extent of more than 50 per cent of the country’s work force, thus agriculture continues to be mainstay for livelihood of rural people. The most challenging problem today is as the population growth increases the demand for food grain increases over the year. Whereas, the production of food grains dropped 259.29 million tone to 252.33 million tonne from 2011-12 to 2015-16.

The agricultural production can be increased by either expansion of area or productivity. In the Indian context, land is becoming a shrinking resource for agriculture owing to competing demand for its use. Also the population growth has resulted in lower carrying capacity of land. Hence, in order to realize the need based targets of agricultural production, the pattern of production enhancement will have to rest heavily on increased yield. This essentially calls for optimizing the usage of the existing farm land by adopting new strategy for agricultural development. One of the strategy includes judicious use of chemical fertilizers. Chemical fertilizers have been considered as an essential input to enhance yield in Indian agriculture for meeting the food grain requirements of the growing population of the country. The use of chemical fertilizers to increase the agricultural production particularly in developing country is well known fact. Some argue that fertilizer was as important as seed in the Green Revolution (Tomich *et al.* 1995) contributed as much as 50 percentages to the yield growth in Asia (Hopper 1993 and FAO 1998). Fertilizer consumption in India has been increasing over the years and today India is one of the largest producer and consumer of chemical fertilizers in the world.

Chemical fertilizers bear a direct relationship with food grain production along with a number of supporting factors like High Yielding Varieties (HYVs), irrigation, access to credit and enhanced total factors of productivity. The importance of the chemical fertilizer sector in Indian agriculture hardly be emphasized as it provides a very vital input for the growth of Indian agriculture and is an expected factor that has to be reckoned within the attainment of the goal of self-sufficiency in food grains. Accurate forecasting of fertilizer demand and supply is essential, both for companies producing, importing and marketing fertilizer and for governments in their efforts to monitor the development of agriculture.

Chemical fertilizer is a substance to soil to improve plants' growth and yield. First used by ancient farmer's fertilizer technology developed significantly as the chemical needs of growing plants were discovered. Chemical fertilizer was identified as one of the three most important factors, along with seed and irrigation, for raising agricultural production and sustaining food self-sufficiency in India (Chand and Pandey 2009).

The importance of fertilizer is because of shrinking cropping land and production need is high. The Indian National Food Security Act. (2013) aims to provide subsidized food grains to approximately two thirds of India's 1.2 billion people. India needs to produce an additional 5-6 million tonnes of food grains annually to meet the requirement of an increasing population. The level of use of fertilizer in India is imbalance, this trend will continuous in India as well as in Karnataka and also in North Eastern Karnataka (NEK) region. The results of the study will be great useful to the policy makers to formulate policy related to efficient utilisation of chemical fertilizers to enhance the crop output at the same time reduce the cost of cultivation and maximise the profit. It is appropriate and most conducive to undertake study on proposes to assess usage of chemical fertilizer in NEK region. Hence, the present paper has examined the economic efficiency of paddy production in Raichur district.

METHODOLOGY

Primary data were obtained from the farmers who are growing selected crops through personal interviews with the help of pre-tested and structured schedule. Multistage random sampling techniques will be employed. In the first stage for Raichur district was selected in the North Eastern Karnataka region based on highest chemical fertilizer consumption. In the second stage from Raichur districts, two taluks was selected by considering above mentioned criteria, Shindhanur and manvi taluks were selected, In the third stage three villages from each taluks were selected by randomly, from the selected villages ten farmers were chosen by randomly. Thus the data was collected from 60 (30 from each taluk) sample farmers.

The DEA was applied by using both classic models CRS (constant returns to scale) and VRS (variable returns to scale) with input orientation, in which one seeks input minimization to obtain a particular product level (Murthy et al. 2009). In this study, to estimate the technical efficiency, allocative efficiency and economic efficiency input oriented and cost minimization DEA were used. This approach was first used by Farrell (1957) as a piecewise linear convex hull approach to frontier estimation and later by Boles (1966) and Afriat (1972). This approach did not receive wide attention till the publication of paper of Charnes *et al.* (1978), which coined the term data envelope analysis.

