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TECHNICAL AND RESOURCE USE EFFICIENCY IN CUT FLOWER PRODUCTION IN INDIA : AN EMPIRICAL ASSESSMENT

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Abstract

This paper presents the production and technical efficiency of cut flowers in India. Demand of cut flowers are discussed in brief initially and the results were analyzed empirically using production function and data development analysis technique. Cut flowers namely Rose, Gerbaria and Carnation were selected for the study. The study revealed that there exists an over utilization of human labour in the study area. From the results of technical efficiency, it is observed that most of the farmers belongs to least efficient category. Moreover, higher price fluctuation was the major constraint.

Key words: Rose, Gerbaria, Carnation, Efficiency, Demand.

Introduction

Floriculture is the art and knowledge of growing flowers to perfection. About two decades back or so, the floriculture was just a pastime of rich people and hobby of flower lovers, Geetha and Lissey, 2018 but now it has opened a new vista in agri-business, commercial floriculture (Geetha and Lissey, 2018). The demand for flowers and ornamental plants for different needs like religious, official ceremonies, parties, house decoration, weddings and funerals is on the rise. This demand for fresh flowers and plants is increasing world-wide over the coming years. Cut-flowers and potted plants have an almost 80 percent share of the world trade among ornamental plants. In Pakistan, about six percent of arable land is under horticultural crops, out of which only 0.5 percent is under floriculture. Total local production of cut-flowers is estimated to be 10,000-12,000 tons per annum (M. Usman *et al.,* 2015). B.P. Pal, (2001) in his book named “The Rose in India” has comments on Marketing of rose. He referred that the government undertaking the State Trading Corporation decided to sponsor a project on the export of cut roses to the Western European market. The awareness on usage of cut flowers for various occasions has raised the demand for cut flowers in the market. The production of cut flowers was gone up to 6,902 million stems during 2011 from 2,071 million stem in 2007 and this was due to the improvement in the standard of living and quality of life which ultimately increase the growth of domestic and export markets (Jafar Naqvi, 2011). The availability of natural resources like favourable and diverse climatic conditions permit production and availability of a large variety of flower crops round the year. Cut flower can be profitable if done efficiently. Armitrage, (2002) in his report concluded, overall cost might be broken down into variable costs (cost per crop) and overhead (cost per acre). The production and marketing of cut flowers is confronted with different location specific problems and the cut flower producers are often facing imperfect market which necessitates for undertaking a systematic integrated and in- depth study on the production and marketing of flowers. With this end in view, the present study is undertaken to address problems in the production and marketing of cut flower crops in Hosur block of Krishnagiri district and to elicit the possibilities and potentialities for improving the production and marketing of cut flowers in the region.

Objective of the Study

The Specific objective of the paper is :

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1. To analyze the production efficiency of cut flowers in the study area

2. To analyze the technical efficiency in cut flower production.

Materials and Methods

Hosur block in Krishnagiri district was purposively for the study. Since the area under cut flower crops in this block was found to the highest with 325.57 hectares among all the blocks present in Krishnagiri district. Moreover, the whole sale flower market for entire Krishnagiri district is located at Hosur and hence this block was selected. The major cut flower growing areas in krishnagiri district are Hosur (325.57 ha), Thally (154.80 ha), Keelamangalam (110.63 ha), Veppanapalli (20.87ha), Krishnagiri (15 ha), Bargur, Kaveripattinam., Mathur, Uthangarai.

Hosur block consists of 30 revenue villages. A two-stage random sampling method was adopted to select the sample farms. At first stage, twelve revenue villages were selected at random. At second stage, all the farmers in the each of the selected revenue villages were arranged and 10 farmers were selected at random from each of the selected twelve revenue villages, thus constituting a total sample size of 120 farmers. The villages selected for the study are Achettipalli, Avalapalli, Bagalur, Baduthapalli, Echangur, Mathigiri, Muthur, Muthali, Onnalvadi, Poonapalli, Sevagapalli, Zeemangalam.

The selected sample farmers were personally contacted and the required primary data were collected through interview method by using the pre tested interview schedules. The objectives and importance of the study were explained to the respondents briefly to solicit their co-operation.

