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Research Article

TECHNICAL, ALLOCATIVE AND ECONOMIC EFFICIENCY OF CROPS IN NORTH-EASTERN DRY ZONE OF KARNATAKA

ROHITH G.V.*, OLEKAR J. AND ROY A.
Department of Agricultural Economics, University of Agricultural Sciences, Bengaluru, 56 0065, Karnataka, India
*Corresponding Author: Email - rohithgv789@gmail.com

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Abstract: This study is to analyze the extent of technical, allocative and economic efficiency in major crops cultivated in NEDZ of Karnataka. A random sample of 30 farmers each under rainfed condition, borewell irrigation and canal irrigation are studied for Manvi and Raichur taluks of Raichur district in NEDZ of Karnataka. The technical, allocative and economic efficiency of crops analyzed using Data envelopment analysis. The borewell cotton farmers are very poor technical efficiency compared with rainfed cotton, however their allocative efficiency was higher at 0.609 compared with the low allocative efficiency of 0.29 for rainfed cotton farmers. Paddy farmers in canal irrigation have impressive technical efficiency score of 0.84, but relatively poor allocative efficiency score of 0.64. In rainfed redgram none of the farmers have technical efficiency with a score below 0.50 and most of the farmers have allocative (55 percent) and cost efficiency (70 percent) with a score below 0.5. Thus, most of the farmers scored high in technical efficiency, but scored poorly in allocative and economic efficiency in rain fed redgram. This shows that farmers need to be well educated regarding their allocative efficiency as they are already well equipped technically. Thus, these farmers need to be trained to achieve allocative efficiency in the use of inputs in order to improve their overall economic efficiency.

Keywords: *Technical, Allocative and economic efficiency, Data Envelopment Analysis (DEA)*

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Introduction

The principle of comparative advantage determines or dictates the crop pattern and land use is an economic puzzle. While agro climatic, socio economic, and biophysical factors rule the cropping pattern, the extent of technical, allocative and economic inefficiencies differ depending upon the crop, region, farmers, access to irrigation and other factors. There are no compelling reasons to accept that prima facie there is efficiency across all farmers and all crops. Due to market price distortions influenced by the extent of subsidies offered to fertilizer, water, credit, and other inputs, price support offered to food crops, the efficiency of crop pattern and resource allocation is bound to be affected. On the other hand, subsidies for vital inputs are also required in order that the area / region / country do not suffer from food insecurity. However, food and livelihood security should not be at the cost of inefficiency in resource use, resource allocation, loss of efficiency, indiscriminate use of natural resources such as land, water and environment affecting sustainability. Again, this does not imply that there is gross inefficiency in allocation of all the resources and that addressing market imperfections alone is a panacea for all the economic illnesses faced by the farmers.

The cropping pattern in the study area North-Eastern Dry Zone (NEDZ) of Karnataka is influenced by rainfall, climate, soil conditions, subsidized inputs, and other market conditions also in addition to growing demand for diverse food for rural and urban population. The subsidies and other distortions influence the efficiency of crop production as well as resource allocation affecting long term food production prospect of the region. This study is aimed at exploring the profitability of crops in Karnataka in general and in North-Eastern Dry Zone of Karnataka in particular in order to estimate the extent of inefficiency in resource use and allocation as reflected in the costs incurred and net returns realized by the farmers [1-6].

Material and Methods

The study was carried out in Manvi and Raichur taluks of Raichur district under North-Eastern Dry Zone (NEDZ) of Karnataka. Random sampling was adopted for selection of sample farmers. Data were collected from 30 rainfed farmers, 30 farmers who are using groundwater irrigation and 30 farmers who are using canal irrigation totalling 90 farmers.

