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 food grain production. The increase in fertilizer consumption has contributed significantly to sustainable production of food grains 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~~This study 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

Comment [O1]: Economic efficiency of farmers on paddy cultivated farms in Raichur district of Karnataka, India

Comment [O2]: Delete this portion. Simply introduce the topic. You can do this by stating "This work is focussed on investigating the economic efficiency of farmers on paddy cultivated farms in... " You may also need to explain why you chose to study this particular location.

Comment [O3]: Delete this statement and instead state the research problem. The research problem should be the existing gap in knowledge that the work intends to fill, e.g., informing and influencing policy, updating literature, contributing to current discussion etc. For a study like this the research problem can be "provision of evidence-based information for present and prospective farmer-entrepreneurs in ..."

Comment [O4]: The research problem should be followed by the core specific objectives of the study.

Comment [O5]: Before the result, comment on the methodology adopted in the study.

Comment [O6]: When presenting the results in the abstract section, concentrate on the major findings of the work. Ensure to include in the abstract, the conclusion and the recommendations of the work based on the study.

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~~strategies 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~~ percent 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 with in 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~~ and ~~proposes to~~

Comment [O7]: What do you mean by this?

assesses usage of chemical fertilizer in NEK region. Hence, the present paper has examined the economic efficiency of paddy production in Raichur district. Please clearly specify in this section the research problem, and the specific objectives of the study. State also why the choice of the study area in spite of all the areas.

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~~was 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, ~~I~~in the third stage three villages from each taluks were randomly selected ~~by randomly~~, from the selected villages ten farmers were randomly chosen ~~b~~y ~~randomly~~. Thus ~~the~~ data ~~was~~ were collected from 60 (30 from each taluk) sample farmers.

Comment [O8]: What selected crops? What is the basis for selection?

Comment [O9]: Which above mentioned criteria? Be specific.

The Data Envelopment Analysis? 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~~ envelopment? analysis.

Comment [O10]: What is this?

Mathematical form of data envelopment analysis as follows

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

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

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

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

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. There are some concepts employed in the discussion which did not receive any exposition in the methodology. They are, the concepts of small and large farms, returns to scale and efficiency measures. With particular reference to efficiency measures, you are required to elaborate on technical, price and allocative efficiencies which you made copies reference in the discussion.

Comment [O11]: Labour is conventionally measured in man days; so convert everything to man days.

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

Comment [O12]: You have not elaborated how you categorized small and large farms. Please do so.

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 change~~s~~ 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~~ farm holding?? nitrogen consumption, ~~in~~ paddy cultivation was negative which indicated that additional unit increase in nitrogen application reduce the output.

Comment [O13]: Do you mean "large farms"?

Comment [O14]: Do you mean "farms"?

Comment [O15]: Small farm holding??

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**	

Source, (Year)??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 smallholder farmers and 46.67 per cent of large scale 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 smallscale and large scale farmers ~~were~~ had technical efficiency score with ranges between 0.8-0.9 under the assumption of ~~CRS~~ constant returns to scale 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~~ constant returns to scale in paddy cultivation. With regard to variable returns to scale, 46.67 per cent of small farmers and 53.33 per cent of large scale 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 scale and large scale farms ~~were~~ had technical efficiency score with ranges between 0.8-0.9 under the assumption of ~~VRS~~ variable returns to scale?? in paddy cultivation respectively. The average technical efficiency score was 0.83 in small farm~~er~~s and 0.89 in large farm~~er~~s under the assumptions of ~~VRS~~ variable returns to scale?? in paddy cultivation. However, the large scale farmers were technically more efficient as compared to smallscale 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 smallscale and large scale 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 scale and large scale farmers cultivation respectively 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 smallscale and largescale farmers cultivation respectively 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~~small-scale and large scale farmers attained efficiency level of 90 per cent?? 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

Comment [O16]: Write in full.

Comment [O17]: This is incomplete sentence!

Comment [O18]: Look at this again and see if you can revise it to "With a score of 13.33 per cent, both small-scale and large scale farmers attained efficiency level 0.80 to 0.90 respectively under CRS assumption."

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~~ had 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~~ had 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~~ farms and 0.63 in large farm~~ers~~s under the assumptions of VRS in paddy cultivation. However, the large farmers ~~were~~ economic efficiency score 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 respectively under the assumption of CRS in paddy cultivation, implies that there exists a 49 per cent and 41 per cent potential for increasing small-scale and large scale farmers cultivation at the existing level of their resources.

Comment [O19]:

Comment [O20R19]: This sentence is hanging! Revise it.

Comment [O21]: Revise this sentence to make meaning.

Comment [O22]: Revise this statement.

Table 2 Economic efficiency of farmers in paddy cultivation

Efficiency score	Small-scale farmers (n=30)			Large scale 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, u~~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.

Comment [O23]: In all the discussions, you found it necessary to cite just this reference. I think this discussion can benefit from some more relevant and recent citations.

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, u~~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 u~~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.

Comment [O24]: Revise this statement.

This appears to be a repetition of the discussion. To that extent it is not a conclusion. So, please go ahead and conclude this work. Furthermore, this work had very few recommendations; so please add some more recommendations.

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