

# Integrating Sericulture into Rural Livelihood Strategies: A Sustainable Development Perspective from Rural India

Ashwini Pandhare\*<sup>1</sup> and Praveen Naik Bellampalli<sup>2</sup>

<sup>1</sup> Department of Rural Development, School of Social Sciences at Punyashlok Ahilyadevi Holkar, Solapur University, Solapur - 413 255, Maharashtra, India

<sup>2</sup> Department of Social Work, PSGR Krishnammal College for Women, Coimbatore - 641 004, Tamil Nadu, India

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## Abstract

Sericulture is one of the oldest farming practices, and it is an essential means of livelihood for farmers in India. In Maharashtra state, for the last decade, Osmanabad has been one of the leading districts in sericulture, and it has an important place in the economy of drought-prone regions. However, drought often leads to crop failures, exhaustion of groundwater levels, food insecurity, and uncertain income for small and marginalized farmers in the district. Therefore, diversification of agriculture through sericulture farming could effectively create employment opportunities and provide sustainable livelihoods to the farmers. The present study is designed to understand the role of sericulture farming in providing sustainable livelihoods for farmers, and it covers 150 farmers engaged in sericulture farming. The study found that sericulture farming has created employment opportunities, improved farmers' economic conditions, and promoted women's empowerment. The findings were presented using the Triple Bottom Line model of Sustainability.

**Key words:** Sericulture, Sustainable livelihood, Employment opportunities, Empowerment

Agriculture is the backbone of the Indian economy and is recognized as the primary sector for employment generation and income. A substantial share of rural livelihood is derived from agricultural work; however, it cannot provide satisfactory income to farmers in the era of competition, industrialization and urbanization. Thus, the transformation of agricultural practices through sustainable diversification is one of the best options, which needs to be stressed to achieve sustainable development goals [1]. Besides crop production activities, which generate employment potentially and substantially are dairy, fisheries, poultry, horticulture, sericulture, etc. Sericulture is one of the essential rural agro-based activities with global reach [2-3]. The unique features of the sericulture sector are rural in nature and ecologically and economically sustainable activity for small, marginal farmers, agricultural labourers, and women in particular [4]. Sericulture practice is divided into two sectors: the farm sector, which involves growing mulberry plants, rearing silkworms, and producing cocoons. The industry sector involves reeling, twisting, dyeing, printing, finishing, and knitting. Every sector of sericulture provides large-scale employment opportunities [5]. Therefore, it has been seen that sericulture farming enhances the sustainable livelihood of rural communities in different countries. It is discretely helping to build an egalitarian society in highly populous countries like India and China [6].

China is the first and largest silk producer country, and India is the second-highest silk producer country globally [7-8]. China's contribution to world silk production is 80 per cent (158,400 metric tonnes), and the share of Indian silk production

is 13 per cent (30,348 metric tons). China and India together account for 93% of world silk production. The remaining 7 per cent of silk-producing countries worldwide are Uzbekistan, Brazil, Japan, the Republic of Korea, Thailand, Vietnam, and Iran [9]. It observed that there had been an increasing demand for silk and silk products from developed countries in the last few decades, which led to earning foreign exchange. This helps to improve the economic status of developing countries [10-11].

India earns a substantial foreign exchange by exporting raw silk and finished products. In India, sericulture has become the most promising allied agricultural activity in rural areas for the reasons of the minimum gestation period, low investment, maximum employment potential and quick turnover for investment [12]. Therefore, sericulture has a place in planning for rural development in India [13]. India is the only country in the world producing all four types of silk. Mulberry, Eri, Tasar and Muga. Mulberry is India's largest practiced sericulture industry [14-15]. Mulberry silk production contributes almost 75 per cent of the entire silk production in the country. The sericulture industry employs approximately 9.52 million people in rural and semi-urban areas in India, of whom about 50 per cent are women. It has been reported that women contribute about 50 per cent and 60 per cent of the labour to mulberry cultivation and silkworm rearing, respectively [16]. Therefore, women's contribution to the silk industry is high at all stages. It provides sustainable employment opportunities for women, particularly in rural areas. Women working in sericulture practice have experienced various benefits, such as increased asset ownership, higher participation in work, decision-making,

\*Correspondence to: Ashwini Pandhare, E-mail: ashwinipandhare22@gmail.com; Tel: +91 9511794441

improved access to resources like credit, land, markets, and involvement in local civic bodies [17-19].

Indian silk production has increased drastically since independence. The raw silk production of 1437 MTs (Metric tons) during 1969- 74 increased to 21000 MTs during 2010- 11 and 35820 MTs during 2019. Out of the total raw silk production in the country, the mulberry sector contributed 25,345 MTs compared to 22,066 MTs in 2017-18. The Vanya sector, comprising tasar, eri and muga silks, produced 10,124 MT of raw silk with 6,910 MT of Eri, 2,981 MT of Tasar and 233 MT of Muga during 2018-19 [20]. In India, Karnataka, Andhra Pradesh, Assam, Tamil Nadu, Meghalaya, Jharkhand, Manipur, West Bengal, Maharashtra, and Chhattisgarh are the major silk-producing states. In India, sericulture provides employment not only to the rural but also semi-urban population, i.e., mulberry cultivators, cooperative institutions, silkworm seed producers, farmers- cum- rearers, reeler, twistlers, weavers, hand spinners of silk waste and traders. Therefore, Sericulture is a cash crop in the agriculture sector; it gives returns within 30 days [21-22].

