

# Resource Use Efficiency in Mulberry Cocoon Production in Tamil Nadu: an economic analysis

S. Lakshmanan<sup>1</sup>

## Introduction

Mulberry sericulture is one among agro-based rural enterprises, which helps in transformation of socio-economic development in the rural areas. This sector promises creation of own family employment and providing handsome returns throughout the year for marginal and small landholdings. Micro-level studies (Lakshmanan et al., 1998 and 1999; Jayaram et al., 1998) reveal that mulberry sericulture generates viable employment opportunities for hired and owned family members and assures periodical returns throughout the year under irrigated conditions.

In India, during 1951-52, silk productivity was a mere 12.426 kg/hectare, which increased to 35.856 kg in 1990-91 (Anonymous, 1992). Post mid-1990s, a technological breakthrough took place in Indian sericulture due to joint efforts made by the Japanese International Co-operation Agency (JICA) and R & D units of Central Silk Board, Government of India to evolve high yielding varieties in mulberry and silkworm races. As a result, silk productivity reached to the extent of 86.116 kg/hectare during 2006-07 at all India level (Anonymous, 2006). These technological changes have not only increased earnings from sericulture but also motivated small and large-scale farmers to adopt new technologies to a large extent (Lakshmanan, et al., 2009).

## Sericulture in Tamil Nadu

Mulberry sericulture has been one of the promising rural industries in Tamil Nadu for many decades. Until 1980s, it was highly concentrated in and around Coimbatore, Dharmapuri and Salem districts in the state. The average cocoon yield obtained by the farmers was in the range of 20-32 kg/100 Dfls as against the potential yield of 70 kg/100 Dfls. This wide gap was perhaps mainly attributed to low level of adoption of the recommended package of practices, plantation of poor yielding mulberry varieties, rearing of poor yielding silkworm races (multivoltine silkworm races) and lack of rearing facilities (Balasarswathi, et al., 2006).

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<sup>1</sup>Scientist-C, Central Sericultural Research and Training Institute, Srirampura, Mysore 570 008, Karnataka

Over the years, particularly, after implementation of JICA project (1997-2002) in Tamil Nadu, the state has emerged as one amongst the potential bivoltine cocoon producing states in India. A large number of farmers were involved in the production of bivoltine cocoons in Erode and Coimbatore districts in Tamil Nadu. This project has not only helped to increase adoption level of new bivoltine technologies but also increased cocoon yield to the extent of 63 kg/100 Dfls in the field ( Himantharaj et al., 2007).

Although Karnataka is the premier mulberry silk producing state in the country, its bivoltine raw silk production had declined from 396 MT in 2005-06 to 358 MT in 2006-07. However, in the case of Tamil Nadu, the volume of bivoltine raw silk production increased from 176 MT to 296 MT, witnessing an increase of 68.2 per cent, for the same period. Although the state showed potential for increasing bivoltine silk production, farmers are confronted with problems, viz., increasing cost of cocoon production and non-availability of hired labour for mulberry cultivation and silkworm rearing (Lakshmanan, et al., 2008). The increasing cost of cocoon production may be partly attributed to increase in resource price and also due to indiscriminate use of resources.

### Objectives

In this context, an attempt has been made to study the resource use efficiency of farmers in silk cocoon production.

This study is expected to help the extension workers to educate the farmers about utilization of resources and reduce cost of cocoon production, ultimately resulting in enhanced economic returns to the mulberry farmers.

### Methodology

To study the resource use efficiency in cocoon production, a field study was conducted in Gobichettipalayam of Erode district and Udumalpet of Coimbatore district in Tamil Nadu. These two taluks are considered as model bivoltine cocoon producing areas in the state. A total of 120 farmers, 60 each from Gobichettipalayam and Udumalpet taluks, were selected randomly. The primary data were collected by direct interview method through a pre-tested schedule. The data were stratified into three farm size groups, viz., farm size I (1.0 acre); farm size II ( 1.0 - 2.0 acre); Farm size III (2.0 acre). Accordingly, 40 out of 120 samples for farm size I, 47 for farm size II and 33 for farm size III, were ultimately used for analysis. A Cobb-Douglas production function type model was used to find out the factors influencing returns in sericulture and resource use efficiency by the sample farmers. The reference period for the study was 2005-06.