Tools of Functional analysis

1. Cobb Douglas production function: Cobb Douglas production function was employed to evaluate the resource use efficiency in cut flower crop production. Cobb-Douglas production function was specified after examining the scatter diagrams for the output and inputs used in the production of Rose, Gerbera and Carnation.

The Cobb Douglas regression function specified for different flower crops is given below:

$$Y = a\, X1b1\, X2b2\, X3b3\, X4b4\, X5b5\, X6b6\, X7b7\, \mu t$$

Where,

Y = Yield of flower crop (in kilogram /hectare)

X_1 = Nitrogen (in kilogram/hectare)

X_2 = Phosphorus (in kilogram/hectare)

X_3 = Potassium (in kilogram/ hectare)

X_4 = Plant Protection chemicals (in rupees/hectare)

X_5 = Machine power (in hours/hectare)

X_6 = Human power (in man days /hectare)

X_7 = Miscellaneous cost (in Rupees/hectare)

μ_t = Error term

a = Intercept / Regression constant

b_1 …. b_7 = Regression co-efficient

2. Economic efficiency: Estimate of the parameters β_1, β_{10} were elasticity of Y with respect of j[th] input. The marginal products of the resources were derived from these elasticity coefficients. The marginal value products of significant inputs were worked out at its geometric mean level by using the formula.

$$MVPj = \beta j \frac{\overline{Y}}{\overline{Xj}} x\, P_y$$

where,

$MVPj$ - Marginal value product of the 'j[th] product

$\overline{Y}$ - Estimated level of yield around the geometric mean of input

$\overline{Xj}$ - Geometric mean of input 'j'

βj - Estimated co-efficient of elasticity

P_y - Price of output

The economic efficiency of resource use and the Marginal Value Products (MVP) of each input were compared with its Marginal Input Cost (MIC) in order to estimate the resource use efficiency of respective input. Equality of MVPj to the MIC of input 'j' indicates the optimum resource use of a particular input. Ratio of MVPj to the MIC of input 'j' indicated the degree of resource use efficiency.

3. Data Envelopment Analysis: The DEA method is frontier method that does not require specification of a functional or distributional form and can accommodate scale issues. This approach was first used by Farrell, (1957) as a piecewise linear convex hull approach to frontier estimation. This approach did not receive wide attention till the publication of the paper by Charnes *et al*., (1979), which coined the term data envelopment analysis. The DEA was applied by using both classic model 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. Under the assumptions of constant return to scale, the linear programming model for measuring the efficiency of crop farms are (Coelli *et al*., 1998):

$$\begin{aligned} &\text{Min}_{\theta,\lambda}\ \theta \\ &\text{Subject to}\quad -y\,i + Y\lambda \geq 0 \\ &\qquad \theta x\,i - X\lambda \geq 0 \\ &\qquad \lambda \geq 0 \qquad (1) \end{aligned}$$

Where,

y_i is a vector (m × 1) of output of the i[th] Crop Producing Farms,

x_i is vector (k × 1) of inputs of the i[th] Crop Producing Farms,

Y is a output matrix (n × m) for n Crop Producing Farms,

X is the input matrix (n × k) Crop Producing Farms,

θ is the efficiency score, a scalar whose value will be the efficiency measure for

the i[th] crop producing farms. If θ = 1, crop producing farms will be efficient, otherwise, it will be inefficient and

λ is a vector (n × 1) whose values are calculated to obtain the optimum solution.

The measure of technical efficiency obtained in the model with variable return is also named as "pure technical efficiency", as it is free of scale effects. The following linear programming model estimated it:

$$\min_{\theta,\lambda} \theta$$

$$\text{Subject to} \quad -y\,i + Y\lambda \geq 0$$
$$\theta x\,i - X\lambda \geq 0$$
$$N1\,\lambda = 1$$
$$\lambda \geq 0 \qquad (2)$$

For an inefficient crop producing farms y values will be weights used in the linear combination of other, efficient crop producing farms, which influenced the projection of the inefficient crop producing farms on calculated the frontier.