Data Envelopment Analysis

Technical, Allocative and economic efficiency were found by using Data Envelopment Analysis (DEA) (Coolie........). DEA is a Linear Programming Problem that facilitates calculating apparent efficiency levels within a group of firms. The efficiency of a farm is calculated relative to the groups observed best practice within the group. Technical Efficiency (TE) refers to the ability of a farm to produce the maximum feasible output from a given bundle of inputs, or the minimum feasible amounts of inputs to produce a given level of output. Allocative Efficiency (AE) refers to the ability of a technically efficient farm to use inputs in proportions that minimize production costs given input prices. Allocative efficiency is calculated as the ratio of the minimum costs required by the farm to produce a given level of outputs and the actual costs of the farm adjusted for TE. Economic Efficiency (EE) is the product of both TE and AE.

Data and Variables for the Study

In this study, six input variables and one output variable are considered for efficiency measurement. The inputs variables are human (Man-days), bullock (Pair days), machine labour (hours), seed (Kg), fertiliser (Kg) FYM (tons), except water in rainfed situation. Similar inputs in addition with water (per acre inch) were considered as inputs in physical quantity for canal and borewell situation to analysing the technical efficiency.

Similar inputs with their cost were considered to check the allocative and cost efficiency using data envelopment analysis.

Mathematical form of data envelopment analysis as follows

$Min_{\theta}, \lambda\ ^{\theta}$

Subject to

$-y_i + Y\lambda \geq 0$

$_{\theta}X_i - X\lambda \geq 0$

$\lambda \geq 0$

Where,

y_i is a vector (m × 1) of output of the i^{th} 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.

Output (Y) was used in present case and total Human labour (man days), Bullock labour (pair days), Machine labour (hours), seeds (kg), Fertilizers (Kg), farm yard manure (tons), and water (per acre inch) only for irrigated crops. Similarly, this is performed for other crops cotton (Canal), Cotton (Borewell), Paddy (Canal), Redgram (Rainfed). The model's analysis was solved using the DEAP version 2.1 taking an input orientation to obtain the efficiency levels.

Factors determining the technical efficiency of crops

To analyze the factors determining the technical efficiency of crops, regression analysis was attempted, considering the technical efficiency score as dependent variable (output per farm) and human labour, bullock, machine, seed, fertilizer, FYM and quantity of water used in the case of irrigated in crops as independent variables.

The empirical model was:

$Y = aX_1 + bX_2 + cX_3 + dX_4 + eX_5 + fX_6 + gX_7 + e$

Where,

Y = Technical efficiency

X_1 = Human labour (man days)

X_2 = Bullock labour (pair days)

X_3 = Machine labour (hours)

X_4 = Seed (kg)

X_5 = Fertilizers (kg)

X_6 = FYM (tons)

X_7 = water applied (acre inches) for irrigated crops

Similarly, procedure and mathematical form was also followed in other crops applicable to cotton (rainfed), Cotton (Borewell), Paddy (Canal), Redgram (Rainfed).

Estimation of allocative and cost efficiency (economic efficiency)

If one has price information and is willing to consider a behavioral objective, such as cost minimization or revenue maximization, then one can measure both technical and allocative efficiencies. One would run the following cost minimization DEA for estimation of cost efficiency (or economic efficiency) as follows:

$Min\ \lambda, X_i^*\ \ W_i X_i^*$,

Subject to

$-y_i + Y\lambda \geq 0$,

$X_i^* - X\lambda \geq 0$,

$N_1\lambda \geq 1$

$\lambda \geq 0$

Where,

Wi is a vector of input prices for the i^{th} Producing Farms (TPF),

X_i is the cost minimizing vector of input quantities for the i^{th} TPF (which is calculated by the LP),

Given the input prices Wi and the output levels Yi. The total cost efficiency (CE) or economic efficiency of the i^{th} TPF would be calculated as

$CE = W_iX_i^* / W_iX_i$.

i.e., the ratio of minimum cost to observed cost. One can then use equation12to calculate the allocative efficiency residually as

AE= CE/TE.

Note that this procedure will include any slacks into the allocative efficiency measure. This is often justified on the grounds that slack reflects an appropriate input mix.

