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Research Article

RESOURCE USE EFFICIENCY OF LONG STAPLE COTTON CULTIVATION IN GUJARAT

DAUD MOHAMMAD* AND SHIYANI R.L.
Department of Agricultural Economics, Junagadh Agriculture University, Moti Baug, Junagadh, 362001, Gujarat, India
*Corresponding Author: Email - dahmadzai@yahoo.com

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Abstract: The Cobb-Douglas production function was used to find out the functional relationship between input and output. Moreover, ratio of MVPs to factor price was used to find out the efficiency ratio or the resource use efficiency of long staple cotton in Gujarat. The necessary time series data were compiled from various official published sources for the period from 1980-81 to 2015-16. The results of Cobb-Douglas production function indicated that human labour, seeds and plant nutrition were found significant during the Overall Period. The summation of all the production co-efficient (0.57) was found to be statistically significant indicating a decreasing return to scale. It implies that adjustments are required in the use of resources for cotton production by farmers to increase the profitability of their long staple cotton crop. Further, the results showed the MVPs of human labour, bullock labour, seeds and plant protection chemicals were found to be underutilized during Overall Period so, the gross returns could be increased by using more of these resources while plant nutrition, irrigation and miscellaneous expenses were observed to be overutilized during Overall Period therefore, it is suggested the excess resources should be decreased to minimize loss.

Keywords: Long staple cotton, resource use efficiency, Cobb-Douglas production function, returns to scale, MVP

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Introduction

Cotton is one of the principal cash crops of India, contributing significantly to its economy and foreign exchange earnings. Cotton is one of the major commercial crops where 70 percent of the crop is under rainfed conditions. The area under cotton crop constitutes almost 9 percent of the total area under agriculture. This commercial crop is an important raw material for India's textile industry that is one of the largest and oldest industries accounting for about 14 percent of the national industrial production and contribution about 5 percent to GDP [1]. India produces a wide range of cotton varieties, which are grouped into five categories on the basis of their staple length. There are; (a) short staple (b) superior medium staple (d) long staple (e) superior long staple. The northwestern belt of India comprising of Punjab, Haryana and Rajasthan specializes mainly in short and medium staple varieties, while southern and western parts of India produce long and superior long staple varieties [2]. The increase in agricultural production during the last decade was largely a result of growth in productivity [3]. An increase of more than 50 percent in cotton acreage over this period indicated that the farmers have exhibited an increasing preference for cotton over pulses and oilseeds. The average annual growth in yield in the case of cotton between 2004-05 and 2014-15 was around 45 percent. The current study entitled the resource use efficiency in long staple cotton cultivation aim is to know the appropriate use of resources to get optimal profit.

Materials and Methods

Resource use efficiency

Resource use efficiency refers to how efficiently the resources are utilized in production of long staple cotton. The resource use efficiency was worked out in the following steps

1. The data were made to stationary
2. Analysis was carried out

Cobb-Douglas production function was used to estimate the effects of various inputs in the production of long staple cotton in consultation with the previous studies. Data pertaining to the entire study period (*i.e.*, 1980-81 to 2015-16) concerning all the variables of CACP data which are likely to have an impact on long staple cotton production was taken in the analysis. All variables were expressed in monetary terms. To determine the contribution of the technical factors in the production process, the following specification of the model was applied:

$$Y = {}_aX_1^{b1}X_2^{b2}X_3^{b3}X_4^{b4}X_5^{b5}X_6^{b6}X_7^{b7}\ e^u \qquad (1)$$

Where,

Y = gross returns from production (Rs. / ha)
X1 = human labour cost (Rs. / ha);
X2 = bullock labour (Rs. /ha);
X3 = seed cost (Rs. /ha);
X4 = plant nutrition cost (Rs. / ha);
X5 = plant protection cost (Rs. / ha);
X6 = irrigation cost (Rs. /ha);
X7 = other cost (Rs. /ha);
$^b{}_1$ to $^b{}_7$ = parameters to be estimated;
U = error term.

For the purpose of estimation, the equation was transformed in logarithmic form,

$$lnY = \ln a + b_1lnX_1 + b_2lnX_2 + b_3\ lnX_3 + b_4lnX_4 + b_5lnX_5 + b_6lnX_6 + b_7X_7 + U \qquad (2)$$

However, the production model specification as given in equation 25 will be of use only when the equation is stationary. In the absence of stationarity, the estimated relationship may be spurious without any significant meaning. The relationship is also expected to hold good when the model specification is found stationary at the same level of differencing. All the components of the model specification were first checked for stationary by using Augmented Dicky-Fuller (ADF) unit-root test. The test was applied after running the regression of the following form:

$$Y_t = \alpha_0 + \delta Y_{t-1} + \alpha_I \sum \Delta Y_{t-i} + \varepsilon_t \quad (3)$$

Where,

Y_t = Price of a commodity in a given market at time't';

$\Delta Y_{t-I} = Y_{t-1} - Y_{t-2}$;

ε_t = Pure white noise error-term.