In Maharashtra, sericulture is a traditional practice. The state has been involved in sericulture and producing mulberry and Tasar silk for the last five decades. Currently, the silk industry is progressive in 28 districts. Mulberry sericulture is practiced in 24 districts, and Tasar in four districts. In 2017-18, farmers produced 2280 MT of mulberry cocoons to produce 350 MT of raw silk. Similarly, the tasar farmers reared 354 lakhs of tasar cocoons, out of which 19.33 MT of tasar raw silk was produced. Presently, in the state, Beed district stands first in mulberry sericulture farming, and secondly, Osmanabad is leading [23]. Thus, sericulture provides good employment opportunities for farmers in the state.

The Osmanabad district of Maharashtra mostly depends on rain-fed farming, with about 73% of the population residing in rural areas. However, the region faces challenges due to low rainfall and unsustainable farming practices, resulting in crop failure, groundwater depletion, and uncertain income for small and marginal farmers. Thus, sericulture is a recently adopted large-scale practice for solving the problems of rural livelihood and income generation. The climate of the Osmanabad district is suitable for rearing silkworms [20]. It has been proved that mulberry silkworm rearing is technically feasible and economically viable in the Osmanabad district. From the last decade, sericulture farming has been boosted in the district. In 2019-20, 1747 farmers were engaged in sericulture activity, and 1897 acres of land were under mulberry plantation in the district. The development of sericulture in this district is increasing continuously, proving its worth. The article focuses on the role of sericulture in the Osmanabad district as a sustainable livelihood source.

The paper is organized into five sections; the first section briefly introduces the topic, focusing on the sericulture situation worldwide and the importance of sericulture in a particular region. The second section elaborates on detailed information about the methods and design of the study, including a thorough description of the study site. The third section contextualized the extensive results and detailed discussion of the primary survey results and secondary information. The triple-bottom-line framework for the sustainability of sericulture farming is described in section four. Finally, the last section provides the conclusion of the study.

## MATERIALS AND METHODS

The present study used a descriptive research design, which aims to understand the role of sericulture as a sustainable

livelihood source in the Osmanabad district, Maharashtra. The study used a mixed research method, which includes both qualitative and quantitative research methods. The district has eight blocks. Out of these eight blocks, three blocks, viz. Kalamb, Washi, and Bhoom were chosen for the study based on their significant adoption of sericulture. Purposive sampling was used to select the farmers engaged in sericulture, and the sample size was 150 farmers who were interviewed. The farmer selection process included 63 farmers from the Washi block, 46 farmers from Kalamb, and 41 farmers from Bhoom, who have been identified for the study. The study collected data from both primary and secondary sources. Primary data were collected through the interview schedule, and secondary data were collected from organizational reports of the Central Silk Board India, the Agriculture and Sericulture Department of Maharashtra, and other relevant sources. To analyze the quantitative data, Microsoft Excel was used. Descriptive statistics, such as diagrams, percentages, and averages, were computed based on the needs of the study.

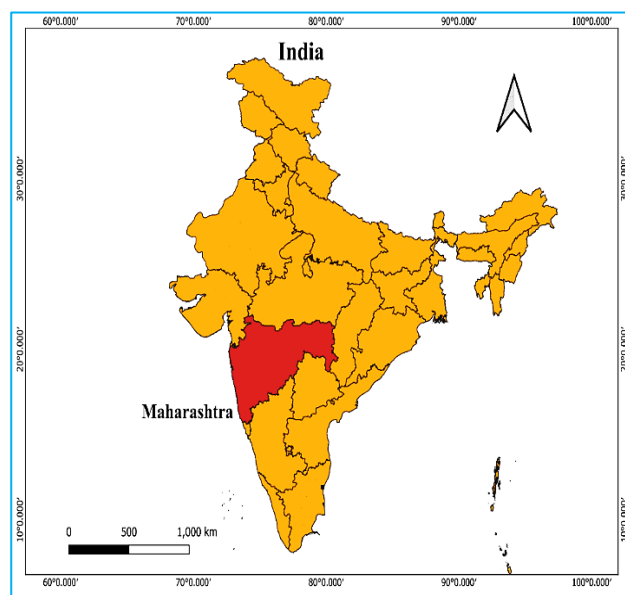


Fig 1 Map of the study area

### Overview of the study area

This study was conducted in the Osmanabad district of Maharashtra state. Osmanabad district, along with the other seven districts of the Marathwada region, was formerly part of Nizam's State up to 1950. Osmanabad district lies between 17 ° 35' and 18 ° 40' latitude and 75 ° 16' and 76 ° 40' east longitudes. It has a geographical area of 7512.4 sq. Kms. The district has eight blocks viz. Osmanabad, Tuljapur, Umarga, Lohara, Bhum, Kalamb, Paranda and Washi. It is surrounded on the South by part of Solapur district and part of Gulbarga district of Karnataka State, on the North by Beed district, on the east by Latur district and on the west by part of Ahmednagar district.