Where, N_1 is a vector (n × 1) of ones.

When there are differences between the values of efficiency scores in the models CRS and VRS, scale inefficiency is confirmed, indicating that return to scale is variable, *i.e.* it can be increasing or decreasing (Fare and Grosskopf, 1994). The scale efficiency values for each analysed unit can be obtained by the ratio between the scores for technical efficiency with constant and variable returns as follows:

$$\theta s = \theta\, CRS\,(XK,\ YK) \,/\, \theta\, VRS\,(XK,\ YK) \qquad (3)$$

where

$\theta\, CRS\,(XK, YK)$ = Technical efficiency for the model with constant returns,

$\theta\, VRS\,(XK, YK)$ = Technical efficiency for the model with variable returns and

θs = Scale efficiency.

It was pointed out that model (2) makes no distinction as to whether crop producing forms is operating in the range of increasing or decreasing returns (Coelli *et al*., 1998). The only information one has is that if the value obtained by calculating in the scale efficiency in Equation (3) is equal to one, the crop producing farms will be operating with constant returns to scale. However, when θs is smaller than one, increasing or decreasing return can occur. Therefore, to understand the nature of scale inefficiency, it is necessary to consider another problem of linear programming, *i.e.* the convexity constraint of model (2), $N_1\lambda = 1$, is replaced by $N_1\lambda \leq 1$ for the case of non-increasing returns, or by $N_1\ \lambda \geq 1$, for the model with non-decreasing returns. Therefore, in this work, the following models were also used for measuring the nature of efficiency.

Non-increasing returns:

$$\min_{\theta,\lambda} \theta$$

$$\text{Subject to} \quad -y\,i + Y\lambda \geq 0$$
$$\theta x\,i - X\lambda \geq 0$$
$$N1\,\lambda \leq 1$$
$$\lambda \geq 0 \qquad (4)$$

Non-decreasing returns:

$$\min_{\theta,\lambda} \theta$$

$$\text{Subject to} \quad -y\,i + Y\lambda \geq 0$$
$$\theta x\,i - X\lambda \geq 0$$
$$N1\,\lambda \geq 1$$
$$\lambda \geq 0 \qquad (5)$$

It is to be stated here that all the above model should be solved n times, *i.e.* the model is solved for each crop producing farms in the sample.

Production was used as an output (Y) in the present case and seeds/planting materials, farmyard manure (tones/ha), chemical fertilizer (Kg/ha), human labour (mandays/ha), machine labour (hrs/ha) and plant protection chemicals (lit/ha) as inputs (X).

The computer program DEAP version 2.1 developed by T.J. Coelli, Centre for efficiency and productivity Analysis, University of New England, Australia, was used for the estimation of efficiencies in production.

It is to be stated here that all the above model should be solved n times, *i.e.* the model is solved for each crop producing farms in the sample.

Production was used as an output (Y) in the present case and seeds/planting materials, farmyard manure (tones/ha), chemical fertilizer (Kg/ha), human labour (man days/ha), machine labour (hrs/ha) and plant protection chemicals (lit/ha) as inputs (X).

Results and Discussion

Resource use Efficiency in Rose Production

The estimated Cobb-Douglas production function for Rose, Gerbaria and Carnation is furnished in table 1. It could be seen from the table that the coefficient of adjusted multiple determination (R^2) was significant with the value of 0.87, indicating that the variables included in the model explained 88 percent of variation in the yield of Rose. The regression constant was positive with a value of 2.92. In log linear production function, the coefficients of the variables represent the production elasticity of the resources used. The coefficient of manures and fertilizers and plant protection chemicals were positive and significant at one percent level with the values of 0.24 and 0.73 respectively, indicating that an increase in the usage of manures and fertilizers and plant protection chemicals by one percent from the existing mean level, *ceteris paribus* would increase the yield of Rose by 0.24 and 0.73 percent, respectively. The result indicated that positive yield response to the usage of inputs such as manures and fertilizers and plant protection chemicals in Rose production.

