

Evaluation of Cost of Cross Breed of Silkworm Cocoon Production in Karnataka – An Economic Study

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ABSTRACT

Sericulture is an alternative to conventional farming that yields fast profits with little initial commitment to the farmers. Reliable revenue generation is one of the sericulture's primary benefits. The expenditure incurred for the process to generate income having a pivotal role in deciding a loss or profit. Therefore, a holistic effort was made to know the cost of cross breed silkworm cocoon production in sericulture practicing 15 districts of Karnataka. The total cost of cocoon production is primarily distributed into Labor charges (44.72%), Chawki worm cost (29.12%), Farmyard manure, fertilizers, and pesticides (18.82%), Rent for mountages and fuel expenses (4.10%), and Rearing consumables (3.24%). The total expenditure also categorized into paid-out costs (55.58%) and unpaid costs (44.42%). The cost of production per kg of crossbreed cocoons was found ₹ 326 and the average market price for cocoons was ₹ 419 per kg. The net income per hectare was ₹ 1,22,790, with a cost-benefit ratio of 1:1.29. It is found that still there is a scope to encourage sustainable sericulture techniques to mitigate labour expenses, as well as training programs and adoption of mechanisation to curtail the expenditure for the silkworm cocoon production. So, the profit shall be increased by minimising the expenditure spending towards labor and chawki worms' cost.

Keywords: cocoon production, costs and returns, paid out cost, unpaid cost, Sericulture economics

The rural economy of India is significantly influenced by agriculture and agro-based industries. Furthermore, the limited land area per family, poor returns from crops, and dependence on irrigation and rain-fed cropping patterns result in low agricultural income, prompting agrarians to seek alternative rural industries such as sericulture.

Sericulture, the production of silkworms and ultimately silk fiber, has emerged as a promising rural activity in India due to its minimal gestation period, low investment requirements, high employment potential, and quick returns on investment. India ranks second only to China in raw silk production

and also a major consumer of pure silk. Sericulture is a labour-intensive, small-scale agrarian industry that requires minimal investment, making it particularly suitable for marginal and small landholders. Its high returns, short gestation period, and potential for generating employment, especially for women, contribute to its economic significance (Santosh Kumar Dewangan, 2018; Shabir Ahmad Bhat *et al.* 2024).

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Sericulture stands out as a viable rural occupation for alleviating poverty, generating employment, empowering women and economically disadvantaged citizens, and fostering inclusive development. This industry has proven to be commercially viable for both marginal and small farmers due to its low investment requirements, high returns, short gestation period, and year-round employment opportunities for families (Kritika Sharma and Bhumika Kapoor, 2020).

Sericulture is both an art and a science, involving the rearing of silkworms to produce cocoons and silk. It encompasses various interdependent activities, including mulberry cultivation for silkworm feed, silkworm rearing for quality cocoon production, silk thread reeling from cocoons, silk yarn weaving, and further processing to produce silk fabric (Kumar *et al.* 2019). The cultivation of mulberry and the rearing of silkworms are farm-based activities managed by silkworm cocoon producers.

It is a well-known fact that, despite being an agricultural country, India struggles with inadequate pricing for agricultural products in the market. Various factors contribute to this issue, and the pricing of silk cocoons in sericulture is no exception. Calculating the cost of cocoon production is crucial for assessing the economic viability of sericulture as a livelihood option. Understanding the economics of cocoon production is essential for farmers, researchers, industry professionals, and policymakers to enhance profitability and sustainability. Accurate cost analysis enables farmers to make informed decisions regarding pricing, resource allocation, expenditure minimization, and productivity optimization. Additionally, cost data is vital for stakeholders across the silk industry, from sericulturists to silk manufacturers, in establishing competitive market prices and enhancing global silk trade.

In this context, an effort has been made to analyse the cost of crossbreed cocoon production at the farmer's level.

MATERIALS AND METHODS

In the present study, data were collected from 1,335 farmers engaged in crossbreed silkworm rearing (Pure Mysore × CSR2), covering 1,005 hectares of

mulberry cultivation, using a random sampling method. The data collection was facilitated by officials from the Department of Sericulture, Government of Karnataka. A structured questionnaire was designed to conduct personal interviews with farmers, ensuring comprehensive coverage of all sericulture-related activities undertaken by them during the 2023–24 period. Data collection was conducted through Google Forms, following the recommendations of Basavaraja (2015) (Table 1).

Cost Calculation Methods

1. Amortized Cost: Amortized cost in agrarian economics refers to the method of distributing the cost of long-term agricultural investments over their useful life to assess their annual financial impact. This approach helps farmers, researchers, and policy makers determine the true cost of production, ensuring financial sustainability and investment feasibility in farming operations.