According to the 2011 census, the population of the district is 16.60 lacks as per 2011 census. Out of which, 8.64 lacks are Males, and 7.96 are Female. The population of SC and ST is 2.74 lacks (16.53%) and 0.31 lacks (1.87%), respectively. The growth rate of the population is 2.39% per annum. Out of the total population, 13.79 lacks lives in a rural area, and 2.81 lacks in an urban area. The literacy rate of the district is 76.33%. The district has a relatively warm and dry climate. In winter, the temperature drops to about 11° Celsius, and in summer, the maximum temperature reaches 43° Celsius. The district climate is generally dry and subject to extremes. The average rainfall of the district is 600-700 mm. Osmanabad district has a diverse

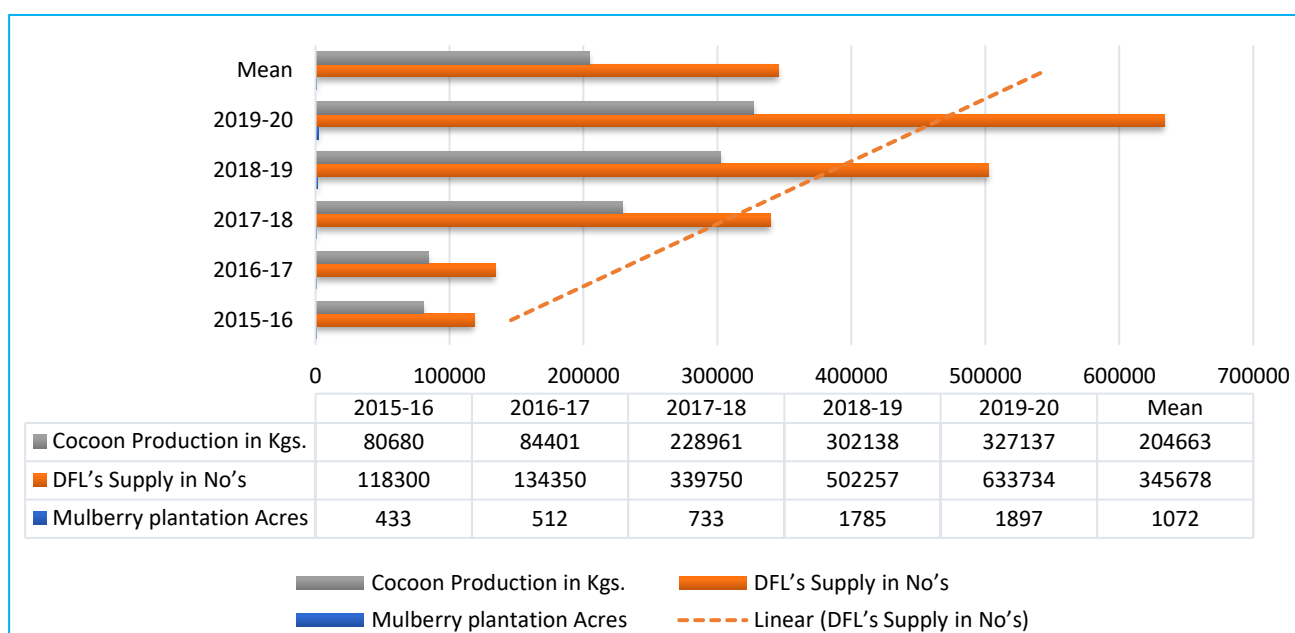
landscape, ranging from hills, plateaus, valleys, and plains, with a significant part of the district's land used for agricultural purposes.

## RESULTS AND DISCUSSION

This article aims to present a comprehensive analysis of the results and discussion obtained from a study on sericulture. The research examines various aspects of sericulture, including cocoon production, economic impact, employment generation and sericulture as sustainability to the farmers.

### Scenario of sericulture in Osmanabad

In Osmanabad, the sericulture industry has gained significant traction due to its favourable climate, Government support, community participation, and growing market demand for silk. It has emerged as an economically viable agricultural practice in the district. The farmers in the district have recognized the potential of sericulture and have increasingly adopted it as an alternative source of income. With a focus on mulberry cultivation and silk production, sericulture has become a prominent sector within the agricultural sector for small and marginal farmers. It not only provides additional income to farmers but also contributes to employment generation and women empowerment. Thus, the growth of sericulture in Osmanabad District is presented in (Fig 2) below.



Source: Sericulture Department Osmanabad, 2021

Fig 2 Growth of Sericulture in Osmanabad District (Five years)

The (Fig 2) represents data on the mulberry plantation, Disease-Free Laying's (DFL's) supply, and cocoon production for the years 2015-2016 to 2019-2020. The first column particulars list the different parameters that were measured, including mulberry plantation in Acres, Disease-Free Laying's (DFL's) Supply in No's (units), and cocoon production in Kgs (kilograms). The next five columns, labelled 2015-16 to 2019-20, represent the values for each of the parameters in the corresponding year. For example, in 2015-16, the mulberry

plantation Acres were 433, and in 2019-20, they were 1897. The mean represents the average or mean value of each parameter over the last five-year period. For example, the mean mulberry plantation in Acres was 1072, which is the average of the values from 2015-16 to 2019-20. Similarly, the mean Disease-Free Laying (DFL) supply in No's were 345678, and the mean of cocoon production in Kgs. were 204663. The chart provides an overview of how these parameters have changed over a period of five years.