The coefficient of maintenance cost was positive and significant at five percent level with a value of 0.11, indicating that one percent increase in maintenance cost usage from the existing mean level, *ceteris paribus,* would increase the yield of Rose by 0.11 percent. On the other hand, one percent increase in human labour would reduce the Rose yield by 0.04 percent, *ceteris paribus,* because the elasticity of human labour was found to be negatively significant.

The marginal value product (MVP), marginal input cost (MIC) and the ratio between the two were worked out for each of input to understand the economic

Table 1: Resource use Efficiency in Rose production.

S. No.	Variables	Regression coefficient		
		Rose	Gerbera	Carnation
1.	Regression Constant	2.92** (0.57)	0.66** (1.93)	1.85** (0.35)
2.	Planting material (No/ha)	0.02 (0.06)	0.44 (0.07)	1.00 (0.08)
3.	Manures and fertilizers (Rs/ha)	0.24** (0.23)	0.006 (0.23)	-0.28 (0.21)
4.	Human Labour (man days/ ha)	-0.04* (0.11)	0.46** (0.17)	0.22** (0.07)
5.	Plant protection chemicals (Rs/ha)	0.73** (0.17)	0.37* (0.18)	0.04** (0.21)
6.	Maintenance cost (Rs/ha)	0.11* (0.17)	0.17** (0.32)	0.02* (0.04)

(*Figures in the parenthesis are percentage to total*)

$R^2 = 0.88$	$\bar{R}^2 = 0.87$	F- ratio = 51.65	N = 40
$R^2 = 0.75$	$\bar{R}^2 = 0.65$	F- ratio = 18.65	N = 40
$R^2 = 0.93$	$\bar{R}^2 = 0.92$	F- ratio = 99.72	N = 40

** Significant at 1 percent level; * Significant at 5 percent level; NS is Non-significant

efficiency of input use in Rose production. The input is used efficiently if the ratio between MVP and MIC is one. A ratio of more-than-one and less-than-one would indicate under-utilization and over-utilization of the resource, respectively. The results are given in table 1.

It could be seen from the table 1, that the ratio between MVP and MIC of manures and fertilizer, plant protection chemicals and maintenance cost was found to be greater than one. It indicated that these resources were underutilized in the above indicated and there exists a possibility for enhancing the yield of Rose by increasing the respective input from the existing mean level usage. Over utilisation of Human labour was observed as MIC is greater than MVP with a ratio of -4.56 which was less than one. This indicated the need for reducing the usage of human labour from the existing mean level.

Resource use Efficiency in Gerbaria Production

The estimated Cobb-Douglas production function for Gerbera is furnished in table 1. It could be seen from the table that the coefficient of adjusted multiple determination (R^2) was significant with the value of 0.65, indicating that the variables included in the model explained 65 percent of variation in the yield of Gerbera. The regression constant was positive with a value of 0.66. In log linear production function, the coefficients of the variables represent the production elasticity of the resources used. The coefficient of human labour and maintenance cost were positive and significant at one percent level with the values of 0.46 and 0.17 respectively, indicating that an increase in the usage of human labour and maintenance cost by one percent from the existing mean level, *ceteris paribus.* would increase the yield of Gerbera by 0.46 and 0.17 percent, respectively. The result indicated that positive yield response to the usage of inputs such as human labour and maintenance cost in Gerbera production.

The coefficient of plant protection chemicals was positive and significant at five percent level with a value of 0.37, indicating that one percent increase in plant protection chemicals usage from the existing mean level, *ceteris paribus,* would increase the yield of Gerbera by 0.37 percent respectively.

The marginal value product (MVP), marginal input cost (MIC) and the ratio between the two were worked out for each of input to understand the economic efficiency of input use in Gerbera production. The results are given in table 2.

It could be seen from the table 2, that the ratio between MVP and MIC of Plant protection chemicals and maintenance cost was found to be greater than one. It indicated that these resources are underutilized and there exists a possibility for enhancing the yield of Gerbera

Table 2: Economic efficiency of resource use of Rose production.