Result and Discussion

Technical, allocative and economic efficiency of farms

Technical, allocative and cost efficiency (economic efficiency) level of different crops under different situation were estimated by Data Envelopment Analysis (DEA). To obtain the efficient level of each of the production farms DEA model (input oriented) was used under the assumption of Constant Returns to Scale (CRS) which operates in perfect competition. The results of technical, allocative, and cost efficiency are presented under below. Further, the criteria used by Ferreira (2005) was used in the present study to decide the cut off score for the efficient firms. The firms operating at 0.90 or more were considered as efficient firms.

Cotton production in Rainfed situation

Technical, allocative, cost efficiency of farmers in cotton production are presented in the [Table-1]. Thirty four percent of farmers producing cotton crops in rainfed situation have technical efficiency score of 0.5. About 95 percent of farmers have allocative efficiency below 0.5 and 98 percent of the farmers have economic efficiency below 0.5. In rainfed cotton, farmers scored low even in technical efficiency with a score of 0.63, much poorer in allocative efficiency resulting in very poor economic efficiency level of 0.19. Therefore, the results point to the necessity of training farmers in both technical and allocative efficiency in the use of inputs in rainfed cotton.

Table-1 *Technical, allocative and economic efficiency of farmers in cotton production in rainfed situation*

Efficiency score	Technical efficiency	Allocative efficiency	Economic efficiency
<0.5	16(34.04)	45(95.74)	46(97.87)
0.5-0.6	9(19.14)	0	0
0.6-0.7	4(8.51)	1(2.12)	0
0.7-0.8	2(4.25)	0	0
0.8-0.9	4(8.51)	1(2.12)	1(2.12)
0.9-1.00	12(25.53)	0	0
Total	47(100)	47	47
Mean	0.631	0.291	0.19

Note *Figures in Parenthesis are percentages, (Y) =Cotton output per farm (quintal), Inputs considered =Human labour, Bullock labour, Machine labour, Seed, Fertilizers, FYM.

Cotton production in Borewell situation

The results of Technical, allocative and cost efficiency of cotton production in borewell situations are presented [Table-2]. The results showed that 77, 27and 92 percent of the farmers have technical, allocative and cost efficiency score below 0.5 and only 3.8 percent of farmers have efficiency levels above 0.9. Comparing the technical efficiency of farmers in rainfed cotton with borewell cotton, it is puzzling to note that borewell cotton farmers are very poor technical efficiency compared with rainfed cotton. However, their allocative efficiency was higher at 0.609 compared with the low allocative efficiency of 0.29 for rainfed cotton farmers. Thus, for borewell cotton farmers since they implicitly incur the cost of groundwater, they have realized the economic importance of groundwater and accordingly their allocative efficiency is impressive. Thus, borewell cotton farmers need to be more technically trained than rainfed cotton farmers, while rainfed cotton farmers need to be trained to achieve allocative efficiency than borewell cotton farmers.

Paddy production in canal situation

The technical, allocative and cost efficiency score for the paddy production in canal situation are presented in [Table-3]. The results indicated that, 37.5 percent, 12.5 percent and 6.25 percent of farmers have efficiency scores above 0.9 in production of paddy in canal situation for technical, allocative and economic efficiency, respectively. The results also showed that, no farmer had technical efficiency score below 0.5, while 25 percent, 43.75 percent of the farmers were having the allocatively efficient score below 0.5. About 28 percent and 22 percent of the farmers were technically efficient with score ranges between 0.7-0.8 and 0.8-0.9, respectively. Paddy farmers in canal irrigation have impressive technical efficiency score of 0.84, but relatively poor allocative efficiency score of 0.64. Thus, these farmers need to be trained to achieve allocative efficiency in the use of inputs in order to improve their overall economic efficiency.

