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Resource use efficiency of banana cultivation in Bharuch district of south Gujarat

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Abstract
The study aims to examine Resource use efficiency of banana cultivation in Bharuch District of South Gujarat. The analysis of Cobb-Douglas production function fitted and in case of small farmers revealed that among the selected variable of banana, human labour and irrigation were found positive and significant at 5 per cent level of significant. In case of PPC (Plant protection Chemical) and chemical fertilizer the regression coefficient was negative. The explanatory variable like tractor charge, human labour, FYM and irrigation were found positive and significant at 5 per cent level of significant in case of medium farms. In case of PPC (Plant protection Chemical) the regression coefficient was negative. The variables of human labour, FYM and irrigation were found positive and significant at 5 per cent level of significant in case of large farms. In case of PPC (Plant protection Chemical) the regression coefficient was negative.

Keywords: Resource use efficiency, marginal value product, marginal costs, cobb-Douglas production function etc.

Introduction
Banana is said to be one the oldest cultivated tropical fruits in India. It is the second important fruit next to mango in India. It is called as "Apple of paradise". In India, banana is predominant and popular among the people as they are relished and consumed both by the poor and rich considering the nutritive and fruit values of banana. It is cheaper and available throughout the year in plenty. Hence, it occupied a special place among all the fruits. Banana is widely used for making chips, jams and powders. Thus, in India banana finds a welcome place among the various section of the society. In India, banana is grown on a large scale in the states of Maharashtra, Tamil Nadu, Andhra Pradesh, Gujarat and Kerala. Gujarat is one of the important banana growing states of the country. Gujarat is the second major Banana producing state in the country and accounts for 13.4 per cent of the total production of banana in the country. In Gujarat, during the year 2015-16 banana crop was cultivated in an area of about 64692 hectares and having production of 4185520.36 MT with productivity of 64.69 MT/Ha (Anonymous, 2015) [1].
South Gujarat is the main banana producing hub in Gujarat. Banana is mainly grown in Bharuch district of South Gujarat. In South Gujarat, Bharuch district during the year 2015-16 area and production of banana crop was 12510 hectares and 891963.00 MT (Anonymous, 2015) [2].

Materials and Methods
The study area was confined to Bharuch district of South Gujarat region, which have fertile land with good irrigation facilities. Multistage random sampling method was adopted for the selection of respondent. The total sample size of 144 banana farmers was selected for the present study which was equally apportioned to select three Taluka of Bharuch district *viz*: Jhagadiya, Bharuch and Ankles war Talukas were selected according to highest acreage under banana were selected for the study. Four villages were selected from each talukas on the predominance of Banana area. The sample farmers were randomly selected from each of the selected villages for getting required information on banana cultivation using pre-tested and well-structured schedules.

Resource use efficiency
The form of Cobb-Douglas production function is as under.
Y = aX1b1X2b2X3b3X4b4X5b5X6b6X7b7X8b8 + Ui

Where,

Y = Total returns from banana cultivation (≠/ha)
X1 = Area under banana cultivation (ha)
X2 = Value of seed/seedling (≠/ha)
X3 = Tractor charges (≠/ha)
X4 = Cost on human labour used in banana cultivation (≠/ha)
X5 = Cost on chemical fertilizers (≠/ha)
X6 = Cost on farmyard manure (FYM) (≠/ha)
X7 = Cost on plant protection chemicals (PPC) (≠/ha)
X8 = No. of irrigations
b1 to b8 = Regression coefficient of respective variable (1 to 8)
Ui = error term

Estimation of marginal value product (MVP)

A neo-classical criterion indicating that marginal value productivity must be equal to or above the unit cost of individual inputs. This criterion was used to examine the input use efficiency. The marginal value productivity of individual resources was estimated by using the following formula.

$$\text{MVP xi} = \frac{b_i \bar{Y}_G * Py}{X_{iG}}$$

Where,

$\bar{Y}_G$ = Geometric mean of output
Py = Price of output (≠/qtl)
XiG = Geometric mean of ith input
Bi = Production elasticity of ith input

The efficiency of inputs use was studied through the comparison of MVPS of inputs with their marginal costs or acquisition costs.