Table 1 Block-wise demographic profile of the sericulturist farmers

Components	Washi Block	Kalamb Block	Bhoom Block	Total (%)
<b>Gender</b>				
Male	47 (74.6)	35 (76.1)	33 (80.5)	115 (76.7)
Female	16 (25.4)	11 (23.9)	8 (19.5)	35 (23.3)
Total	63 (100.0)	46 (100.0)	41 (100.0)	150 (100.0)
<b>Age</b>				
20-30	8 (12.7)	5 (10.9)	4 (9.8)	17 (11.3)
31-40	40 (63.5)	25 (54.3)	26 (63.4)	91 (60.7)
41-50	12 (19.0)	13 (28.3)	8 (19.5)	33 (22.0)
Above 50	3 (4.8)	3 (6.5)	3 (7.3)	9 (6.0)
Total	63 (100.0)	46 (100.0)	41 (100.0)	150 (100.0)
<b>Caste</b>				
General	32 (50.8)	22 (47.8)	27 (65.9)	81 (54.0)
SC	14 (22.2)	16 (34.8)	7 (17.1)	37 (24.7)
ST	2 (3.2)	0 (0.0)	0 (0.0)	2 (1.3)
OBC	15 (23.8)	8 (17.4)	7 (17.1)	30 (20.0)
Total	63 (100.0)	46 (100.0)	41 (100.0)	150 (100.0)

Education				
Illiterate	5 (7.9)	2 (4.3)	2 (4.9)	9 (6.0)
Primary	4 (6.3)	2 (4.3)	2 (4.9)	8 (5.3)
Secondary	22 (34.9)	25 (54.3)	17 (41.5)	64 (42.7)
Higher Secondary	21 (33.3)	13 (28.3)	14 (34.1)	48 (32.0)
Graduate	11 (17.5)	4 (8.7)	6 (14.6)	21 (14.0)
Total	63 (100.0)	46 (100.0)	41 (100.0)	150 (100.0)
Land holdings				
1 Acre	34 (54.0)	24 (52.2)	18 (43.9)	76 (50.7)
1.5-2.5 Acre	20 (31.7)	11 (23.9)	13 (31.7)	44 (29.3)
3-5 Acre	5 (7.9)	8 (17.4)	10 (24.4)	23 (15.3)
More than 5 Acre	4 (6.3)	3 (6.5)	0 (0.0)	7 (4.7)
Total	63 (100.0)	46 (100.0)	41 (100.0)	150 (100.0)

Data depicted in (Table 1) provides a block-wise demographic profile of sericulturist farmers, presenting data on different variables such as gender, age, caste, education, and land holdings. Each column represents a specific block (Washi Block, Kalamb Block, and Bhoom Block). The gender-wise classification shows that across all blocks, male sericulturist farmers account for 76.7% of the total. In comparison, female sericulturist farmers account for 23.3%, which shows that the participation of females in sericulture activities is significant. In the age-wise classification, Washi Block has the highest percentage (63.5%), which falls in the 31-40 age group, followed by 12.7% in the 20-30 age group. In Kalamb Block, the highest percentage (54.3%) falls in the 31-40 age group, followed by 10.9% in the 20-30 age group. In Bhoom Block, the highest percentage (63.4%) falls in the 31-40 age group, followed by 9.8% in the 20-30 age group. However, across all blocks, the 31-40 age group has the highest representation (60.7%), which shows that young farmers are more involved in sericulture. Data in (Table 1) also provides information on the caste distribution among sericulturist farmers in three different blocks. In Washi Block indicates that among sericulturist farmers, the majority (50.8%) belong to the General category, followed by 22.2% who are from the Scheduled Caste (SC) category, and a smaller proportion of 3.2% who belong to the Scheduled Tribe (ST) category. Additionally, 23.8% of sericulturists are from the Other Backward Classes (OBC) category. In Kalamb Block, a similar pattern is observed, with 47.8% of sericulturist farmers belonging to the General category, 34.8% from the SC category, and no representation from the ST category. Among sericulturists, 17.4% are from the OBC category. In Bhoom Block, the caste distribution indicates that a significant majority (65.9%) of sericulturist farmers belong to the General category, followed by 17.1% from the SC category, and no representation from the ST category. Additionally, 17.1% of sericulturists are from the OBC category. Overall blocks it is evident that the majority (54.0%) of sericulturist farmers belong to the General category, followed by 24.7% from the SC category and a small proportion of 1.3% from the ST category. Furthermore, 20.0% of sericulturists are from the OBC category. The data shows that the SC and OBC farmers are major involved in sericulture farming in the district. The education attainment of the sericulturist farmers shows that, across all blocks, the largest group of sericulturist farmers have secondary education (42.7%), followed by higher secondary education (32.0%).

Landholding in sericulture plays a significant role in determining the productivity and economic viability of sericulture farming. So, the data shows the land holding distribution in the Washi block; among sericulture farmers with land holdings of 1 acre, there are 34 farmers, accounting for 54.0% of the total in that block. The land holdings range from 1.5 to 2.5 acres, and there are 20 farmers, representing 31.7%

of the total. The remaining land holding categories (3-5 acres and more than 5 acres) have smaller numbers of farmers in very few percentages. In Kalamb Block, a similar pattern is observed, with the majority of sericulturists (52.2%) having 1 acre of land and 23.9% owning land holdings between 1.5 and 2.5 acres. Additionally, 17.4% of sericulturists have land holdings between 3 and 5 acres. A small percentage, 6.5%, own more than 5 acres of land. In Bhoom Block, the majority of sericulturists (43.9%) have 1 acre of land, and 31.7% have land holdings ranging from 1.5 to 2.5 acres. Furthermore, 24.4% of sericulturists own land holdings between 3 and 5 acres, while none of them own more than 5 acres of land. The total number of sericulturist farmers across all blocks, the table indicates that 50.7% of sericulturist farmers own 1 acre of land, while 29.3% possess land holdings between 1.5 and 2.5 acres. Furthermore, 15.3% of sericulturists have land holdings between 3 and 5 acres, and a small proportion, 4.7%, own more than 5 acres of land. It is observed that in all blocks, the small and marginal landholders constitute a larger proportion of sericulturist farmers.