Functional analysis method was followed to study the resource use efficiency and

to identify the factors influencing returns. The production function fitted to the data is as follows.

$$Y = a X_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6} e$$

Where Y = Value of output of cocoons in rupees (per acre/year)

X<sub>1</sub> = human labour (Rs.) per acre/year

X<sub>2</sub> = farm yard manure (Rs.) per acre/year

X<sub>3</sub> = fertilizer (Rs.) per acre/year

X<sub>4</sub> = irrigation (Rs.) per acre/year

X<sub>5</sub> = Dfls (Rs.) per acre/year

X<sub>6</sub> = Disinfectants (Rs.) per acre/year

e = Random error

a = Constant

Separate production functions were fitted for each farm size. The resource use efficiency could be judged based on the marginal value of productivity (MVP), which indicates the increase in gross returns from the use of an additional unit of a given input while keeping other inputs constant. The MVP of the *i*th input factor was measured by using the following formula:

$$\text{MVP of } X_i = b_i \frac{Y}{X_i}$$

Where, Y = Geometric mean of output/acre/year

X<sub>*i*</sub> = Geometric mean of respective input variable

b<sub>*i*</sub> = Regression coefficient of respective input variable

The ratio of MVP to opportunity cost for each factor was calculated in order to determine the efficiency of resource use in each size group.

## Results and Discussion

Production function is the functional and mathematical relationship between inputs and output. In silk cocoon production, the important factors such as human labour, farm yard manure (FYM), chemical fertilizer (NPK), irrigation, disease free layings (DFLs) and disinfectants, were considered to find out the contribution of each input on the returns realized in bivoltine cocoon production. The results of the estimated production elasticities, returns to scale and resource use efficiency are presented for farm size I, II and III under the following heads.

### Production Elasticities of Resources

It is observed from Table 1 that the co-efficient of multiple determination (R<sup>2</sup>) was 0.78 on farm size I indicating 78 per cent of variation in the gross returns which could be explained by the selected input variables viz., human labour, FYM, NPK, irrigation, disease free layings (DFLs) and disinfectants.

The coefficient of human labour was negative and significant on the gross returns of cocoon for the farm size I which implies that for every one per cent increase in human labour, the output declined by 0.199 per cent which reflects the paradox of disguised unemployment.

**Table 1. Results of the estimated production elasticities by farm size groups**

Particulars	Unit	Farm size I (n= 40)	Farm size II (n=47)	Farm size III (n=33)
Constant		6.414	8.721	6.873
<b>Production elasticities</b>				
Human labour	Rs.	-0.199* (0.056)	0.216** (0.019)	0.312**(0.102)
Farm yard manure	Rs.	0.188* (0.046)	0.164*(0.014)	0.467*(0.162)
Chemical fertilizer	Rs.	0.299 (0.178)	0.179** (0.046)	-0.246** (0.076)
Irrigation	Rs.	0.010 (0.119)	0.274** (0.021)	0.346* (0.124)
Disease free layings	Rs.	0.463* (0.153)	0.314** (0.102)	0.337 (0.173)
Disinfectants	Rs.	0.112** (0.016)	0.156* (0.376)	-0.145** (0.011)
Sum of elasticities		0.87	1.303	1.071
R <sup>2</sup>		0.78	0.84	0.93
<b>Geometric mean</b>				
Output	Rs.	117826.20	123458.30	129470.65
Human labour	Rs.	28929.71	27460.76	29745.35
Farm yard manure	Rs.	5118.82	5612.65	7740.40
Chemical fertilizer	Rs.	4258.30	4760.35	6745.70
Irrigation	Rs.	3477.02	4115.65	5326.45
Disease free layings	Rs.	5694.25	6715.48	6820.66
Disinfectants	Rs.	4282.05	3715.60	4250.15

