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Resource use efficiency and yield gap analysis of bivoltine cocoon production in Bilaspur district of Himachal Pradesh

Megha Rattan[1] and S.K. Chauhan*
Akal College of Economics, Commerce and Management
Eternal University, Baru Sahib-173 101, District Sirmour, India.

*Corresponding author: skchauhan1958@gmail.com
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Abstract

Sericulture an agro-based multitudinous activity involves growing of mulberry, production of laying, rearing of silkworms for cocoons, marketing and reeling of cocoons for value added products such as processing and weaving of the silk yarn.Due to short gestation period and labour intensive enterprise, it can go a long way in promoting economic growth and poverty alleviation in rural areas. A study was carried out to examine the resource use efficiency, technology adoption and yield gaps at silkworms' rearer level in Bilaspur district of Himachal Pradesh. Purposive two- stage random sampling method was used to select a sample of 60 silkworm (41 small and 19 large) rearers, who mostly raised one crop of bivoltine cocoons in spring season (March-April) whereas 68.33 per cent could raise two crops one in spring and other in autumn season (September-October).The findings revealed that average seed used by the rearers was 0.66 Oz (18.48 g) in spring season while it was just 0.28 Oz (7.84 g) in autumn because of its less suitability. Technologies adopted included the important parameters like improved mulberry variety plantation, disinfection, silkworm rearing house, maintenance of hygiene, good harvesting of required size and shape of cocoons etc. The index of realised potential farm yield (IRPFY) varied from 68.89 per cent in small farm to 72.48 per cent in large for the spring season whereas in the autumn season it varied between 41.00 to 47.33 per cent. Regression analysis indicated that 69 per cent of the variation in the cocoon yield was significantly affected by use of silkworm seed and daily frequency of mulberry feeding and thus considered important in cocoon production.

Key words: Mulberry, silk worm, cocoon, spring, resource use efficiency, yield gap.

Sericulture being an agro-based enterprise plays a significant role in shaping the economic destiny of the rural people and fits very well in India's rural structure, where agriculture continues to be the main industry. Being a labour intensive rural based industry, it offers a qualitative and quantitative change in the poverty alleviation with a chain creation of employment from unskilled farm labourers to skill artisans. The sericulture industry provides employment to more than 7.6 million people across 51,000 villages, which operate 328,627 handlooms and 45,867 power looms with 8, 14,616 weavers (Chauhan, 2002 and Chauhan *et al.* 2015). India, despite of its best efforts to promote sericulture; still continues to be one of the importers of raw silk. This indicates that there is vast scope for the development of silk industry in India. According to statistics, major mulberry silk producing states are Karnataka (43%), Andhra Pradesh (32%), West Bengal (7%), Tamil Nadu (10%) and Jammu and Kashmir (0.62%) which together accounts for 93 per cent of the country's total mulberry raw silk production. Clearly indicating that, major silk production is shared by Karnataka followed by Andhra Pradesh (Varmudy, 2011).Several socio-economic studies have affirmed that the benefit-cost ratio in sericulture is highest among comparable agricultural crops (Ganghopadhyay, 2008).

Himachal Pradesh is also quite well known countrywide for the quality of bivoltine silk cocoon production. This has been possible because of the suitable climate in the state for production of quality bivoltine silk cocoons. Sericulture activities are spread over in ten of the twelve districts.

[1] Agricultural Extension Officer, Development Block, Barsar, HP
*Professor- cum- Dean, AC ECM, Eternal University, Baru Sahib, HP

Sericulture has provided a fairly remunerative occupation to about 9000 families in 1900 villages and its major concentration is found in Bilaspur, Mandi, Hamirpur, Kangra, Una and Sirmaur districts. Therefore, keeping this into consideration, the present investigation was planned to study resource-use efficiency, the extent of adoption of recommended technology and prevailing yield gaps in cocoon production at different levels in Bilaspur district of Himachal Pradesh.

Methodology

The study was carried out purposively in Bilaspur district of Himachal Pradesh due to the reason that this district has come up as the largest producer of mulberry silk cocoons and agro climatic conditions & soil characteristics of the district are favourable for the mulberry silk production and quality mulberry raising trees.Wide representation point of view, three Government Sericulture Centres (GSCs), namely Auhar, Kandraur and Singasiwin being the most advanced, moderately advanced and less advanced centres, respectively were purposively selected. Two-stage random sampling technique was followed to select a sample of 10 villages and 60 silk worm rearers as ultimate unit of sampling. The entire sample of 60 silkworm rearers was divided into two categories viz., small (41) rearers (upto half ounce seed) and large (19) rearers (>half ounce seed).