Mathematical form of data envelopment analysis as follows

$$\text{Min}\theta, \lambda\ \theta$$

$$\text{Subject to}\quad -yi + Y\lambda \geq 0$$

$$\theta Xi - X\lambda \geq 0$$

$$\lambda \geq 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

Where,

yi is a vector (m × 1) of output of the ith Producing Farms TPF(Total productivity factor),

x_i is a vector (k × 1) of inputs of the i^{th} TPF

Y is an output matrix (n × m) for n TPFs

X is an input matrix (n × k) for n TPFs

θ is the efficiency score

a scalar whose value will be the efficiency measure for the i^{th} TPF. If θ =1, TPF (Total productivity factor) will be efficient; If θ ≠1it will be inefficient, and λ is a vector (n × 1) whose values are calculated to obtain the optimum solution. For an inefficient TPF, the λ values will be the weights used in the linear combination of other, for efficient, TPFs, which influence the projection of the inefficient TPF on the calculated frontier.

The DEAP version 2.1 software developed by Coelli and Battese, (1996), Centre for Efficiency and Productivity Analysis, University of Queensland, Australia, was used in this study by taking input orientation to obtain the efficiency levels of paddy farms.

Gross return (Rs/acre) was used as a output (Y) in the present case and seed (kg), farm yard manure (tonnes), plant nutrients N (Kg), P (kg), K (kg) separately, total men labour (man days), total women labour (woman days), plant protection chemicals (Rs), other input costs and fixed input costs as inputs (X). The models were solved using the DEAP version 2.1 taking an input orientation to obtain the efficiency levels.

Result and Discussion

Table 1 depicts the chemical fertilizer use efficiency among small and large farmers for paddy cultivation. It is revealed from the table that, value of coefficients of multiple determinations was found 68 per cent and 79 per cent in small and large farmers respectively for paddy cultivation. In small farmers the regression coefficients of the resource variables were found positive for seed (0.05), FYM (0.39), potash (0.18) and labour usage (0.12), negative regression coefficients was observed for nitrogen (-1.68) phosphorous (-1.10), and PPC (-0.16). The highly significant regression coefficient was observed for nitrogen indicated that one per cent change in its use level would decrease the output of paddy by 1.68 per cent, phosphorous 1.10 per cent, keeping the use levels of the other variable constant. Similarly plant protection chemical (PPC) reflected negative effect on paddy yield but it was non-significant. The significant regression coefficient was observed in case of FYM indicated that the one per cent changes in its use level would increase the output of paddy by 0.39 per cent, potash 0.18 per cent.

With regard to large farmers, the significant regression coefficient of nitrogen indicate that one per cent change in its use level would decrease the output of paddy by 1.24 per cent keeping the use levels of the other variable constant. Whereas regression coefficients of the resource variables for seed (0.14), FYM (0.51), potash (0.13) and labour usage (0.03) were found positive. The significant regression coefficient was observed in case of FYM indicated that the one per cent changes in its use level would increase the output of paddy by 0.51 per cent, potash 0.13 per cent.

The regression model adequacy was examined with coefficient of multiple determination (R^2) 68 per cent and 79 per cent in case of small and large farmers for paddy cultivation. This implies that, about 68 per cent and 79 per cent of the variation in the output was explained by the selected exogenous variables such as seed, FYM, nitrogen, phosphorous, potash, PPC and labour. Small farmer's regression variable coefficients were negative for nitrogen consumption and phosphorous which indicate that there was no scope for attaining optimal level of output by increasing the input application. With regard to large farmers nitrogen consumption in paddy cultivation was negative which indicated that additional unit increase in nitrogen application reduce the output.

Table 1 Chemical fertilizer use efficiency for small and large farmers for paddy cultivation

Sl. No.	**Variables**	**Small Farmers (n=30)**		**Large Farmers (n=30)**	
		Coefficient	**t-value**	**Coefficient**	**t-value**
1	**Constant**	5.98**	2.384	6.52**	3.413
2	**Seed (kg/acre)**	0.05	0.729	0.14	1.625
3	**FYM (kg/acre)**	0.39*	2.130	0.51*	3.13
4	**Nitrogen (kg/acre)**	-1.68**	3.158	-1.24**	2.914
5	**Phosphorus (kg/acre)**	-1.10*	-2.075	-1.04	-1.569
6	**Potash (kg/acre)**	0.18**	3.180	0.13**	2.680
7	**PPC (Rs./acre)**	-0.16	-1.374	-0.28	-1.705
8	**Labour usage (Rs./acre)**	0.12	0.093	0.03	0.374
	R^2	**0.68**		**0.79**	