Note: Values in the parenthesis shows standard errors

\* Significant at 5 per cent level of probability \*\* Significant at 1 per cent level of probability

The coefficients of FYM, Dfls and disinfectants were positive and significant at 5 per cent level. This suggests that, for every increase in one per cent of FYM, the gross value of cocoon increased by 0.188 per cent when all other factors were kept constant.

In the case of farm size II, the factors such as human labour, FYM, NPK, irrigation, disease free layings and disinfectants were all influencing the returns in cocoon production. These inputs were not only positive but also statistically significant, indicating that for every increase in one per cent of chemical fertilizer, the gross value of cocoons increased by 0.179 per cent holding all other factors constant.. It was also observed during the field investigation that most of the sample farmers expressed that the realization of higher returns in sericulture was mainly due to application of recommended quantity of disinfectants (such as vijetha powder and bleaching powder, FYM and chemical fertilizer. Added to that, the DD staff revealed that farmers in the study region were having adequate knowledge about new sericulture technologies and having entrepreneurial skills in rearing bivoltine silkworm races. The  $R^2$  value was 0.84 per cent.

For farm size III, except NPK and disinfectants, all the coefficients of other variables included in the model were positively significant. The inputs NDK and disinfectants were negatively significant indicating that for every one per cent increase of the aforesaid inputs, the output declines by 0.246 and 0.145 per cent respectively. The  $R^2$  value was 0.73 per cent showing 73 per cent of variation in the gross returns which could be revealed by the inputs used in the model.

### **Returns to Scale**

The production elasticities for each input indicate the estimated percentage change in gross return associated with one per cent change in the input, while the factors are held constant. The sum of elasticities of regression coefficients shows the returns to scale, which was estimated to be 0.87, 1.303 and 1.071 for farm size I, II and III. The estimated returns to scale for farm size I is positive but less than one, suggesting the decreasing returns to scale, i.e., if all the inputs are increased by one per cent, the gross returns will increase but at a magnitude of less than one per cent. The reason for this is that, the farmers of smaller mulberry holding size (less than one acre of mulberry cultivation) usually engage more number of human labour than what is actually required, as it was available without additional expenses within the family.

However, farm size II and III were operating under increasing and constant returns to scale. This was perhaps mainly due to rational allocation of resources by farm size II vis-à-vis farm size III and I.

### **Resource Use Efficiency**

The efficiency of input use was judged by estimating the marginal value of productivity (MPV) of various inputs (Rs./acre/year), affecting the gross returns of cocoon, such as human labour, farmyard manure, chemical fertilizer, irrigation, disease free layings and

disinfectants. The MVPs of different factors suggest the scope for additional amount of expenditure for revenue enhancing for cocoon production as it encompasses the prices of input and output both.

The estimated MVPs of all the inputs of cocoon were tested to find out whether MVP and opportunity costs (O) are significantly differing. The MVPs, O, ratio of MVP to O values are presented farm size-wise in Tables 2 through 4.

The opportunity costs for all the inputs were considered to be one rupee. The utilization of human labour was not at optimum level in the case of farm size I. Since there was a significant difference between MVPs and O as the marginal value products of human labour (-0.890) and irrigation (0.338) were less than acquisition costs (1.00). This warrants judicious use of such inputs. Therefore, there is need to reduce the number of human labour, so as to achieve higher gross returns. While the inputs such as farmyard manure, disease free layings and disinfectants were under-utilized as reflected by higher MVP to O, higher returns would be derived by increasing the use of these resources.