Factors affecting yield of cocoon were examined through regression technique. Both linear and Cobb-Douglas production functions were tried to examine the factors affecting the yield of cocoons but on the basis of number of significant variables and the higher value of coefficient of multiple determination (R^2), Cobb Douglas production function was considered to be the best fit, the functional form of which is given as under:

$Y = b_0 X_1^{b1} X_2^{b2} X_3^{b3} X4^{b4} X_5^{b5} X_6^{b6} e^{\mu}$

$LogY = Logb_0 + b_1 LogX_1 + b_2 LogX_2 + b_3 LogX_3 + b_4 LogX_4 + b_5 LogX_5 + b_6 LogX_6 + \mu$

where, Y = Cocoon production per farm in Kg

X_1 = Human labour (man-days/farm)

X_2 = Silk seed used/farm for spring crop

X_3 = Mulberry leaves for feed (quintals/farm)

X_4 = Experience of silkworm rearing in years

X_5 = Feeding schedule (number of times feed application per day)

X_6 = Rearing house (dummy variable: 10 for separate rearing house; 1 otherwise)

b_0 = Intercept term

b_1 to b_6 = Regression coefficients

μ = Error term

The regression coefficients derived from observations in logarithms, are the elasticities with respect to individual variables. Their sum indicated the nature of returns to scale. With the sum being equal to 1, a given percentage increase in input results in proportional increase in output. With elasticity sums being more or less than one, implies that output will increase by a greater or smaller percentage respectively, than proportionate increase in inputs and depicted increasing and decreasing returns to scale. Coefficient of multiple determination (R^2) was computed to know the extent to which dependent variable got affected by all the explanatory variables. As the number of variables in the function increased, the value of R^2 also got increased.

Therefore, to overcome this problem, adjusted coefficient of multiple determination ($\overline{R}^2$) was calculated as follows:

$$\overline{R}^2 = 1 - (1 - R^2) . \frac{N-1}{N-K}$$

where, $\overline{R}^2$ = Adjusted coefficient of multiple determination

R^2 = Coefficient of multiple determination

N = Number of sample observations used in the model

K = Number of parameters estimated from the sample

The significance of R^2 was tested with the help of F-test as under:

$$F = \frac{R^2}{(1-R^2)\big/(N-K)} \sim F(K-1), (N-K)$$

where, N = Number of sample observations used in the model

K = Number of bi's (including constant term b_0)

The **yield gap analysis** included following concepts which were used by Lakshmanan (2007).

(i) *Total Yield Gap (TYG):* It is the difference between the experimental farm yield (Y_p) and the actual yield (Y_a).

$$TYG = Y_p - Y_a$$

Further the total yield gap comprised of yield gap-I and yield gap-II

a) Yield gap-I:It is the difference between the experimental farm yield (Y_p) and the progressive silk worm rearer yield (Y_d).

$$\text{Yield gap-I (per cent)} = \frac{(Y_p - Y_d)}{Y_p} * 100$$

b) Yield gap- II: It is the difference between the progressive silk worm rearer yield (Y_d) and the actual yield (Y_a).

$$\text{Yield gap- II (per cent)} = \frac{(Y_d - Y_a)}{Y_d} * 100$$

(ii) *Index of Yield Gap (IYG): It* is the ratio of the difference between the experimental farm yield (Y_p) and the actual yield (Y_a), expressed in percentage terms.

$$IYG = \left[{(Y_p - Y_a)}/{Y_p}\right] * 100$$

(iii) *Index of Realised Potential Yield (IRPY):*It is the ratio of the actual yield (Y_a) to the experimental farm yield (Y_p) expressed in percentage terms.

$$IRPY = \left({Y_a}/{Y_p}\right) * 100$$

(iv) *Index of Realised Potential Farm Yield (IRPY):*It is the ratio of the actual yield (Y_a) to theprogressive farmer yield (Y_d) expressed in percentage terms.