Data presented in (Table 2) provides information on various aspects related to sericulture farmers and their economic activities in three different blocks. The first section of the table shows the distribution of sericulture farmers based on the starting year of their sericulture activity. It is observed that the highest percentage of farmers started sericulture between 2016-2018 in all three blocks. The Kalamb block has the highest percentage of farmers (60.9%) who started sericulture during 2016-2018, while the Bhoom block has the highest percentage of farmers (36.6%) who started between 2013-2015. The next section of the table provides information on the land under the mulberry plantation. The majority of farmers have land between 1.01-2 acres, which is about 51.3% of the total land under mulberry plantations. The land under mulberry plantations between 2.01-3 acres is the lowest in Washi Block, with 3.2%.

The above table shows the farmers' investment in sericulture in the three blocks. It is observed that a majority of the farmers have invested between rupees 1,00,001-1,50,000. The highest percentage of farmers in this investment range is in the Kalamb block (54.3%), while the lowest percentage is in the Washi block (9.5%). Similarly, the data also represent the cocoon production in quintals for each block. The highest percentage of cocoon production is in Kalamb Block, with 46% of production between 21-25 quintals. The lowest percentage of cocoon production is in Washi Block, with 9.5% between 21-25 quintals.

The significant economic impact of sericulture is evident in the three blocks, with 57.3% of farmers earning an income ranging from 2.50 to 3.50 lakhs, while 27.3% of farmers earn between 3.30 to 4.50 lakhs per year through sericulture activity.

These statistics highlight the vital role sericulture plays in boosting farmers' earnings.

The table also shows the percentage of farmers who received training from the Centre Silk Board (CSB) Mysore and the District Sericulture Office (DSO). It is observed that the majority of farmers in all three blocks have received training from CSB and DSO. The Washi block has the highest percentage of farmers (84.1%) who received training, while the Bhoom block has the lowest percentage (73.2%) as compared to Washi.

The last section of the table shows the details of the schemes under which the farmers operate. The majority of farmers in all three blocks operate under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) scheme. The Kalamb block has the highest percentage of farmers (93.5%) who operate under this scheme, while the Washi block also has the highest percentage (90.5%). The Catalytic Development Program on Sericulture (CDP) scheme is being operated by a very small percentage of farmers in all three blocks.

Table 2 Blocks wise details about sericulture farmers and their economic activities

Components	Washi Block	Kalamb Block	Bhoom Block	Total (%)
Sericulture Starting Year				
2016-2018	34 (54.0)	28 (60.9)	22 (53.7)	84 (56.0)
2013-2015	12 (19.0)	11 (23.9)	15 (36.6)	38 (25.3)
2010-2012	12 (19.0)	7 (15.2)	3 (7.3)	22 (14.7)
Before 2010	5 (7.9)	0 (0.0)	1 (2.4)	6 (4.0)
Total	63 (100.0)	46 (100.0)	41 (100.0)	150 (100.0)
Land under Mulberry Plantation				
0-1 Acres	28 (44.4)	20 (43.5)	17 (41.5)	65 (43.3)
1.01-2 Acres	33 (52.4)	24 (52.2)	20 (48.8)	77 (51.3)
2.01-3 Acres	2 (3.2)	2 (4.3)	4 (9.8)	8 (5.3)
Total	63 (100.0)	46 (100.0)	41 (100.0)	150 (100.0)
Investment in Sericulture (In Rupees)				
50001-100000	6 (9.5)	6 (13.0)	9 (22.0)	21 (14.0)
100001-150000	32 (50.8)	25 (54.3)	18 (43.9)	75 (50.0)
150001-200000	19 (30.2)	13 (28.3)	11 (26.8)	43 (28.7)
200001-250000	6 (9.5)	2 (4.3)	3 (7.3)	11 (7.3)
Total	63 (100.0)	46 (100.0)	41 (100.0)	150 (100.0)
Cocoon Production (2019-20)				
5-10 Quintals	8 (12.7)	7 (15.2)	6 (14.6)	21 (14.0)
11-15 Quintals	29 (46.0)	19 (41.3)	12 (29.3)	60 (40.0)
16-20 Quintals	20 (31.7)	17 (37.0)	15 (36.6)	52 (34.7)
21-25 Quintals	6 (9.5)	46 (6.5)	8 (19.5)	17 (11.3)
Total	63 (100.0)	46 (100.0)	41 (100.0)	150 (100.0)
Income from Sericulture (2019-20)				
1.50- 2.50 Lakhs	5 (7.9)	10 (21.7)	3 (7.3)	18 (12.0)
2.50- 3.50 Lakhs	37 (58.7)	22 (47.8)	27 (65.9)	86 (57.3)
3.50- 4.50 Lakhs	18 (28.6)	14 (30.4)	9 (22.0)	41 (27.3)
4.50- 5.50 Lakhs	3 (4.8)	0 (0.0)	2 (4.9)	5 (3.3)
Total	63 (100.0)	46 (100.0)	41 (100.0)	150 (100.0)
Training from CSB and DSO				
Received	53 (84.1)	38 (82.6)	30 (73.2)	121 (80.7)
Not Received	10 (15.9)	8 (17.4)	11 (26.8)	29 (19.3)
Total	63 (100.0)	46 (100.0)	41 (100.0)	150 (100.0)
Details of the Scheme				
CDP Scheme	6 (9.5)	3 (6.5)	3 (7.3)	12 (8.0)
MGREGS Scheme	57 (90.5)	43 (93.5)	38 (92.7)	138 (92.0)
Total	63 (100.0)	46 (100.0)	41 (100.0)	150 (100.0)

Note: CSB- Centre Silk Board Mysore, DSO- District Sericulture Office, CDP- Catalytic Development Program on Sericulture (CDP)

#### Production and sales received from sericulture

The (Table 3) presents data on the average production and sale of production received by sericulture activity for the years 2018-2020. The first column lists the different components that were measured, including the Number of Crops, Number of DFLs, Cocoon Production (Kg), and Income Received (In lakhs).