**Table 2. Marginal value products (MVP), Opportunity cost and Ratios of MVP to opportunity cost (Monetary) of variable inputs for farm size I**

Particulars	Variables	Marginal value product (MVP)	Opportunity cost (OC)	MVP/OC
Human labour	X1	-0.810*	1.0	-0.810
Farm yard manure	X2	4.327*	1.0	4.327
Chemical fertilizer	X3	8.270*	1.0	8.270
Irrigation	X4	0.338*	1.0	0.338
Disease free layings	X5	9.580*	1.0	9.580
Disinfectants	X6	3.082*	1.0	3.082

Note : \* Significant at 5 per cent level of probability

For farm size II, the MVPs to O ratio of chemical fertilizer, FYM, irrigation, disease free layings and disinfectants were significant and greater than unity, indicating under utilization of such resources than the recommended quantity while the utilization of human labour was more than the optimal level, suggesting that increasing use of inputs such as chemical fertilizer, FYM, irrigation, disease free layings and disinfectants would add additional revenue and at the same time minimize the level of human labour usage.

**Table 3. Marginal value products (MVP), Opportunity cost and Ratios of MVP to opportunity cost (Monetary) of variable inputs for farm size II**

Particulars	Variables	Marginal value product (MVP)	Opportunity cost (OC)	MVP/OC
Human labour	X1	0.971*	1.0	0.971
Farm yard manure	X2	3.607*	1.0	3.607
Chemical fertilizer	X3	4.642*	1.0	4.642
Irrigation	X4	8.220*	1.0	8.220
Disease free layings	X5	5.773*	1.0	5.773
Disinfectants	X6	5.184	1.0	5.184

Note: \* Significant at 5 per cent level of probability

In the case of farm size III, quantity of NPK and disinfectants were used excessively than the optimal level, as evidenced by the negative MVP to Ratios thereby suggesting immediate curtailment of the quantity of the above inputs in order to increase revenue. However, inputs such as human labour, NPK, irrigation and disease free layings were under utilized, indicating scope for efficient use of those inputs.

**Table 4. Marginal value products (MVP), Opportunity cost and Ratios of MVP to opportunity cost (Monetary) of variable inputs for farm size III**

Particulars	Variables	Marginal value product (MVP)	Opportunity cost (OC)	MVP/OC
Human labour	X1	1.358*	1.0	1.358
Farm yard manure	X2	7.811*	1.0	7.811
Chemical fertilizer	X3	-4.721*	1.0	-4.721
Irrigation	X4	8.410*	1.0	8.410
Disease free layings	X5	6.396*	1.0	6.396
Disinfectants	X6	-4.417*	1.0	-4.417

Note: \* Significant at 5 per cent level of probability

### Policy Implications

The present study reveals that the usage of resources such as labour, chemical fertilizer, irrigation and disinfectants were either used excessively or underutilized. Both excessive and underutilization of such resources than at optimum level, are a matter of concern since it has a bearing on the monetary realization as utilization of higher

quantity of inputs than the recommended level of quantity will eventually increase cost of production and decrease gross returns. Similarly, use of lesser quantity of resources than at optimum level would reduce productivity and curtail profitability. The analysis of MVP to O clearly indicated the moderate degree of resource use inefficiency on cocoon production irrespective of farm size groups.

Further, demand for labour in sericulture is intensive as it has a direct relationship with farm size and brushing capacity. Like wise, high yielding mulberry varieties (V1 and S36) under irrigated condition require use of recommended quantity of chemical fertilizer and farm yard manure to produce optimum output. Therefore, extension personnel of DDO have to educate the farmers about optimum utilization of resources. This would help to reduce cost of production on the one hand and conserve the scarce resources on the other hand. This can be addressed effectively through Farmers Field Schools (FFS) to educate the farmers about adoption of new technologies and better utilization of resources to increase returns in bivoltine sericulture. Further, cost-cutting technologies like partial mechanization and drip irrigation should be popularized through subsidy schemes. These measures could encourage farmers to continue bivoltine sericulture and increase returns in the long run.

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