$$IRPFY = \left({Y_a}/{Y_d}\right) * 100$$

Adoption coefficient was worked out to study the impact of socio- economic factors on the adoption of different sericulture practices. For this purpose, very good practice was scored a value 3, in the same way good was scored value 2 and fair level of technology adoption was given score value of 1. The total score (actual score) was worked out for each rearer based on the level of adoption of technologies recommended for sericulture.

$$Adoption\ coefficient = \left[\frac{Actual\ score\ obtained}{Total\ score\ obtained}\right] * 100$$

Regression technique was followed to find out the extent of relationship between the socio-economic variables and adoption level of sericulture technologies. The general form of the regression equation was as follows:

$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + \mu$

where, Y = Dependent variable (Adoption coefficient)

X_1 = Education (number of schooling years)

X_2 = Area under mulberry (ha)

X_3 = Family members involved in sericulture (No.)

X_4 = Experience (years)

b_0 = Intercept term

b_1 to b_4 = Regression coefficients to be estimated

μ = Error term

Results and Discussion

Socio economic features and cocoon production function

During investigation, it was observed that there was no constraint of caste, age or marital status for participation in sericultural activities. Nuclear families with a family size of 3-4 members accounting for 50 per cent were engaged in sericulture. Majority of the women were found to possess middle standard education. Bulk of them had taken up sericulture as a main occupation with an experience of more than 15 years. By and large women from all the sample villages practiced sericulture as a family work with an average annual income upto Rs. 1.22 lakh. Thus, there has been impact of sericulture on socio-economic empowerment of women in the study area.

The mulberry cocoons production was the main crop output realised by sericulture households with large number of women in the study area and it is being determined by several factors. From the policy point of view, it is essential to quantify the degree of association and cause and effect relationship between the cocoon production on one hand and numerous factors affecting cocoon production on the other. Such an exercise may help the policy makers and sericulture farmers to concentrate upon the strategic variables. Therefore, an attempt has been made to examine the input-output relationship for cocoon production using Cobb Douglas production function on all farms in study area. The results for full model and stepwise function are given in Table 1 and Table 2.

The results of production function with all variables (Table 1) showed that only silk worms seed (X_2) and number of mulberry feedings per day (X_5) were the significant variables affecting the cocoon production. Average of silk seed used per farm in spring and autumn season was worked out to be 0.66 and 0.28 ounce. The remaining variables were found to be non-significant hence were not included in the results. The regression coefficients of Cobb-Douglas production function are the direct measures of elasticities of production for the inputs. These coefficients with positive signs and negative signs indicate, *ceteris paribus*, the percentage increase and or decrease in the dependent variable with one per cent increase in the quantity/number of independent variables.

The results of stepwise production function depicted in Table 2 revealed that silk worm seed (X_2) was the most important variable in affecting the cocoon production. The coefficient attached to this variable indicated that 1 per cent increase would enhance the cocoon production by 0.75 per cent. Next in importance was the number of mulberry feedings (X_5) provided per day to the silk worms. About 73 per cent farmers fed mulberry leaves to worms daily 4 to 5 times. This variable (mulberry feeding) shows that 1 per cent increase in the frequency of silk worms feeding may bring 0.39 per cent increase in the cocoon production. During the survey period it was found that the fresh mulberry leaves fed number of times significantly helped quick growth and maturity of silk worms. The sericulture farmers who could not provide fresh leaves at least four times a day, their crop was delayed by the same number of days and cocoon size also get reduced.

The returns to scale for these variables were found to be greater than unity thus indicating a scope for enhancing the use of specified variables on sericulture farms. The coefficient of adjusted multiple determination (was 0.77 for model fitted for overall farms which implies that the variables included in the linear regression model while put together explained 0.77 per cent of the variation in the level of technology adoption.

It can be observed from the table that socio-economic variables like education and area under mulberry showed negative relationship with level of technology adoption. However, the values for the coefficients were statistically non-significant revealing no specific conclusion. The other variables i.e. family members involvement and experience in this profession were found to have a positive relation with adoption level of sericulture practices. The positive and significant results for family involvement revealed that as sericulture is a labour intensive activity hence more the number of working hands better will be the quality and quantity of cocoon output. The estimated value of 3.22 for family members involvement showed that there would be an average increase of 3.22 in the index value of technology adoption if the family members involvement was enhanced by an additional member. During data collection it was noticed that lopping of mulberry branches and their transportation to home was made by men and children. However, pruning, chopping, feeding, bed cleaning, mounting etc. were nicely performed by women with their nimble hands.