Note: * Significance at 5 per cent level ** Significance at 1 per cent level

The results of technical, allocative and economic efficiency are presented in Table 2. The results indicated that, 40 per cent of small farmers and 46.67 per cent of large farmers have efficiency scores above 0.9 under the assumption of constant returns to scale in paddy cultivation. While, 10 per cent and 16.67 per cent of the small and large farmers were technical efficiency score with ranges between 0.8-0.9 under the assumption of CRS in paddy cultivation. The average technical efficiency score was 0.74 in small farmers and 0.81 in large farmers under the assumptions of CRS in paddy cultivation. With regard to variable returns to scale, 46.67 per cent of small farmers and 53.33 per cent of large farmers have efficiency scores above 0.9 under the assumption of VRS in paddy cultivation. While, 23.33 per cent and 20 per cent of the small and large farms were technical efficiency score with ranges between 0.8-0.9 under the assumption of VRS in paddy cultivation respectively. The average technical efficiency score was 0.83 in small farmers and 0.89 in large farmers under the assumptions of VRS in paddy cultivation. However, the large farmers were technically more efficient as compared to small farmers under the assumptions of CRS and VRS in paddy cultivation.

The results pertaining to technical efficiency revealed the estimated mean of 0.74 and 0.81 for small and large farmers under the assumption of CRS in paddy cultivation. This implied that, there exists a 26 per cent and 19 per cent potential for increasing small and large farmers cultivation by using the present technology. Whereas, technical efficiency mean of 0.83 and 0.89 for small and large farmers under the assumption of VRS in paddy cultivation. It indicated that, there exists a 17 per cent and 11 per cent potential for increasing small and large farmers cultivation by using the present technology. Therefore both categories of farmers need to practice recommended dosage of application in fertilizers and also other inputs as per the package of practice given by State Agriculture Universities (SAU) in order to achieve the 100 per cent efficiency.

With regard to allocative efficiency in paddy cultivation is concerned about 16.67 per cent and 26.67 per cent of small and large farmers attained efficiency level 90 and above under CRS assumption respectively. With a score of 13.33 per cent of both small and large farmers attained efficiency level 0.80 to 0.90 under CRS assumption. The average technical efficiency score was 0.58 in small farmers and 0.62 in large farmers under the assumptions of CRS in paddy cultivation. While, 33.33 per cent of both small farmers and large farmers have efficiency scores above 0.9 under the assumption of VRS in paddy cultivation. While, 6.67 per cent and 10 per cent of the small and large farmers were allocative efficiency score with ranges between 0.8-0.9 under the assumption of VRS in paddy cultivation. The average technical efficiency score was 0.67 in small farmers and 0.71 in large farmers under the assumptions of VRS in paddy cultivation. It implies that, the large farmers were allocative more efficient as compared to small farmers under the assumptions of CRS in paddy cultivation.

The small and large farmers in paddy cultivation have an allocative efficiency mean level of 0.58 and 0.67 under the assumption of CRS. This means that, there exist a 42 per cent and 33 per cent potential for increasing output by using optimum input combination. While under VRS assumption, the allocative efficiency mean level were 0.67 and 0.71 for small and large farms respectively. This implied that, there exist a 33 per cent and 29 per cent potential for increasing output by using optimum input combination.

The average economic efficiency score was 0.51 and 0.56 of small and large farmers under the assumptions of CRS in paddy cultivation respectively. 10 per cent of small farmers and 13.33 of large farmers and have efficiency scores above 0.9 under the assumption of constant returns to scale in paddy cultivation. While, 6.67 10 per cent of small farmers and 20 per cent of large farmers were economic efficiency score with ranges between 0.8-0.9 under the assumption of CRS in paddy cultivation. With regard to variable returns to scale, 13.33 per cent and 20 per cent of small and large farmers have efficiency scores above 0.9 under the assumption of VRS in paddy cultivation. While, 16.67 per cent and 23.33 per cent of the small and large farmers were economic efficiency score with ranges between 0.8-0.9 under the assumption of VRS in paddy cultivation respectively. The average economic efficiency score was 0.59 in small farmers and 0.63 in large farmers under the assumptions of VRS in paddy cultivation. However, the large farmers were economic efficiency was higher as compared to small farmers under the assumptions of CRS and VRS in paddy cultivation. The economic efficiency mean of 0.51 and 0.59 for small farmers and large farmers under the assumption of CRS in paddy cultivation, implies that there exists a 49 per cent and 41 per cent potential for increasing small and large farmers cultivation at the existing level of their resources.