Marginal costs/acquisition costs

The marginal cost of land has been taken the average rental value of land under the selected crops. The estimated average wage rate for a man day was taken as the marginal cost of human labour. Similarly, the marginal cost of bullock labour includes the average market rate of a bullock pair for a day. The average market prices of manures and fertilizers prevailed during the study year at the village level has been taken as marginal cost of manures and fertilizers. The marginal cost of other inputs taken as cash expenditure incurred for all other inputs together was considered as one rupee since these inputs have been measured in value terms.

Determination of optimum allocation of fertilizers

From the Cobb-Douglas production function, the optimum allocation of inputs was determined under limited capital situation of each selected crop growing sample farms. It could be obtained by using production elasticities of respective inputs as under.

$$Xi = \frac{bi * C}{S * Pxi}$$

Where,

Xi = Optimum level of ith input
Bi = Production elasticity of ith input
C = Existing total expenditure incurred on all selected inputs
S = Sum of elasticities
Pxi = Price per unit of ith input

Result and Discussion

Resource use efficiency in banana production

Functional relationship between input and output

In order to estimate the resource use efficiency in banana production on the sample farms, Cobb-Douglas production fuction was fitted to the farm level data. The elasticities were tested with't' test for their significance. The results of the estimated production function for banana production have been discussed in this section.

Regression coefficients of different production variables in cultivation of Banana for small farmers

In the case of small farmer the result of the production function for banana crop are presented in Table 1.1. The results indicated that the coefficient of multiple determinations (R^2) is 0.77 per cent. It implies that 77 per cent of the total variation in the output of banana was explained by the explanatory variables included in the model. The regression analysis showed that the coefficient of FYM (0.32), human labour (0.50) and irrigation (0.39) were found positive and significant at 5 per cent level of significant (Table 1.1). The positive and significant coefficient indicated that one unit increase in the FYM, human labour and irrigation will increase the yield of banana by 0.50, 0.32 and 0.39 per cent respectively. FYM was found to be the most influential input on yield determination followed by human labour and irrigation. In case of PPC (Plant Protection Chemical) and chemical fertilizer the regression coefficient was negative which indicates the use of one more unit PPC (Plant Protection Chemical) and chemical fertilizer will minimize the yield by 0.08 and 0.12 per cent respectively. Results are in accordance with Kumar *et al*., (2015) [4].

Table 1.1: Regression coefficients of different production variables in cultivation of Banana for small farmers

Input variable	Coefficient	Standard error
Area	1.32	0.10 (13.09)
Seed	0.15	0.08 (1.82)
Tractor charge	1.13	0.50 (1.41)
Human labour	0.50	0.23 (2.19*)
Chemical fertilizer	-0.08	0.27 (-0.32)
FYM	0.32	0.15 (2.13*)
Plant protection chemical	-0.15	0.66 (-0.22)
Irrigation	0.39	0.19 (2.03*)
R2	0.77	

Note: *denotes significant 5 per cent levels

Finger in parentheses indicates percentage to 't' value in Coefficient.

Regression coefficients of different production variables in cultivation of Banana for medium farmers

In the case of medium farmer the result of the production function for banana crop are presented in Table 1.2. The results indicated that the coefficient of multiple determinations (R^2) is 0.84 per cent. It implies that 84 per cent of the total variation in the output of banana was explained by the explanatory variables included in the model. However, only Tractor charge, Human labour, FYM, and irrigation found at 5 per cent level of significant. The magnitude of the regression Coefficient of Tractor charge was 0.70, Human labour was 0.33, FYM was 0.65 and Irrigation was 0.45. It

implies that one per cent increase in this variable could increase yield by 0.70, 0.33, 0.65 and 0.45 per cent respectively. Tractor charge was found to be the most influential input on yield determination followed by FYM, irrigation and human labour. In case of PPC (Plant Protection Chemical) the regression coefficient was negative which indicates the use of one more unit PPC will minimize the yield by 0.08 per cent. Similar trained was noticed by Kumar *et al*. (2015) [4] who results indicated that the coefficient of multiple determinations (R^2) is 0.86.