The data indicates that the average number of crops produced during two years was 7, with some years producing

more and some years producing less. Similarly, the highest number of DFLs was 3850, the lowest was 1100, and the mean value was 2143. This indicates that the average number of DFLs produced during the two years was 2143. The highest Cocoon Production was 3124 Kg, the lowest was 783 Kg, and the mean value was 1745.2 Kg. This indicates that the average Cocoon Production during the two years was 1745.2 Kg. Finally, the income received ranged from 3.17 rupees lakh to 11.5 rupees lakh, with an average of 6.36 lakh rupees.

Table 3 Average production and sale of production received from sericulture in the last two years (2018-2020)

Components	Highest	Lowest	Mean
Number of crops	11	5	7
Number of DFLs	3850	1100	2143
Cocoon production (Kg)	3124	783	1745.2
Income received (Lakh in Rupees)	11.5	3.17	6.36

*Employment generation from sericulture*

Sericulture, the practice of rearing silkworms for silk production, has emerged as a significant source of employment generation in various regions. The sericulture industry provides

employment opportunities across multiple stages of the value chain, from mulberry cultivation to cocoon production, silk processing, and weaving. So, (Table 4) provides information about labour participation.

Table 4 Labour participation in sericulture farming

Components	Washi Block	Kalamb Block	Bhoom Block	Total (%)
Hired labour for sericulture farming				
Four Labours	4 (6.3)	1 (2.2)	0 (0.0)	5 (3.3)
Three Labours	43 (68.3)	27 (58.7)	28 (68.3)	98 (65.3)
Two Labours	12 (19.0)	12 (26.1)	11 (26.8)	35 (23.3)
One Labour	4 (6.3)	6 (13.0)	2 (4.9)	12 (8.0)
Total	63 (100.0)	46 (100.0)	41 (100.0)	150 (100.0)
Family labour involved in sericulture farming				
Two members	41 (65.1)	34 (73.9)	25 (61.0)	100 (66.7)
Three Members	19 (30.2)	11 (23.9)	12 (29.3)	42 (28.0)
Four Members	3 (4.8)	1 (2.2)	4 (9.8)	8 (5.3)
Total	63 (100.0)	46 (100.0)	41 (100.0)	150 (100.0)

The (Table 4) presents data pertaining to the number of manpower engaged in sericulture farming across three blocks. In hired labour section, majorly 65.3% of farmers are employing three labour and 23.3% of farmers employ two labours in sericulture activity. This shows that sericulturist

farmers are engaging more labour at the village level. Additionally, in the family labour section, prominently 66.7 % of farmers engage two family labour, and 28% of farmers engages three family labour. Through this activity, farmers are engaging a significant amount of manpower at the village level.