Y_t = Refers to the gross returns from long staple cotton production as well as all the technical factors involved in long staple cotton production which were all expressed in Rs./ha.

Specification of variables

Dependent variable

The gross return from long staple cotton production obtained in rupees per hectare was taken as dependent variable.

Independent variables

Human labour cost (X_1)

This input consists of both family labour and hired human labour in which family labour are employed to perform farm operations and it has been duly represented in CACP data and the hired human labour is expressed in terms man days of eight hours each that includes the cost of all hired human labour utilized for performing crop production activities right from preparation of land to threshing.

Bullock labour cost (X_2)

Bullock labour used for different farm operations has been considered as a separate variable and its cost has been measured in Rs./ha. A pair day refers to eight hours of work by one pair of bullocks and the cost incurred for bullock labour is referred to as bullock labour cost.

Seed cost (X_3)

The cost incurred in buying the seeds of long staple cotton from the market it has been measured in Rs./ha.

Plant nutrition cost (X_4)

This included both chemical fertilizer cost and manure cost in which chemical fertilizer cost incurred in the purchase of chemical fertilizers for effective growth of long staple cotton from the market has been expressed in Rs./ha and manure variable is measured in physical units and expressed in Rs./ha that is measured in cartloads and one cartload refers to the quantity of manure in one bullock cart.

Plant protection cost (X_5)

This input has been expressed in Rs./ha. It included cost of all plant protection chemicals that were used from sowing to before harvesting operations.

Irrigation cost (X_6)

This includes the cost of irrigation that is used for application in the field to the long staple cotton crop.

Other cost (X_7)

This variable cost included all the managerial costs incurred in cultivation of long staple cotton crop.

Calculation of Returns to scale

Returns to scale indicates what would happen to output if all inputs were increased simultaneously. The sum of bi is then used as an indicator of returns to scale. The constant, increasing and decreasing returns to scale occur when the sum of coefficients equal to 1, > 1 and < 1value, respectively [4]. The 't' test for return to scale was computed by the following formula.

$$t = \frac{\sum bi - 1}{\text{S.E. of} \sum bi} \quad (4)$$

Where,

$\sum b_i$ = Sum of elasticities

Calculation of resource use efficiency

To accomplish the objective of profit maximization for efficient allocation of resources, one should use more of the variable resource so long as the value of the added production is greater than the cost of the added amount of the resource used in producing it. The efficiency was examined by comparing marginal value product (MVPs) with marginal factor cost (MFCs) of each variable input. By using the following economic formula, the resource efficiency of an input was calculated;

$$MVP/MFC = 1 \quad (5)$$

Decision rule

If r = 1, resource is efficiently utilized;

r > 1, resource is underutilized;

r < 1, resource is overutilized.

When marginal physical product is measured in monetary term then it is called Marginal Value Product (MVP). But in this model, MVP is estimated in terms of an additional rupee invested on individual inputs. According to Dhawan and Bansal, (1977) [5], the useful estimate of MVP is obtained by taking the geometric mean of the resources (xi) as well as the gross return. MVP is calculated by multiplying the coefficient of a given resource with the ratio of the geometric mean (GM) of gross return to the GM of the given resource. Thus,

$$MVP(x_i) = b_i * (Y/X_i) \quad (6)$$

Where,

b_i = Regression co-efficient;

Y = Mean value (GM) of gross return in Rs;

X_i = Mean value (GM) of different resources in Rs

I = (1, 2, 3…………..n)

GM = Geometric mean

The equation can also be written as;

$$dY/dX_i = b_i * (Y/X_i) \quad (7)$$

Where,

dY/dX_i = Marginal Value Product (MVP)

All the inputs and outputs were expressed in monetary terms, the cost of the inputs was taken as one rupee. The efficient production was represented by an index value of 1.0, while lower values indicate a greater degree of inefficiency. The ratio based on the estimated regression coefficients were used to estimate the relative efficiency of resource use (r)

$$r = MVP/MFC \quad (8)$$

Results and Discussion

Resource use efficiency

Resource use efficiency means how efficiently farmer can use his resources in production process. It is important to ensure efficient use of resources, because resources are always limited [6]. Resource use efficiency analysis was done only for Overall periods as it has sufficient observations to take care of degrees of freedom. The Augmented Dickey Fuller Test (ADF) is unit root test for stationarity and it is utilized for a larger and more complicated set of time series models. This test was carried out for Overall Period by detrending the data and the results are given in Appendices A and B. The results showed that only few variables were significant.