Table 1.2: Regression coefficients of different production variables in cultivation of Banana for medium farmers

Input variable	Coefficient	Standard error
Area	1.14	0.13 (8.15)
Seed	0.24	1.14 (0.21)
Tractor charge	0.70	0.60 (1.15)
Human labour	0.33	0.15 (2.14*)
Chemical fertilizer	0.70	0.30 (2.35*)
FYM	0.65	0.30 (2.13*)
Plant protection chemical	-0.01	1.34 (-0.01)
Irrigation	0.45	0.22 (2.00*)
R2	0.84	

Note: *denotes significant 5 per cent levels
Finger in parentheses indicates percentage to 't' value in Coefficient.

Regression coefficients of different production variables in cultivation of Banana for large farmers

In the case of medium farmer the result of the production function for banana crop are presented in Table 1.3. The results indicated that the coefficient of multiple determinations (R2) is 0.83 per cent. It implies that 83 of the total variation in the output of banana were explained by the explanatory variables included in the model. However, only Human labour, FYM, and irrigation found five per cent level of significant. It implies that one per cent increase in this variable could increase yield by 0.72, 0.64 and 0.51 per cent respectively. Human labour was found to be the most influential input on yield determination followed by FYM and irrigation. In case of PPC (Plant Protection Chemical) the regression coefficient was negative which indicates the use of one more unit plant protection chemicals will minimize the yield by 1.41 per cent. The present findings more or less in conformity with earliyer worker like Kumar *et al*. (2015) [4].

Table 1.3: Regression coefficients of different production variables in cultivation of Banana for large farmers

Input variable	Coefficient	Standard error
Area	0.98	0.11 (8.39)
Seed	0.17	0.36 (0.47)
Tractor charge	0.56	0.29 (1.89)
Human labour	0.72	0.35 (2.02*)
Chemical fertilizer	0.01	0.89 (0.02)
FYM	0.64	0.26 (2.43*)
Plant protection chemical	-1.41	1.76 (-0.80)
Irrigation	0.51	0.22 (2.29*)
R2	0.83	

Note: *denotes significant 5 per cent levels
Finger in parentheses indicates percentage to 't' value in Coefficient.

Marginal value productivity

It is pertinent that the 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 banana crop. The details regarding marginal value product, factor unit cost and the ratio of MVP to factor price for banana crop have been discussed in this section.

Marginal value productivity of resource inputs of banana for small farmers

It could be seen for small farmers, from the Table 1.4 that the MVPs of seeds, tractor charge, human labour, FYM and irrigation were lower than their corresponding unit price the ratio of MVP to factor price of seeds (0.003), tractor charge (0.248), human labour (0.010), FYM (0.099) and irrigation (0.026) was less then unity which calls for its underutilization. The underutilization use of the resource would lead to increase the banana production. Similar trained was noticed by Surwase *et al.* (2015) [3].

As a whole, chemical fertilizer (-0.002) and PPC (Plant Protecton Chemical) (-0.030) were found to be over utilized in the study. The reason behind over use of chemical fertilizer a few farmers have over used since due to poor fertility of soil, increase growth of plant and in case of plant protection chemical would have been due to increased incidence of rhizome weevil, Pseudostem borer, banana aphid, bunchy top, panama disease and sigatoka disease in the study area.

From the above discussion, it is concluded that, seeds, tractor charge, human labour, chemical fertilizer, FYM and irrigation have positive and statistically significant relationship which indicate that an increase in the application of these inputs would lead to increase in the output of banana. All the variables except chemical fertilizer and plant protection chemicals were found to be underutilized.