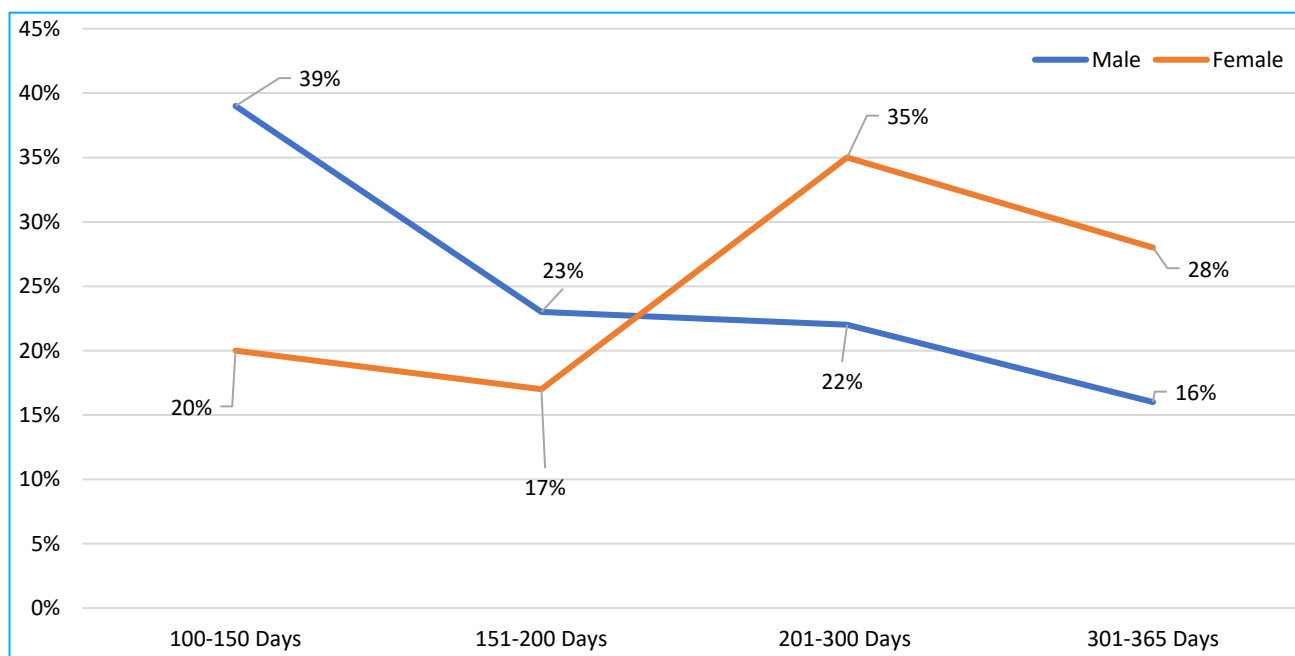


Fig 3 Days of receiving employment in sericulture farming in a year

The (Fig 3) illustrates the distribution of employment generation days among male and female labourers. It can be observed that 39% of male labourers receive 100-150 days of employment, while 23% are provided with 151-200 days. Moreover, 22% of male labourers receive 201-300 days of employment, and the remaining 16% are engaged for 301-365 days. In comparison, female labourers show a slightly different,

with 20% receiving 100-150 days of employment, 17% receiving 151-200 days, 35% receiving 201-300 days, and 28% engaged for 301-365 days. The data demonstrate that sericulture farming offers satisfactory employment opportunities throughout the year for both male and female labourers. Especially the sector generates a significant number of employment days specifically for female labourers.

Table 5 Distribution of wage rate among male and female labourers

Gender	Wages (₹)/day	Working days	Hours of work
Male	Rs 250-300/day	150-200	7-8 Hours
Female	Rs 200-300/day	201-300	7-8 Hours

Data in (Table 5) provides information about the distribution of wage rates among male and female labourers in sericulture. The wages are listed in Indian Rupees (₹) per day and the number of working days per year and working hours. According to the data, male labourers earn between rupees 250-300 per day, while female labourers earn between rupees 200-300 per day. The number of average working days per year for male labourers is between 150-200, and they work for 7-8 hours per day. Female labourers work for more days per year, between 201-300 days, and they also work for 7-8 hours per day. The gender wage gap is there, but women are getting more average working days than men, which shows that women are getting yearlong employment and getting more wages.

#### *Successful case studies on sericulture farming*

The successful case studies on sericulture farming illustrate the transformative power of sericulture in the lives of two individuals. These case studies highlight the profound impact that sericulture can have on farmers, not only in terms of financial stability but also their overall well-being. By examining their experiences, we can observe how sericulture has opened up new opportunities, boosted their income, and emphasized a positive perspective on their life.

#### *Case study-1*

##### *Silk thread which binds the farmers*

Sudhakar Jadav is an educated unemployed youth who struggled to find a suitable job. He was involved in traditional farming with his family and cultivating crops such as sugarcane, maize, and chillies. However, the earnings from one acre ranged from 50,000 to 80,000 rupees per year, which was not satisfactory.

During a visit to the village, Sudhakar noticed other farmers engaged in sericulture activities, which inspired him to engage in sericulture. Initially, his family and relatives were unaware of this practice and tried to discourage him. However, in 2014, Sudhakar started sericulture farming with a capital investment of 1,75,000 rupees. He established a mulberry plantation and constructed a silkworm-rearing shed. Currently, he is able to cultivate four to five crops per year. This could be able to possible with the help of the Catalytic Development Programme (CDP) implemented under the Central Silk Board (CSB) and District Sericulture Office (DSO). Sudhakar's dream came true when his hard work & dedication improved productivity and received high returns. In the past two years, his income has increased significantly. His success in generating income through sericulture has motivated him to encourage others to take up sericulture for their livelihood. According to Sudhakar, a favourable market rate, combined with high productivity, can result in excellent returns from sericulture. He is happy to share his knowledge with fellow sericulturists to help them improve their productivity. He believes that the adoption of technology is crucial for the success of sericulture.

Proudly, Sudhakar states that sericulture has brought about a positive change in his economic status. Instead of working for someone else, he has found his own employment through sericulture and is now in a position to offer employment to others. He believes that with a positive approach and continuous effort, nothing is impossible. He stated that proper management of available resources and effective utilization of technology are key factors for success in sericulture.

#### *Case study-2*

##### *Sericulture for empowerment*

Savita Andhare belongs to the medium-income group, and she has studied up to the 10th standard. As a housewife, she was responsible for managing household work and occasionally assisted with agricultural activities due to her background in a traditional farming family. Prior to taking up sericulture, she was engaged in cultivating traditional crops such as cotton, black gram, and soybeans. Her family used to earn an annual income of rupees 25,000 to rupees 30,000 per acre.

During a visit to her relatives, she learned about sericultural activities happening in their area, which inspired her to approach the officials at the District Sericulture Office (DSO) and Central Silk Board (CSB) in Osmanabad. She discussed sericulture practices with them and decided to engage in sericulture. In June 2017, she started a mulberry plantation on a 1-acre plot and obtained her first cocoon yield, earning 18,000 rupees. By the end of the year, her total income reached 38,000 rupees. Over time, her earnings from sericulture increased, and she now earns up to 3 lakhs per year. The transition from growing cotton to sericulture had a significant impact on Savita. She also advises nearby farmers to take up sericulture, stating that it is not only easy but also more profitable than other crops in their area.

Sericulture has provided her with financial stability. She has built a house and provided a good education for her children using the higher income generated from sericulture. Additionally, she now provides employment opportunities to villagers by engaging them in sericulture activities. She willingly shares her knowledge and experiences gained over the years with others, encouraging them to pursue successful sericulture farming. When reflecting on the lessons learned and challenges faced, she smiles and says, "Optimism brings positive results." She is delighted that her entire family is working harmoniously towards their betterment through sericulture.