Cobb-Douglas production function

For calculating resource use efficiency in the current study, seven factors were taken into consideration which are namely human labour, bullock labour, seeds, plant nutrition, plant protection chemicals, irrigation and other expenses. Resource use efficiency was analyzed by using Cobb-Douglas production function and the results revealed that only few of the variables are found significant. OLS estimates of long staple cotton production using the Cobb-Douglas function during Overall Period are presented in [Table-1]. The estimated Cobb-Douglas production function shows a F value of 4.14 which is significant at ten percent level of significance [Table-1]. The value of the adjusted R2 was 0.39 which indicates that 39.27 percent of variability of gross returns could be explained by the explanatory variables used in the model. The summation of all the production co-efficient indicates returns to scale and the returns to scale were found to be significant with 0.57(<1) which means that production function exhibits a decreasing return to scale.

Table-1 OLS estimates of long staple cotton production using the Cobb-Douglas function during Overall Period

Variables	Coefficient	t-ratio	p-value
Human labour	0.8601**	2.8676	0.0079
Bullock labour	0.0997	0.7041	0.4874
Seeds	0.3175+	1.7095	0.0988
Plant nutrition	-0.7228*	-2.4558	0.0208
Plant protection chemicals	0.1439	0.7431	0.4639
Irrigation	-0.0266	-0.1655	0.8698
Miscellaneous	-0.1032	-0.7016	0.4889
R^2	0.5176	-	-
Adjusted R^2	0.3926	-	-
F-value	4.1391	-	-
Returns to scale	0.5685*	-	-

*Note: +, *, ** Indicates significant at 10%, * 5% and 1% level, respectively.*

Table-2 MVPs of inputs/resources in production function of Overall Period

Resources	Geometric Mean	Co-efficient	MVP	MFC	Efficiency Ratio
Gross returns	56316.10				
Human labour**	11641.48	0.8601	4.1608	1	4.1608
Bullock labour	3434.775	0.0997	1.6343	1	1.6343
Seeds+	1846.31	0.3175	9.6840	1	9.6840
Plant nutrition*	6157.07	-0.7228	-6.6111	1	-6.6111
Plant protection chemicals	3607.38	0.1439	2.2468	1	2.2468
Irrigation	5320.95	-0.0266	-0.2815	1	-0.2815
Miscellaneous cost	1654.97	-0.1032	-3.5136	1	-3.5136

*Note: 1. MVP=Marginal Value of Product; MFC=Marginal Fixed Cost; 2. + Significant at 10 % level, *significant at 5% level and ** significant at 1 %.*

The returns to scale was tested for its significance which found to be statistically significant at 5 percent level. Adjustments are required in the use of resources for cotton production by farmers to increase the profitability of their long staple cotton crop. A clear-cut government agricultural policy is needed to improve the profitability of the crops by providing access to information regarding best management practices, access to credit, awareness about proper use of fertilizer and manures through extension workers. These findings are in conformity with those of Ardeshna, *et al*., (2008) [7] who found similar findings in their study. They estimated returns to scale for cotton crop in Saurashtra region was 0.8405 which indicated decreasing returns to scale. A perusal of [Table-1], revealed that the coefficients of human labour, bullock labour, seeds and plant protection chemicals were found to be positive with 0.8601, 0.0997, 0.3175 and 0.1439, respectively, while the coefficients of plant nutrition, irrigation and others were found to be negative with -0.7228, -0.0266 and -0.1032, respectively. The p-value of human labour, bullock labour, seeds, plant nutrition, chemical fertilizers, irrigation and miscellaneous resources were found to be 0.0079, 0.4874, 0.0988, 0.0208, 0.4639, 0.8698 and 0.4889, respectively which indicates that human labour, seeds and plant nutrition were found significant at one, ten and five percent, respectively during Overall Period of study. The significant variables of human labour and seeds imply that one percent addition in the value of human labour and seeds inputs will give increment of 0.86 and 0.32 percent, respectively in gross returns of long staple cotton. On the other hand, the negatively significant coefficient of plant nutrition (-0.72) implies that one percent rise in it, will lead to reduce the gross returns of long staple cotton by 0.72 percent. Hence, from the policy point of view, it is suggested to increase the use of resources such as human labour and seeds as they are underutilized and reduce the use of plant nutrition as it is overutilized in order to get optimum returns. These findings are supported by those of Ashfaq, *et al*., (2012) [8] who found the similar results. They reported that the elasticity of production (Ep) for medium sized Bt cotton farmers was found to be 0.77 showing decreasing returns to scale. The results are also in accord with those of Satashia, (2016) [9] who found similar findings in his study. He observed that labour coefficient was positive and significant with 0.21 percent in Bt cotton in middle Gujarat. He also found that the sum of values of regression coefficients ($\Sigma\ b_i$'s) was observed to be 0.509 for Bt-cotton indicating decreasing returns to scale.

