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Optimizing Returns in Mulberry Cultivation: A Resource use Efficiency Study in Chikkaballapur District of Karnataka, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study was conducted to analyze resource use efficiency in mulberry cultivation using data from cultivators of the Chikkaballapur district of Karnataka collected during 2021-22 from mulberry growing farmers. Twenty mulberry growers were selected using a multistage random sampling technique from each of the two chosen taluks leading in mulberry cultivation in Chikkaballapur district. The resource use efficiency analysis was carried out using production function analysis by comparing the marginal value productivity from each of the resources with the marginal input cost from each of the resources (profitability ratio). Results

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indicated scope to increase the use of fertilizer, FYM, and irrigation as additional expenditure on these resources would result in additional return. The summation of the production coefficients indicated increasing returns to scale and scope to increase the use of resources and optimize returns from mulberry cultivation from the current level.

Keywords: Mulberry; resource use efficiency; profitability ratio; global textile market; silk.

1. INTRODUCTION

Sericulture, the art and science of silk production, has been an integral part of India's cultural and economic heritage for centuries. Silk is known throughout the world as the "Queen of Textiles" because of its unparalleled grandeur, natural sheen, inherent affinity for dyes, lightweight, and high durability. It is a natural fiber derived from silkworm cocoons through a process known as sericulture. It involves various activities such as growing of mulberry leaves (Moriculture), rearing of silkworms, silk reeling from cocoons, weaving of silk yarn and produce of silk fabric from it [1,2].

Silk forms a small part of the global textile market, the major silk-producing countries in the world include China, India, Uzbekistan, Brazil, Japan, the Republic of Korea, Thailand, Vietnam, Korea, Iran, etc. Few other countries, such as Kenya, Botswana, Nigeria, Zambia, Zimbabwe, Bangladesh, Colombia, Egypt, Japan, Nepal, Bulgaria, Turkey, Uganda, Malaysia, Romania and Bolivia are also engaged in the production of cocoons and raw silk in negligible quantities [3,4]. Among the leading contributors to the global silk industry, India stands out as a prominent player with a rich history of sericulture, its trade dates back to the 15th century it is believed that the art of silk production was introduced to India by Chinese travelers during the reign of Emperor Wu of Han in the 2nd century BC. India has a good climate condition which allows it to grow all four varieties of silk such as mulberry silk, Eri silk, Muga silk and Tasar silk [5,1]. Among the four varieties of silk produced, Mulberry silk produced from an insect called *Bomboxy Mori* accounted for 72.51 per cent of the total raw silk production. The total area under mulberry plantation in India was increasing over a year and it stood at 2.55 million ha during 2022-23 with annual mulberry silk production of 20,118 metric tonnes [6,12].

Sericulture is a tradition in Karnataka and culturally the state accords great value to silk. It is a fascinating story of Soil to Silk & Fabric. Sericulture flourished with the royal patronage of the Tippu Sultan and the Wodeyars the Mysore Royal family in the Mysore Kingdom. It has been practiced in the State for the last 250 years [3]. Karnataka, one of India's leading states in sericulture, produces nearly 31.4 per cent of the country's total raw silk. The total area under mulberry plantation in Karnataka (2022-23) accounted for 1.12 lakh hectares, Ramanagara accounted for the highest area of 20,805 hectare (18.66 %) closely followed by Chikkaballapura 20,545 hectare (18.43 %) and Kolar 19,908 hectare (17.85 %) respectively. Sericulture plays a predominant role in shaping the economic destiny of rural communities. India ranks as the world's second-largest silk producer, with domestic demand surpassing current supply levels, indicating ample scope to increase production. In this background, given the importance of mulberry cultivation in sericulture, the present study is an attempt to estimate the resource use efficiency in the cultivation of mulberry [7-10].

2. METHODOLOGY

2.1 Study Area and Sampling Framework

The study was undertaken in Sidlaghatta and Chintamani taluks of Chikkaballapur district in Karnataka during 2021-22. The study area was selected based on secondary data. Sidlaghatta taluk has largest area under mulberry cultivation of about 6,758 ha followed by Chintamani taluk which has about 4,752 ha of area under mulberry cultivation. Primary information on inputs, labour utilization, output and prices were collected from a randomly selected 40 respondents using pre-tested and well-structured schedule through personal interview method. Multistage random sampling technique was employed in the sample selection [11,12].

2.2 Analytical Tools

The Cobb-Douglas type production function was fitted to the data to analyse the resource use efficiency in mulberry cultivation. The following equation was specified for further analysis.

$$Y = a X_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{b5} e^{u} \quad \ldots\ldots (1)$$

Where,

Y = Mulberry Yield (tons/acre)
X_1 = land Area under mulberry cultivation (acre)
X_2= Human labour (man days)
X_3 = Farm yard manure (Tractor load)
X_4 = Fertilizer (kg)
X_5 = Irrigation dummy (1 for irrigated, 0 for non-irrigated)
A = Intercept

b_1 to b_5 indicates production elasticity coefficients of respective inputs.