Table-2 *Technical, allocative and economic efficiency of farmers in cotton production in borewell situation*

Efficiency score	Technical efficiency	Allocative efficiency	Economic efficiency
<0.5	20 (76.9)	7(26.9)	24(92.3)
0.5-0.6	2 (7.7)	7(26.9)	0(0.0)
0.6-0.7	1(3.8)	4(15.4)	1(3.8)
0.7-0.8	1(3.8)	3(11.5)	0(0.0)
0.8-0.9	1(3.8)	4(15.4)	0(0.0)
0.9-1.00	1(3.8)	1(3.8)	1(3.8)
Total	26	26	26
Mean	0.393	0.609	0.254

Note: Figures in parenthesis are percentages of the total sample size, (Y) =Cotton output per farm (quintal), Inputs considered =Human labour, Bullock labour, Machine labour, Seed, Fertilizers, FYM, Water

Table-3 *Technical, allocative and economic efficiency of farmers in paddy production in canal situation*

Efficiency score	Technical efficiency	Allocative efficiency	Economic efficiency
<0.5	0(0)	8(25)	14(43.75)
0.5-0.6	1(3.125)	6(3.125)	7(21.87)
0.6-0.7	3(9.375)	6(18.75)	4(12.5)
0.7-0.8	9(28.12)	4(12.5)	4(12.5)
0.8-0.9	7(21.870	4(12.5)	1(3.125)
0.9-1.00	12(37.5)	4(12.5)	2(6.25)
Total	32	32	32
Mean	0.844	0.64	0.54

Note: (Y) =Paddy output per farm (quintal), Inputs considered =Human labour, Bullock labour, Machine labour, Seed, Fertilizers, FYM, Water.

Redgram production in Rainfed situation

The range of technical, allocative, cost efficiency for Redgram cultivated in rainfed situation estimated and results are presented in [Table-4]. The results showed that, the redgram production farmers in rainfed situation have the highest average technical efficiency than allocative and economic efficiency given by 0.902, 0.457 and 0.41, respectively. About 65 percent of red gram farmers have technical efficiency score above 0.90 and only 10 percent and 5 percent of farmers have allocative and cost efficiency score of above 0.90. None of the farmers have technical efficiency with a score below 0.50 and most of the farmers have allocative (55 percent) and cost efficiency (70 percent) with a score below 0.5. Thus, most of the farmers scored high in technical efficiency, but scored poorly in allocative and economic efficiency. This shows that farmers need to be well educated regarding their allocative efficiency as they are already well equipped technically.

Table-4 *Technical, allocative and economic efficiency of farmers in Redgram production in Rainfed situation*

Efficiency score	Technical efficiency	Allocative efficiency	Economic efficiency
<0.50	0(0)	11(55)	14(70)
0.5-0.6	0(0)	4(20)	1(5)
0.6-0.7	2(10)	1(5)	2(10)
0.7-0.8	2(10)	1(5)	1(5)
0.8-0.9	3(15)	1(5)	1(5)
0.9-1.00	13(65)	2(10)	1(5)
Total	20(100)	20(100)	20(100)
Average	0.902	0.457	0.41

Note: Figures in Parenthesis are percentages, (Y) =Redgram output per farm (quintal), Inputs considered =Human labour, Bullock labour, Machine labour, Seed, Fertilizers, FYM.

Conclusion

Crops cultivated by farmers with irrigation namely paddy (0.64) and cotton (0.60) had higher allocative efficiency than crops cultivated in rainfed situation namely redgram (0.41). All the crops had higher technical efficiency score than allocative and economic efficiency except paddy.

Application of research: Study shows that, while Universities and State Agriculture departments have emphasized greater role providing technical inputs for farmers, there has been little effort in training farmers in the field of allocative efficiency which is a vital factor determining economic efficiency of crops.

Research Category: Agricultural Economics

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****Research Guide or Chairperson of research: Dr Jaganath Olekar**
University: Department of Agricultural Economics, University of Agricultural Sciences, Bengaluru, 56 0065, Karnataka, India
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Study area / Sample Collection: Manvi and Raichur taluks of Raichur district in NEDZ of Karnataka

Cultivar / Variety / Breed name: Cotton, Paddy, Redgram

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