S. No.	Variables	Regression Coefficient			MVP			MIC			MVP/MIC		
		R	G	C	R	G	C	R	G	C	R	G	C
1	Human Labour (man days/ ha)	-0.04	0.46	0.22	-1.14	15.75	7.60	250	250	250	-4.56	0.06	0.03
2	Plant protection chemicals (Rs/ha)	0.73	0.37	0.04	3.36	2.07	2.40	14014.71	11363.64	15014.29	2.39	1.82	1.59
3	Maintenance cost (Rs/ha) (Rs/ha)	0.11	0.17	0.02	5.64	5.73	9.50	12563.73	18951.05	19006.74	4.48	3.02	4.99

by increasing the respective input from the existing mean level usage. Over utilization of Human labour was observed as MIC is greater than MVP with a ratio of 0.06. This indicated the need for reducing the usage of Human labour from the existing mean level.

The estimated Cobb-Douglas production function for Carnation is furnished in table 1. It could be seen from the table that the coefficient of adjusted multiple determination (R^2) was significant with the value of 0.92, indicating that the variables included in the model explained 93 percent of variation in the yield of Carnation. The regression constant was positive with a value of 1.85. The coefficient of human labour and plant protection chemicals were positive and significant at one percent level with the values of 0.22 and 0.04 respectively, indicating that an increase in the usage of human labour and plant protection chemicals by one percent from the existing mean level, *ceteris paribus* would increase the yield of Carnation by 0.22 and 0.04 percent, respectively. The result indicated that positive yield response to the usage of inputs such as human labour and plant protection chemicals in Carnation production. The coefficient of maintenance cost was positive and significant at five percent level with a value of 0.02, indicating that one percent increase in maintenance cost usage from the existing mean level, *ceteris paribus,* would increase the yield of Carnation by 0.02 percent respectively.

The marginal value product (MVP), marginal input cost (MIC) and the ratio between the two were worked out for each of input to understand the economic efficiency of input use in Carnation production. The results are given in table 2. It could be seen from the table 2, that the ratio between MVP and MIC of protection chemicals and maintenance cost was found to be greater than one. It indicated that the sub optimal usage of these resources and there exists a possibility for enhancing the yield of Carnation by increasing the respective input from the existing mean level usage. Over utilisation of human labour was observed as MIC is greater than MVP with a ratio of 0.03. This indicated the need for reducing the usage of human labour from the existing mean level.

Technical efficiency in Rose, Gerbera and Carnation farms

It could be observed from the table 3 that the level of technical efficiency for Rose farm ranged from 48.70 to 100.00 with mean efficiency of 85.10 percent in constant return to scale. The mean level of technical efficiency indicated that 14.90 percent of Rose farmers are falling short of the maximum possible level of technology. Scale of efficiency ranged from 70.60 to 100.00 with mean efficiency of 92.90 percent. For Gerbera, the level of technical efficiency for Gerbera farm ranged from 60.30 to 100.00 with mean efficiency of 83.70 percent. The mean level of technical efficiency indicated that 16.30 percent of Gerbera farmers are falling short of the maximum possible level of technology. Scale of efficiency ranged from 55.40 to 100.00 with mean efficiency of 87.10 percent.

For Carnation, the level of technical efficiency ranged from 56.00 to 100.00 with mean efficiency of 79.20 percent. The mean level of technical efficiency indicated that 20.80 percent of Carnation farmers are falling short of the maximum possible level of technology. Scale efficiency ranged from 63.00 to 100.00 with mean efficiency of 90.70 percent. Similar high technical efficiency was reported by Sridhar, (2013) who showed that the mean technical efficiency score of organic turmeric and inorganic turmeric was 96.36 percent and 98.21 percent respectively. Saranya, (2014) also reported high technical efficiency of 94.00 percent and 95.00 percent respectively in sugarcane and groundnut.

The frequency distribution of technical and scale efficiency measures for Rose, Gerbera and Carnation is furnished in table 4. The technical efficiency measures for Roses indicated that most farmers belonged to the least efficient category (<90 percent) with a proportion of 62.50 percent to total followed by high efficient category (>98 percent) with a proportion of 20.00 percent Rose farmers. The rest 17.50 percent of Rose farmers belonged to the medium efficient category (90-98

Table 3: Technical Efficiency of major cut flowers.