The positive and significant outcome with regard to experience revealed that if experience increases by one year it may count for 0.47 points in the index level of technology adoption. Prakash and Dandin (2005)

Table 1. Estimates of cocoon production function for all variables

Sr. No.	Particulars	Regression coefficient	Standard error
1.	Constant (b_0)	3.2419	-
2.	Labour(X_1)	0.1900	0.1708
3.	Seed (X_2)	0.6699*	0.1328
4.	Mulberry (X_3)	-0.0121	0.1047
5.	Experience (X_4)	0.0586	0.0551
6.	Feeding (X_5)	0.3202**	0.1510
7.	Rearing house (X_6)	0.0133	0.0401
8.	Adjusted coefficient of multiple determination ($\overline{R}^2$)	0.71	-
9.	F - ratio	21.63	-
10.	$F_{tab(6,53)}$	3.254	-

* Indicate significance at 5 % level ; ** Indicate significance at 1 % level

Table 2. Estimates of cocoon production function for significant variables

Sr. No.	Particulars	Regression coefficient	Standard error
1.	Intercept (b_0)	5.7969	-
2.	Seed (X_2)	0.7548**	0.0922
3.	Feeding (X_5)	0.3943**	0.1405
4.	Coefficient of multiple determination ($\overline{R}^2$)	0.69	-
5.	F- ratio	63.41	-
6.	$F_{tab(2,57)}$	4.998	-

** Indicate significance at 1 % level

reported that socio- economic variables of farmers were found important in deciding about bivoltine silkworm rearing.

Yield gap analysis

The analysis of yield gap is very important in order to frame policies by the Government for the betterment of technologies being made available for the successful crop of cocoons. It has helped a vision of sericulture enterprise as an industry on a wider scale as well as one of the sources of bread and butter to the poorer sections of the society. The analysis of yield gaps at different levels in cocoon production depicted in Table 4 revealed that total yield gap for bivoltine cocoon in spring and autumn crop were 11.57 kg and 9.61 kg respectively.

Table 3. Relationship between socio-economic variables with technology adoption

Sr. No.	Variable	Symbol	Regression coefficient	Standard error
1.	Constant	b_0	17.3290	1.6219
2.	Education	X_1	-0.1165	0.1462
3.	Area under mulberry	X_2	-0.0273	0.0783
4.	Family members involved	X_3	3.2247**	0.4023
5.	Experience in years	X_4	0.4687**	0.1057
6.	Coefficient of multiple determination	$\overline{R}^2$	0.77	-
7.	F - ratio		46.03	-
8.	$F_{tab(4,55)}$		2.545	-

** Indicate significance at 1% level of significance

The index of realised potential farm yield (IRPFY) was to the tune of 70.87 per cent and 43.78 per cent for spring and autumn, respectively. The magnitude of yield gaps for different seasons at the overall farm level was also estimated. Yield gap I for spring crop was estimated to be 46.28 per cent while it was 64.07 per cent for the autumn season at the overall level. Across the farms, it was found that in the small farm category this gap was 64 per cent and 66.67 per cent for spring and autumn season, respectively, whereas, in large farms the gap was smaller with 8.00 per cent for spring and 60.00 per cent for autumn season, respectively. With regard to yield gap II at the overall level, it was 29.11 per cent and 56.21 per cent for spring and autumn, respectively. The other indices worked out were index of yield gap (IYG) and index of realised potential yield (IRPY). Index of yield gap (IYG) was 61.92 per cent in spring and 84.26 per cent in autumn season for the overall farmswhereas across the farms, for small farms IYG was 75.20 per cent and 86.33 per cent in spring and autumn season , respectively and it was lower in case of large farms i.e. 33.32 per cent and 81.07 per cent for spring and autumn, respectively. Realisation of potential yield achieved based on experimental farm, IRPY was also calculated. At the overall level 38.08 per cent yield in spring and 15.73 per cent yield in autumn season were achieved. Across the farms, small farms attained 24.80 per cent yield in spring and 13.67 per cent in autumn season whereas in the large farms higher percentage was realised with 66.68 per cent in spring and 18.93 per cent in autumn. The in-depth analysis of this table revealed that there were yield gaps in the spring crop to the extent of 29 per cent to 62 per cent which could be reduced with the technology package being adopted by sample farmers equivalent to their counterparts. Similar findings were reported by Prakash and Dandin (2005).