To calculate the amortized cost of investments in mulberry garden establishment, rearing house construction, and silkworm rearing infrastructure, the total investment amount was divided by the expected number of feasible years of use. This was done to introduce the depreciation concept, which encourages reinvestments. Additionally, a 12% interest rate was applied to the obtained amount.

2. Rental Value of Mulberry Garden (Per Acre): Including rental value in cost calculations provides a realistic and holistic economic assessment, ensuring that farming remains sustainable, competitive, and profitable in the long run. Therefore, estimated rental income prevailing for agricultural land in the state was included as the rental value of the mulberry garden.

3. Imputed Value of Family Labor: The imputed value of family labor refers to the estimated monetary worth of labor contributed by family members in agricultural activities, even though they are not directly paid wages. Since many farming households rely on family labor instead of hired workers, assigning a value to this labor is crucial for accurately assessing production costs and profitability. It ensures that agricultural cost calculations are realistic and reflect the true economic value of unpaid work, playing a vital role in profitability analysis,

investment decisions, and rural development policies, making it a key component in agricultural economics.

The cost of labor contributed by the farmer and their household members was accounted for in the form of wages. This included the opportunity cost—the wages the farmer would have earned had they engaged in other agricultural activities instead of sericulture.

4. Minimum Profit: Minimum profit is a crucial factor in agricultural economics because it ensures that farming remains a sustainable and economically viable occupation. Unlike other businesses, agriculture involves high risks due to unpredictable weather, fluctuating market prices, and varying input costs. By incorporating a minimum profit margin into cost calculations, farmers can cover their expenses, sustain livelihoods, and reinvest in their farms for long-term productivity.

A minimum profit margin of 10% was assumed to reflect the baseline earnings expected by any individual engaged in productive work.

5. Anticipated Loss: Anticipated loss refers to the estimated percentage of production loss that farmers expect due to various uncontrollable factors such as pest infestations, weather conditions, diseases, and market fluctuations. In agricultural economics, incorporating anticipated loss is essential for ensuring realistic cost estimations, risk management, and financial sustainability.

A 5% loss in silkworm cocoon yield was factored in as an anticipated loss while calculating cocoon production costs. This adjustment was made despite the assumption that the farmer successfully produced a healthy cocoon crop.

6. Cost of Production Per Kilogram of Crossbreed Cocoons: The production cost per kilogram of crossbreed cocoons was determined by dividing the total production cost (Table 1) by the average cocoon yield per 100 dfles (disease-free layings).

In addition to the parameters listed in Table 1, additional data were collected on the adoption of modern sericulture techniques, including:

- ♦ **Mulberry Varieties:** V1, Vishala, and G series.
- ♦ **Source of Irrigation:** Borewell, canal, and open well.

- ♦ **Type of Irrigation:** Drip irrigation, ridges and furrow method, and sprinklers.
- ♦ **Rearing Method:** Shoot-feeding with a tray system.

Statistical tools such as mean and percentage analysis were employed to meet the study's objectives, as suggested by Basavaraja (2015).

RESULTS AND DISCUSSION

Understanding the economics of cocoon production is crucial for both farmers and policymakers to enhance profitability and sustainability in sericulture. Therefore, the present study have been conducted across the sericulture adopted districts.

In Karnataka, the total area under mulberry cultivation is 1,16,898 hectares, with 1,48,704 farmers engaged in bivoltine and crossbreed silkworm rearing (Anonymous, 2024). The present study covered 1,005 hectares of mulberry cultivation, accounting for 0.86% of the total area and 1,335 crossbreed silkworm rearers, representing 0.90% of the total sericulture farmers.

The survey was conducted across 15 silkworm-rearing districts in Karnataka: Bangalore City, Bangalore Rural, Kolar, Chikkaballapur, Chitradurga, Davangere, Ramanagara, Shimoga, Tumkur, Chamarajanagar, Hassan, Mandya, Mysore, Belgaum, and Kalaburagi. It included 180 Technical Service Centres (TSCs) across these districts.

From the study, it was found that 276 man-days of employment were generated per acre of mulberry cultivation and silkworm rearing annually. This makes sericulture one of the highest employment-generating sectors compared to other agriculture and agro-based industries. The average labor wage was found to be ₹ 440 per person per day (Table 2).