Table 1.4: Marginal value productivity of resource inputs of banana for small farmers

Input variable	MVP	MFC	MVP/MFC
Seed	0.003	1.00	0.003
Tractor charge	0.248	1.00	0.248
Human labour	0.010	1.00	0.010
Chemical fertilizer	-0.002	1.00	-0.002
FYM	0.099	1.00	0.099
Plant protection chemical	-0.030	1.00	-0.030
Irrigation	0.026	1.00	0.026

Marginal value productivity of resource inputs for banana for medium farmers

It could be seen from medium farmers, from the Table 1.5 that the MVPs of seeds, tractor charge, human labour, chemical fertilizer, FYM and irrigation were lower than their corresponding unit price the ratio of MVP to factor price of seeds (0.009), tractor charge (0.335), human labour (0.012), chemical fertilizer (0.043), FYM (0.335) and irrigation (0.041) was less then unity which calls for its underutilization. The underutilization use of the resource would lead to increase the banana production. These results are in line with Kumar *et al.* 2015) [4].

As a whole, plant protection chemical (-0.006) were found to be over utilized in the study. The reason behind over use plant protection chemical would have been due to increased incidence of rhizome weevil, Pseudostem borer, banana aphid, bunchy top, panama disease and sigatoka disease in the study area.

From the above discussion, it is concluded that, seeds, tractor charge, human, labour, chemical fertilizer, FYM and irrigation have positive and statistically significant

relationship which indicate that an increase in the application of these inputs would lead to increase in the output of banana. All the variables except plant protection chemicals were found to be underutilized.

Table 1.5: Marginal value productivity of resource inputs for banana (medium)

Input variable	MVP	MFC	MVP/MFC
Seed	0.009	1.00	0.009
Tractor charge	0.325	1.00	0.325
Human labour	0.012	1.00	0.012
Chemical fertilizer	0.043	1.00	0.043
FYM	0.033	1.00	0.033
Plant protection chemical	-0.006	1.00	-0.006
Irrigation	0.041	1.00	0.041

Marginal value productivity of resource inputs for banana for large farmers

It could be seen in large farmers, from the from Table 1.6 that the MVPs of seeds, tractor charge, human labour, chemical fertilizer, FYM and irrigation were lower than their corresponding unit price the ratio of MVP to factor price of seeds (0.018), tractor charge (0.697), human labour (0.064), chemical fertilizer (0.002), FYM (0.554) and irrigation (0.030) was less then unity which calls for its underutilization. The underutilization use of the resource would lead to increase the banana production. Result are in accordance with Surwase *et al.* 2015) [3].

As a whole, plant protection chemical (-1.213) were found to be over utilized in the study. The reason behind over use plant protection chemical would have been due to increased incidence of rhizome weevil, Pseudostem borer, banana aphid, bunchy top, panama disease and sigatoka disease in the study area.

From the above discussion, it is concluded that, seeds, tractor charge, human, labour, chemical fertilizer, FYM and irrigation have positive and statistically significant relationship which indicate that an increase in the application of these inputs would lead to increase in the output of banana. All the variables except plant protection chemicals were found to be underutilized.

Table 1.6: Marginal value productivity of resource inputs for banana for large farmers

Input variable	MVP	MFC	MVP/MFC
Seed	0.180	1.00	0.180
Tractor charge	0.697	1.00	0.697
Human labour	0.064	1.00	0.064
Chemical fertilizer	0.002	1.00	0.002
FYM	0.554	1.00	0.554
Plant protection chemical	-1.213	1.00	-1.213
Irrigation	0.030	1.00	0.030

Conclusion

The MVP of seeds, tractor charge, human, labour, chemical fertilizer, FYM and irrigation have positive and statistically significant relationship which indicate that an increase in the application of these inputs would lead to increase in the output of banana. All the variables except plant protection chemicals and chemical fertilizer were found to be underutilized.

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