The reason for this disparity between small and large farms may be due to the low adoption of technologies and poor resources with small farmers in following silkworm practices. The large farms were adjudged better in terms of labour utilization, input use, experience, interest, better technical know- how and knowledge gained through regular in touch with department officials/ personnel to harvest better output of cocoons and through technology follow up. During the investigation it was also observed that autumn season crop was not a very successful one because of the higher humidity. The autumn season not only affected production rather the quality of cocoon harvest became poor due to higher humidity and increased fibrous content in mulberry leaves. Besides, spring crop was profitable than autumn season as it could fetch Rs. 2863 net returns per ounce of silk seed, however, the autumn season crop resulted negative returns to the extent of Rs. 933, Rs. 782 and Rs. 894 on small, large and overall farms mainly due to low average yield of cocoons.

Table 4. Average yield of cocoons and gaps under different scenarios

Sr. No.	Particulars	Unit	Farm size				Overall	
			Small		Large			
			Spring	Autumn	Spring	Autumn	Spring	Autumn
1.	Experimental farm yield (Y_p)	kg	25.00	15.00	25.00	15.00	25.00	15.00
2.	Progressive farmer yield (Y_d)	kg	9.00	5.00	23.00	6.00	13.43	5.39
3.	Actual Yield (Y_a)	kg	6.20	2.05	16.67	2.84	9.52	2.36
4.	Total yield gap (1-3)	kg	18.80	12.95	8.33	12.16	11.57	9.61
5.	Yield gap I $\left(1-2/_1 * 100\right)$	%	64.00	66.67	8.00	60.00	46.28	64.07
6.	Yield gap II $\left(2-3/_2 * 100\right)$	%	31.11	59.00	27.52	52.67	29.11	56.21
7.	Index of yield gap (IYG) $\left(1-3/_1 * 100\right)$	%	75.20	86.33	33.32	81.07	61.92	84.26
8.	Index of realised potential yield (IRPY) $\left(3/_1 * 100\right)$	%	24.80	13.67	66.68	18.93	38.08	15.73
9.	Index of realised potential farm yield (IRPFY) $\left(3/_2 * 100\right)$	%	68.89	41.00	72.48	47.33	70.87	43.78

Conclusion and Policy Implications

The study revealed that only two variables *viz*; silk worms seed and daily frequency of mulberry feeding to worms were the most important in affecting the cocoon production. Thus, enhanced use of these inputs may increase the volume of cocoon production significantly. Similarly, experience of sericulture farmers and effective involvement of number of family members in this enterprise were found to have significant importance in the adoption of technology. To reduce observed yield gaps, sericulture implementing agencies such as Department of Sericulture, NGOs and Self- Help Groups should train the farmers to attain potential yield which may indirectly enhance women empowerment as they play a major role in this enterprise. Since, the autumn season crop was found to give negative returns; therefore, sericulture farmers should be provided with technology which could control humidity in the rearing room, develop silkworm races thriving well in high humid condition as well as to develop varieties of mulberry plantation yielding quality leaves with less fibre content after the rainy season.

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References

Chauhan SK. 2002. Sericulture - A tool for income and employment generation in Himachal Pradesh. Asian Economic Review **44** (3): 512-520.

Chauhan SK, Chouhan Sakshi and Rattan Megha. 2015. A study in the impact of sericulture development programmes in Himachal Pradesh. Indian Journal of Agricultural Economics **70** (3): 289-290.

Gangopadhyay D. 2008. Sericulture industry in India-An overview. India, Science and Technology http://www.nistads.res.in

Lakshmanan S. 2007. Yield gaps in mulberry sericulture in Karnataka: An Econometric Analysis. Indian Journal of Agricultural Economics **62** (4): 623-636.

Prakash Vijay NB and Dandin SB. 2005. Yield gaps and constraints in bivoltine cocoon production in Mandya district of Karnataka- An economic analysis. Indian Journal of Sericulture **44** (1): 50-54.

Prakash Vijay NB and Dandin SB. 2005. Factors influencing the adoption of bivoltine sericultural practices in Mandya district of Karnataka. Indian Journal of Sericulture **44** (1): 55-58.

Varmudy Vigneshwara. 2011. Silk industry: Need to become competitive. Market Survey 17-22.