Breakdown of Production Costs

The total cost of cocoon production is primarily distributed as follows (Table 2):

- ♦ Labor charges: ₹ 1,21,440 (44.72%)
- ♦ Chawki worm cost: ₹ 79,071.84 (29.12%)
- ♦ Farmyard manure, fertilizers, and pesticides: ₹ 51,094 (18.82%)

Table 1: List of various factors considered for the calculation of cost of CB cocoon production (1 kg)

Sl. No.	Particulars
A	Mulberry Cultivation Cost
1	Labour Charges (Removal of weak branches & weeding, Irrigation, Ploughing, Pruning, Input application and Spraying) approximately 13 days/crop
2	Cost of Farm yard manure (8 tons as per recommendations)
3	Cost of Fertilizers (NPK)
4	Cost of Pesticides (Pests and Diseases management)
5	Amortized establishment cost: <ul style="list-style-type: none"> • Establishment cost of mulberry garden - Tractor tilling-4 hrs., Harrowing-2 hrs., Final land preparation by Bullock power, making trenches with tractor (hr). • Mulberry saplings cost • Labor Charges (Planting mulberry saplings-20 man days (MD), Fertilizer application-2 MD, Irrigation-10 MD, Hoeing/Weeding-3 times 20 MD). • Borewell, irrigation facilities and garden implements • Miscellaneous expenditure.
6	Land revenue/Tax
B	Silkworm Rearing
1	Labour Charges (Mulberry shoot harvesting, feeding silkworm, bed cleaning, selecting ripened silkworm larvae and monitoring the spinning, cocoon harvesting, cocoon marketing) approximately 38 days
2	Cost of Silkworm Chawki worms
3	Rearing consumables (Old Newspapers, Room Disinfectants, Bleaching Powder, Lime Powder and Bed Disinfectants)
4	Electricity (fuel) charges
5	Mountages rent
6	Amortized establishment cost: <ul style="list-style-type: none"> • Construction of Silkworm Rearing building (1064 sq ft/100 dfls) • Silkworm Rearing implements - Leaf chopping board, Leaf chopping knife, Leaf Chamber, shoot rearing stand (1200sq ft/100dfls), Electric power sprayer for disinfection, Room heater + Thermostat, Bed cleaning net 15 Nos. (2x'), Wet & Dry thermometer, Egg carrying box, Pot incubator, Plastic ware.
C	Rental value of mulberry garden 1 acre
D	Imputed value of family labour (MD)
E	Managerial Cost [Minimum Profit - 10 % of (A + B + C + D) + Anticipated loss - 5% of paid out cost of (A + B + C + D) + Marketing Cost]
F	Total Production Cost - A + B + C + D + E

Table 2: Economics of cost of production of cross breed silkworm cocoon

Sl. No.	Particulars	Quantity	Rate	Amount	Paid out Cost	Unpaid Cost
A	Mulberry Cultivation and Silkworm rearing Cost					
1	Amortized establishment cost	—	—	70,636	—	70,636
2	Labour Charges (Man Days)	174	440	76,560	76,560	—
3	Cost of Farm yard manure (Ton)	08	3,100	24,800	24,800	—
4	Cost of Fertilizers	—	—	21,294	21,294	—
5	Cost of Pesticides	—	—	5,000	5,000	—
6	Land revenue/Tax	—	—	500	500	—
7	Cost of Silkworm Chawki worms	1548	51.08	79,072	79,072	—
8	Rearing consumables	—	—	8,800	8,800	—
9	Electricity (fuel) charges	—	—	3,121	3,121	—
10	Mountages rent	—	—	8,000	8,000	—
B	Rental value of mulberry garden			20,000	—	20,000
C	Imputed value of family labour (MD)	102	440	44,880	—	44,880
	Total (A+B+C)	—	—	3,62,663	2,27,147	1,35,516
E	Managerial Cost	—	—	49,912	2,179	47,733
F	Total Production Cost	—	—	4,12,574	2,29,326	1,83,249

- ♦ Rent for mountages and fuel expenses: ₹ 11,121 (4.10%)
- ♦ Rearing consumables: ₹ 8,800 (3.24%)

Scope for Cost Reduction and Mechanization

The study reveals that 73.84% of total production costs are spent on labor charges and chawki worms. This indicates a significant scope for mechanization to reduce labor dependency and lower production costs.

Additionally, if farmers adopt scientific silkworm rearing techniques-including black boxing, hatching, and adult rearing-they can reduce their reliance on private chawki rearing centers. This would minimize expenses and enhance farmer savings, ultimately improving the profitability of sericulture.

Cost Analysis of Cocoon Production

The total expenditure for cocoon production can be categorized into paid-out costs and unpaid costs.