The estimated production co-efficient (bi) were tested for their significance using 't' test

$$t = bi/\text{Standard error of } bi \quad \ldots\ldots. \quad (2)$$

The above equation was converted into the logarithmic form and parameters were estimated using OLS technique.

$$\ln Y = \ln a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X4 + b_5 \ln X_5 + u \quad (3)$$

2.3 Specification of Variables

2.3.1 Dependent variables

a. Yield obtained from mulberry cultivation per acre was taken as a dependent variable

2.3.2 Independent variables

a. Land Area (acres) – The input was measured in terms of area under mulberry cultivation in acres.
b. Human labour (Man days/acre) – Quantity of human labour used.
c. FYM (Tractor load/acre) – Quantity of farm yard manure applied in mulberry cultivation.
d. Fertilizer (kgs/acre) - Quantity of chemical fertilizer applied in the cultivation of mulberry.
e. Irrigation (Dummy) - X_5

The optimality in resource use was assessed using the Marginal Value Product (MVP) and the Marginal Factor Cost (MFC). The Marginal value product (MVP) of each input was obtained as the product of its Marginal Product (MP) and the price of output (Py). The MP was calculated using the production function estimates (bi) and the ratio of Geometric Mean (GM) level of output and input. The Marginal Factor Cost (MFC) was the cost incurred on per unit of the input.

Then the Economic Efficiency was arrived at using the following relationship.

$$EE = r = MVP/MFC$$

Where,

EE = Economic efficiency
MVP = Marginal value product of variable inputs
MFC = Marginal factor cost (price per unit of inputs)

Based on economic theory, a firm maximizes profits or reaches economically optimum level of output when the ratio of the marginal value product to its opportunity cost is unity. Thus, if,

- *r* is <1; resource was overused and indicates the need to reduce its use.
- *r* is >1; indicates the resource is underutilized and hence increasing its use from the existing level would increase profit.
- *r* is = 1; shows the optimum utilization of resource and the point of profit maximization.

3. RESULTS AND DISCUSSION

3.1 Resource use Efficiency in Mulberry Cultivation

To study the economic optima in use of various resources in mulberry leaf cultivation, the Cobb-Douglass type of production function as specified earlier was fitted to the data collected from sample farmers. The results presented in Table-1 reveals that area under mulberry cultivation, human labour, FYM, fertilizer, and irrigation were found to be the significant contributors to leaf output. Among the production coefficients for various inputs, the coefficient for fertilizer input was found to be highly significant at one per cent probability level, while the coefficients for human labour and farm yard manure were significant at five per cent probability level. In other words, the production coefficients indicated that one per cent increase in mulberry area on sample farms labour, FYM, fertilizer and irrigation would result in increase in mulberry leaf output by 0.13 per cent, 0.19 per cent, 0.16 per cent, 0.58 per cent and 0.05 per cent, respectively from current level

Table 1. Estimates of the Cobb-Douglass production function in mulberry cultivation
[Dependent variable (Y): Mulberry Yield (tons/acre)]

Sl. No.	Variables	Parameters	Elasticity coefficients
1.	Intercept	a	-1.0823
2.	Area in acre (X_1)	b_1	0.1301* (0.0743)
3.	Labour in man days (X_2)	b_2	0.1925**(0.0894)
4.	FYM in tractor load (X_3)	b_3	0.1641**(0.0539)
5.	Fertilizer in kgs (X_4)	b_4	0.5756***(0.0679)
6.	Irrigation dummy (X_5)	b_5	0.0465*(0.0264)
7.	Co-efficient of multiple Determination (R^2)		0.9121
8.	Returns to scale		1.11

*Note: 1. ***, ** and * and indicates significant at one per cent, five per cent and ten per cent probability level, respectively*
2. Figures in parentheses represents standard error

Table2. Economic efficiency of resource use in mulberry cultivation (Per farm)

Independent Variables	Geometric mean level of inputs	Elasticity Coefficient	MVP (Rs.)	MFC (Rs.)	MVP/MFC
Area in acre	1.94	0.1301	3440.39	4485.00	0.77
Labour in man days	29.63	0.1925	333.01	550.00	0.61
FYM in tractor load	2.86	0.1641	2936.69	1662.00	1.77
Fertilizer in kgs	92.23	0.5756	319.78	30.00	10.66
Irrigation dummy	0.85	0.0465	2805.82	853.67	3.29

of production. The production variables included in the model found to account for about 90 per cent of the variation in mulberry yield as revealed by the co-efficient of multiple determination (R^2) value. The sum of the regression coefficients (1.11) illustrates increasing returns to scale i.e., incremental use of all inputs simultaneously, would result in more than one unit increase in mulberry leaf yield [13,14].

3.2 Economic Efficiency

To assess the economic optimality in resource use, the profitability ratio of various resources used in mulberry cultivation was estimated using the MVP/MFC ratio presented in previous section and results are presented in Table-2. It could be observed from the results that the ratio of MVP to MFC was found to be less than unity for two inputs *viz.,* human labour and area under mulberry cultivation, indicating that these inputs were over-utilized on the farmers' field and that the use of these inputs needs to be reduced to optimize returns from mulberry cultivation. In other words, the cost of these two resources *viz.* land rent and wage rates were found to be higher than their marginal value products and this leading to ratio being less than unity. These findings revealed that the prevailing high land rent and high wage rates cautioning the farmers to use them very judiciously. On the other hand, the MVP to MFC ratio for fertilizer, irrigation, and FYM was found to be greater than unity, this indicated that there exists opportunity to optimize returns from mulberry cultivation by increasing the use of these resources from the current use level. Thus, farmers can reap more benefits from mulberry cultivation by reallocating the expenditure among the resources used in the model based on results of profitability ratios.

4. CONCLUSION

The resource use efficiency in mulberry cultivation using cobb-Douglass production function estimates showed that inputs such as area under mulberry cultivation, human labour, FYM, fertilizer, and irrigation are positive and significant. Analysis of the ratio of Marginal Value Product to Marginal Factor Cost shows that human labour and the area under mulberry cultivation were found to be over-utilized. Thus, there is need to reallocate the expenditure among various resources or more specifically increase the use of underutilized resources like fertilizer, irrigation, and FYM and reduce use of human labour and area under mulberry for better management to optimize mulberry leaf production and realize better return.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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