S. No.	Parti-culars	Rose		Gerbera		Carnation	
		TE	SE	TE	SE	TE	SE
1	Mean	85.10	92.90	83.70	87.10	79.20	90.70
2	Standard deviation	0.13	0.07	0.13	0.10	0.18	0.09
3	Minimum	0.487	0.706	0.603	0.554	0.560	0.632
4	Maximum	1.00	1.00	1.00	1.00	1.00	1.00

Table 4: Frequency distribution of major cut flowers based on Technical Efficiency.

Technical efficiency class (percent)	Rose		Gerbera		Carnation	
	TE	SE	TE	SE	TE	SE
<90	25 (62.50)	12 (30.00)	26 (65.00)	24 (60.00)	28 (70.00)	16 (40.00)
90-98	7 (17.50)	14 (35.00)	6 (15.00)	5 (12.50)	3 (7.50)	10 (25.00)
>98	8 (20.00)	14 (35.00)	8 (20.00)	11 (27.50)	9 (22.50)	14 (35.00)
Total	40 (100.00)	40 (100.00)	40 (100.00)	40 (100.00)	40 (100.00)	40 (100.00)
Mean technical efficiency	85.10	92.90	83.70	87.10	79.20	90.70

percent). The scale efficiency measures indicated the farmers belonging to the high efficient category and medium efficient category occupied the highest proportion of 35.00 percent and 35.00 percent respectively followed by Rose farmers belonging to least efficient category with a proportion 30.00 percent.

The technical efficiency measures for Gerbera indicated that most farmers belonged to the least efficient category (<90 percent) with a proportion of 65.00 percent to total followed by high efficient category (>98 percent) with a proportion of 20.00 percent Gerbera farmers. The rest 15.00 percent of Gerbera farmers belonged to the medium efficient category (90-98 percent) of constant return to scale. The scale efficiency measures indicated the same distribution pattern as under technical efficiency with farmers belonging to the least efficient category with a highest proportion of 60.00 percent followed by Gerbera farmers belonging to high efficient category with a proportion of 27.50 percent and lastly the medium efficient farmers with a proportion of 12.50 percent.

The technical efficiency measures for Carnation indicated that most farmers belonged to the least efficient category (<90 percent) with a proportion of 70.00 percent to total followed by high efficient category (>98 percent) with a proportion of 22.50 percent Gerbera farmers. The rest 7.50 percent of Carnation farmers belonged to the medium efficient category (90-98 percent). The scale of efficiency measures indicated the same distribution pattern as under technical efficiency with farmers belonging to the least efficient category with a highest proportion of 40.00 percent followed by Carnation farmers belonging to high efficient category with a proportion of 35.00 percent and lastly the medium efficient farmers with a proportion of 25.00 percent. The results showed that majority of farmers of Rose, Gerbera and Carnation belonged to the least efficient category in spite of their high mean technical efficiency. With regard to scale efficiency also, majority of Gerbera and Carnation farmers belonged to least efficient category.

Conclusion

It could be observed from the table that in case of Rose and Gerbaria, there exist an over utilization of human labour where MIC is greater than MVP. This indicates the need for reducing the usage of human labour from the existing mean level. In case of carnation over utilisation of human labour was observed as MIC is greater than MVP with a ratio of 0.03. This also indicates the need for reducing the usage of human labour from the existing mean level. It could also be concluded from the results of technical efficiency that for Rose, Gerbera and Carnation, the most proportion of the farmers belonged to least efficient category (less than 90.00 percent) followed by high efficient category (more than 98.00 percent) and lastly with medium efficient category of less than (90.00 to 98.00 percent). Higher price fluctuation was the major constraint in the Rose, Gerbera and Carnation. The price forecast of cut flowers must be regularly communicated by the action market of Bengaluru to the farmer. Also, Carnation growers fell under high cost zone with a proportion zone and hence this crop required location specific techniques to improve the situation. Hence necessary efforts should be undertaken by the horticulture department to conduct appropriate training programmes to cut flower farmers to attain the frontier yield.

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