Marginal value productivity

A neo classical theory indicates that marginal value product (MVP) must be equal to or above the unit price of respective input for profit maximization. This principle is used to examine the resource use efficiency for the long staple cotton crop. Marginal factor cost is the price per unit of resources. If the efficiency ratio is greater than one, the resource under consideration is underutilized and vice versa. It is observed that the resources such as human labour, bullock labour, seed and plant protection chemicals were underutilized whereas the rest of the resources were overderutilized. The details regarding marginal value product of inputs/resources for long staple cotton during Overall Period have been discussed in this section. The estimated MVPs of different resources for long staple cotton are presented in [Table-2]. It can be revealed that MVPs and efficiency ratios of human labour, bullock labour, seeds and plant protection chemicals were found to be greater than one with 4.1608, 1.6343, 9.6840 and 2.2468, respectively which indicate that the resources were found to be underutilized in long staple cotton production. The MVPs and efficiency ratio of plant nutrition, irrigation and other expenses were found to be negative and were lesser than one with -6.61, -0.28 and -3.51, respectively which indicate that these resources were overutilized in long staple cotton production. That means the farmers used more inputs than the optimal. There is a scope for the farmers to decrease the use of all selected resources such as plant nutrition, irrigation and miscellaneous resources to obtain optimum gross return. The MVPs of seeds was found to be 9.68 which utilized most efficiently in the production process as it gave return of Rs. 9.68 per investment of one rupee. The MVPs of seeds, followed by MVPs of human labour (4.16), plant protection chemicals (2.25) and bullock labour (1.63) were found to be positive and among them the human labour and seeds were significant at one percent and five percent, respectively while the plant nutrition resource was found to be negative and significant at five percent. The above results are in accord with those of [7] who concluded that in cotton crops, all the selected variables included in the production function for cotton crop have jointly explained 80 percent variation in income from cotton. The human labour (0.5563) was found positive and highly significant, indicating positive contribution of this factor to income from cotton. The results revealed that the maximum of the resources such as human labour, bullock labour, seeds and plant protection chemicals were underutilized in long staple cotton production which indicated that the farmers should increase the use of these resources to maximize gross returns. On the other hand, resources like plant nutrition, irrigation and miscellaneous cost were overutilized in long staple cotton production which the farmers should reduce the use of these resources up to the optimal level to maximize gross returns.

These findings are in conformity with those of Shrey and Kamble, (2014) [10] who studies the resource productivity and resource use efficiency of cotton on small farms in Parbhani district of Marathwada region found that the efficiency ratio of family labour, bullock labour, machine labour and manure were greater than unity indicating their underutilization. However, all other resources such as hired labour and plant protection chemicals were used in excess. These findings are also in conformity with those of Ahmed, *et al*., (2015) [11] who observed that the efficiency ratio for given resources is greater than one hence, all the resources were underutilized. That means the sample farmers used less inputs than the optimal implying thereby the scope for the farmer to increase the use.

Conclusion

The results of the Cobb-Douglas production function fitted to find out the resource use efficiency revealed that during Overall Period, the plant nutrition had an inverse relationship with 0.7228 percent reduction in net returns for every one percent increment in plant nutrition. The summation of all the production co-efficients (0.57) were found to be statistically significant indicating decreasing returns to scale. It implies that adjustments are required in the use of resources for Bt cotton production by farmers to increase the profitability of their long staple cotton crop. A clear cut agricultural policy is needed to improve the profitability of the crops by providing access to information regarding best management practices, access to credit as well as awareness about proper use of fertilizer and manures through extension workers. The results of MVPs showed that MVPs and efficiency ratio of human labour, bullock labour, seed and plant protection chemicals were found to be greater than one which indicated underutilization of these resources while those of plant nutrition, irrigation and miscellaneous resources were found to be less than one which showed overutilization. Thus, it is concluded that the resources like plant nutrition, irrigation and miscellaneous expenses were overutilized and there is scope to decrease the use of all these resources to maximize the gross returns.

Application of research: The current research will provide recommendation to policy makers and farmers of long staple cotton as to which practice and inputs should be focused while cultivating long staple cotton

Research Category: Agricultural Economics

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University: Junagadh Agriculture University, Moti Baug, Junagadh, 362001, Gujarat

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