- ♦ Paid-out costs refer to the actual amount spent by farmers on mulberry garden maintenance (labor charges, farmyard manure, fertilizers, pesticides, and land revenue/tax) and silkworm rearing (labor charges, chawki worms, rearing consumables, electricity/fuel charges, mountage rent, and marketing costs).
- ♦ Unpaid costs represent the amount retained by the farmer without direct payments to others. These include the amortized establishment cost of mulberry garden and silkworm rearing, rental value of the mulberry garden, imputed value of family labor, and managerial costs.

In the present study, the paid-out cost was ₹ 2,29,326 (55.58%), while the unpaid cost was ₹ 1,83,248 (44.42%). This means that 44.42% of the total expenditure on cocoon production remains with the farmer as unpaid costs. Compared to other commercial crops, this high proportion of retained costs serves as a strong incentive for non-sericulture farmers to adopt sericulture.

Cocoon Yield and Economic Returns (Table 3)

- ♦ The average crossbreed cocoon yield in the present study was 84.35 kg per 100 DFLs.

- ♦ Farmers rear 194 DFLs per crop per acre, with an average of 6 crops per acre per year, resulting in a total of 1,165 DFLs per year per acre.
- ♦ The average market price for cocoons was ₹ 419 per kg.
- ♦ The cost of production per kg of crossbreed cocoons was ₹ 326.
- ♦ The average annual income from rearing crossbreed silkworm cocoons was ₹ 5,35,364 per hectare.
- ♦ The net income per hectare was ₹ 1,22,790, with a cost-benefit ratio of 1:1.29.

Table 3: Economics of cost of production of cross breed silkworm cocoon

Sl. No.	Particulars	Data
1	No. of data collected (Sericulture farmers)	1335
2	Area under mulberry (in acre)	2513
3	Area under mulberry (in hectare)	1005
4	No. of crops brushed/year	6
5	Average Chawki brushed/acre/crop	194
6	Chawki brushed/acre/Year	1165
7	Average cocoon rate/kg/year (₹)	419
8	Average cocoon yield per 100 DFL's	84.35
9	Average income/ha (₹)	535364
10	Cost of Cocoon Production (₹/kg)	326
11	Cost : Benefit	1:1.29

Comparison with Previous Studies

A similar cost-benefit ratio was reported by Susikaran (2020), who observed:

- ♦ Marginal farmers: Cost-benefit ratio of 1:2.11, total production cost ₹ 3,28,962.53/ha/year, and net income ₹ 3,66,357.67/ha /year.
- ♦ Small farmers: Cost-benefit ratio of 1:2.15, total production cost ₹ 3,70,544.47/ha/year, and net income ₹ 4,25,594.43/ha/year.
- ♦ Medium farmers: Cost-benefit ratio of 1:2.31, total production cost ₹ 3,96,102.52/ha/year, and net income ₹ 5,19,466.78/ha /year.

However, Choudhari *et al.* (2021) provided contradictory estimates in Parbhani District,

Maharashtra. They reported:

- ♦ A total cost of ₹ 1,33,507.20 for rearing 672.51 DFLs in 4.16 batches per year.
- ♦ A gross return of ₹ 2,79,442.42 and a net profit of ₹ 1,45,935.21.
- ♦ A per kg cocoon production cost of ₹ 215.82.

Joycy Rani *et al.* (2024) assessed the silkworm cocoon production and its profitability in 11 mega clusters of Karnataka through structured survey during 2021-22, comprising sample of 220 farmers. They highlighted, that The farmers take 7 crops/year⁻¹, the average cocoon yield was 85.09 kg per 100 dfls. The cost of production per kg of cocoon was ₹ 354 and the average market rate fetched was 609.64 ₹ / kg, The total cost incurred for rearing of 1285 dfls was worked out to be ₹ 4,11,500.95 acre/annum. Among the total cost, maximum cost was incurred towards the operational costs ₹ 2,67,697 (65.05%), among which labour cost accounted to 30.78%. The total fixed costs Were accounted to ₹ 1, 43,803, the depreciation cost incurred on rearing house and assets was 22.50% (₹ 92,583.86). In Karnataka, practising sericulture was found to be remunerative with a net profit of ₹ 2,87,448 acre/year with returns per rupee of investment is 1.64.

Hajare, (2008) reveals that mulberry sericulture generates 170 man days, while alternative crop combinations like soybean-wheat, soybean-gram and cotton-pigeon pea generate 66, 61 and 65 man days, respectively.

Usha Rani (2007) has shown that 96.36 man days of employment are generated from the establishment of one acre of mulberry garden for rearing 300 dfls (disease free layings) of silkworms in two months.