Table 2 Economic efficiency of farmers in paddy cultivation

Efficiency score	**Small farmers (n=30)**			**Large farmers (n=30)**		
	Constant returns to scale					
	Technical efficiency	Allocative efficiency	Economic efficiency	Technical efficiency	Allocative efficiency	Economic efficiency
<0.5	2 (6.67)	7(23.33)	11 (36.67)	--	6 (20.00)	9 (23.33)
0.5-0.6	4 (13.33)	8 (26.67)	4 (13.33)	2 (6.67)	6 (20.00)	5 (16.67)
0.6-07	3 (10.00)	4 (13.33)	6 (20.00)	2 (6.67)	3 (10.00)	2 (6.67)
0.7-0.8	6 (20.00)	2(6.67)	4 (13.33)	7 (23.33)	3 (10.00)	4 (13.33)
0.8-0.9	3 (10.00)	4 (13.33)	2 (6.67)	5 (16.67)	4 (13.33)	6 (20.00)

0.9-1.00	12 (40.00)	5 (16.67)	3 (10.00)	14 (46.67)	8 (26.67)	4 (13.33)
Total	30 (100.00)	30 (100.00)	30 (100.00)	30 (100.00)	30 (100.00)	30 (100.00)
Mean	**0.74**	**0.58**	**0.51**	**0.81**	**0.62**	**0.56**
	Variable returns to scale					
<0.5	2 (6.67)	4 (13.33)	8 (26.67)	--	3 (10.00)	3 (10.00)
0.5-0.6	1 (3.33)	6 (20.00)	5 (16.67)	1 (3.33)	5 (16.67)	4 (13.33)
0.6-07	3 (10.00)	4 (13.33)	3(10.00)	2 (6.67)	5 (16.67)	5 (16.67)
0.7-0.8	3 (10.00)	4 (13.33)	5 (16.67)	5 (16.67)	4 (13.33)	5 (16.67)
0.8-0.9	7 (23.33)	2 (6.67)	5 (16.67)	6 (20.00)	3 (10.00)	7 (23.33)
0.9-1.00	14 (46.67)	10 (33.33)	4 (13.33)	16 (53.33)	10 (33.33)	6 (20.00)
Total	30 (100.00)	30 (100.00)	30 (100.00)	30 (100.00)	30 (100.00)	30 (100.00)
Mean	**0.83**	**0.67**	**0.59**	**0.89**	**0.71**	**0.63**

Note: Figures in parenthesis are percentages.

While, under the assumption of VRS in paddy cultivation economic efficiency mean of 0.59 and 0.63 for small farmers and large farmers under the assumption of VRS in paddy cultivation indicates that, there exists a 41 per cent and 37 per cent potential for increasing small and large farmers cultivation at the existing level of their resources. The results were in conformity with Samarpitha *et al*. (2016) who found that the mean economic efficiency of the sample farms was 81.68 per cent in rice farms in Nalgonda district of Telangana.

CONCLUSION

The economic efficiency mean of 0.51 and 0.59 for small farmers and large farmers under the assumption of CRS in paddy cultivation, implies that there exists a 49 per cent and 41 per cent potential for increasing small and large farmers cultivation at the existing level of their resources. While, under the assumption of VRS in paddy cultivation economic efficiency exists a 41 per cent and 37 per cent potential for increasing small and large farmers cultivation at the existing level of their resources. The small and large farmers in paddy cultivation have an allocative efficiency mean level of 0.58 and 0.67 under the assumption of CRS. This means that, there exist a 42 per cent and 33 per cent potential for increasing output by using optimum input combination. While under VRS assumption, the allocative efficiency mean level were 0.67 and

0.71 for small and large farms respectively. This implied that, there exists a 33 per cent and 29 per cent potential for increasing output by using optimum input combination.

The results pertaining to technical efficiency revealed the estimated mean of 0.74 and 0.81 for small and large farmers under the assumption of CRS in paddy cultivation. This implied that, there exists a 26 per cent and 19 per cent potential for increasing small and large farmers cultivation by using the present technology. Whereas, technical efficiency mean of 0.83 and 0.89 for small and large farmers under the assumption of VRS in paddy cultivation. It indicated that, there exists a 17 per cent and 11 per cent potential for increasing small and large farmers cultivation by using the present technology. Therefore both the categories of farmers need to practice recommended dosage of application in fertilizers and also other inputs as per the package of practice given by State Agriculture Universities (SAU) in order to achieve the 100 per cent efficiency.

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