These variations highlight the regional differences in cocoon production economics and the number of crops cultivated per year. Emphasizing the need for localized cost assessments to optimize profitability in sericulture.

Sericulture Practices Adopted by Farmers (Table 4)

Data on mulberry varieties (V1, Vishala, and G series), source of irrigation (borewell, channel, and open well), type of irrigation (drip irrigation, ridges

& furrow method, and sprinklers), and rearing method (shoot feeding with tray system) were collected from sericulture farmers (Table 4).

Table 4: Details of the adoption of new techniques for the mulberry cultivation and silkworm rearing

Sl. No.	Particulars	Numbers
1	Mulberry variety	
	V1	1332 (99.78)
	Vishala	2 (0.15)
	G Series	1 (0.07)
2	Source of Irrigation	
	Bore well	1300 (97.38)
	Channel	25 (1.87)
	Open well	10 (0.75)
3	Type of irrigation methods	
	Drip Irrigation	939 (70.34)
	Ridges & Furrow Method	391 (29.29)
	Sprinklers	5 (0.37)
4	Rearing Type	
	Shoot Rearing	1335 (100)

Data in parenthesis is %.

- ♦ Mulberry Varieties Used for Silkworm Rearing:
 - ♦ The V1 variety was used by 1,332 farmers (99.78%).
 - ♦ The Vishala variety was used by 2 farmers (0.15%).
 - ♦ The G series variety was used by 1 farmer (0.07%).
- ♦ Source of Irrigation for Mulberry Cultivation:
 - ♦ 1,300 farmers relied on borewell water.
 - ♦ 25 farmers used channel water.
 - ♦ 10 farmers depended on open well water.
- ♦ Irrigation Methods Adopted:
 - ♦ Drip irrigation was followed by 939 farmers (70.34%).
 - ♦ Ridges and furrow method was used by 391 farmers (29.29%).
 - ♦ Sprinkler irrigation was adopted by 5 farmers (0.37%).

- ♦ Rearing Method:
 - ♦ All 1,335 farmers (100%) adopted the mulberry shoot harvesting method and used the tray system for silkworm rearing.

This data highlights the dominance of the V1 mulberry variety, widespread use of borewell irrigation, and a strong preference for drip irrigation among sericulture farmers. Additionally, the universal adoption of the shoot harvesting method and tray system suggests a standardized approach to silkworm rearing in the region.

Inference and suggestions

The study highlights the economic viability of sericulture as a sustainable and profitable rural enterprise in Karnataka. With high employment generation, low investment requirements, and quick returns, sericulture proves to be a lucrative alternative to traditional agriculture for small and marginal farmers.

Key findings indicate that:

- ♦ Mulberry Variety & Irrigation Practices:
 - ♦ The V1 mulberry variety is overwhelmingly preferred by farmers (99.78%).
 - ♦ Borewell irrigation (97.4%) is the dominant water source, and drip irrigation (70.34%) is the most widely adopted method, ensuring efficient water use.
- ♦ Cost of Production & Profitability:
 - ♦ The total production cost per kilogram of crossbreed silkworm cocoons was ₹ 326, while the average market price was ₹ 419 per kg, yielding a cost-benefit ratio of 1:1.29.
 - ♦ Sericulture offers higher retained income (44.42% of total costs remain unpaid, benefiting farmers directly).
- ♦ Employment Generation:
 - ♦ Sericulture generates 276 man-days of employment per acre per year, significantly higher than other agricultural and agro-based industries.

- ♦ The average wage per laborer was ₹ 440 per day, further emphasizing the sector's role in rural employment and income generation.
- ♦ Scope for Cost Reduction:
 - ♦ Labor (44.72%) and chawki worms (29.12%) constitute the largest portion of production costs.
 - ♦ Mechanization and scientific silkworm rearing techniques can significantly reduce costs and enhance profitability.

Policy Implications

1. *Scaling Up Drip Irrigation:* Given its dominance among successful sericulture farmers, government incentives and subsidies should encourage its adoption among the remaining 30% of farmers to optimize resource utilization.
2. *Promotion of Scientific Rearing Techniques:* The reliance on private chawki centers increases production costs. Training farmers in self-rearing techniques can enhance profitability and reduce dependence on external sources.
3. *Sericulture as a Poverty Alleviation Tool:* The study reinforces sericulture's potential to generate rural employment, empower women and small farmers, and enhance livelihood security. Expansion of sericulture programs can reduce rural distress and provide year-round income opportunities.
4. *Regional Cost Analysis for Better Profitability:* The variation in cost-benefit ratios across regions underscores the need for localized strategies to optimize production efficiency and market competitiveness.

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