##### *Triple bottom line framework for sustainability of sericulture farming*

Sericulture farming, which involves the rearing of silkworms for silk production, has been practiced for centuries in many parts of the world. Presently, it is recognized as a sustainable practice that provides economic, social, and environmental benefits. Because it provides remunerative employment to families and labour throughout the year and ensures periodic income for small landholding farmers. It is an eco-friendly activity that provides an opportunity for the rural population to uplift their socio-economic status. In the study area, sericulture farming has emerged over the last ten years as an additional source of livelihood for farmers, along with their main agricultural practices. It creates employment opportunities and improves the economic condition of the farmers. With this background study focuses Triple Bottom Line model of sustainability, proposed by John Elkington in 1997, to explore the sustainability of sericulture farming. This model is for evaluating sustainability based on three pillars: social, economic, and environmental. By applying this model to sericulture farming, we can assess the sustainability and potential for creating positive impacts across these three dimensions [24]. This approach has become an effective

strategy for transitioning agri-allied activities towards sustainability based on three significant dimensions of sustainable development: environmental quality, social equity,

and economic benefits. The sustainability of sericulture farming is presented in the following triple bottom-line framework of sustainability.

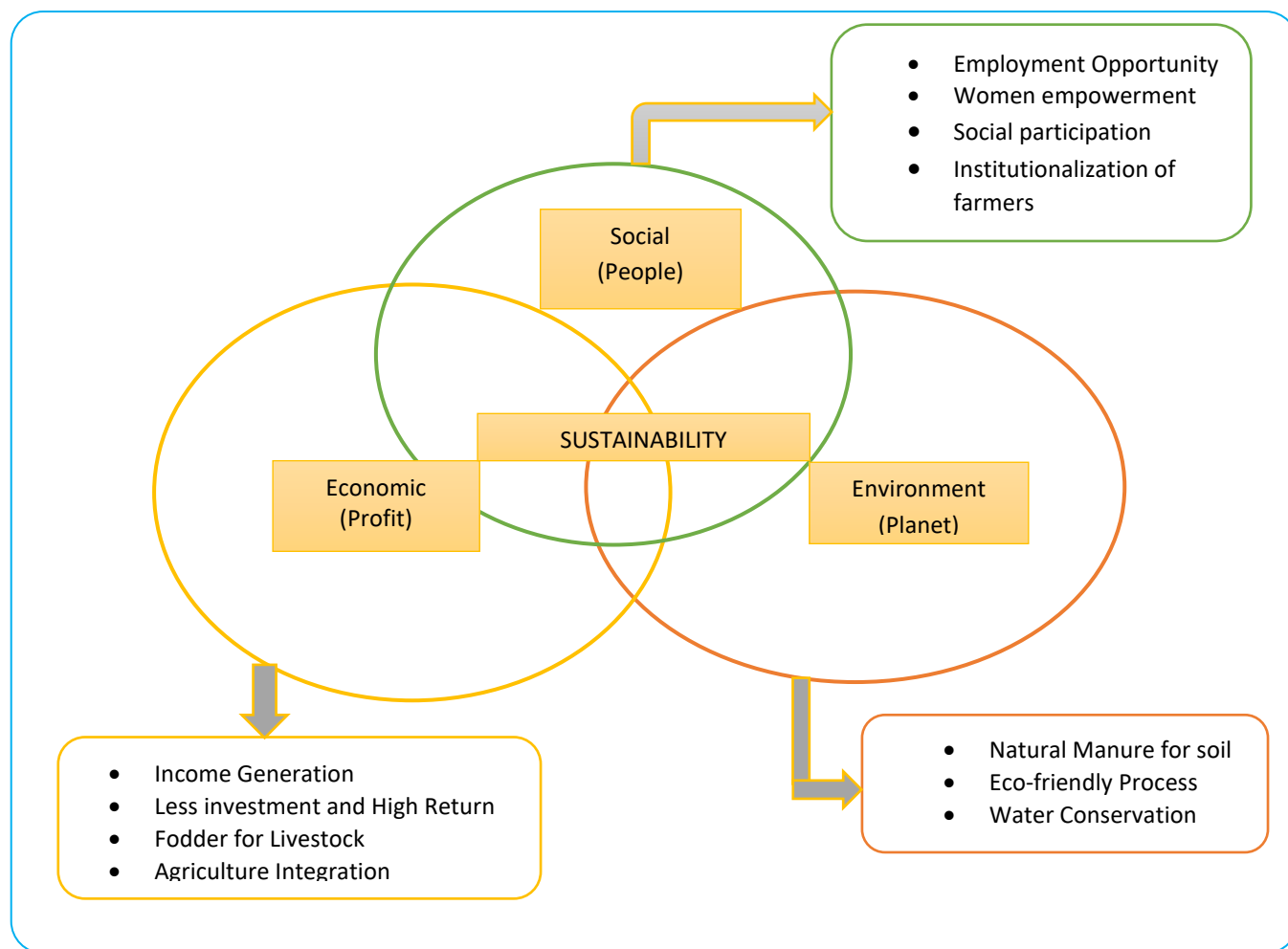


Fig 4 Triple bottom line framework

*Social sustainability*

Sericulture activity offers significant employment opportunities for farmers, including both male and female labourers. The study reveals that farmers play a crucial role in generating employment for themselves, their family members, and other members of the village community. The findings indicate that female labourers receive employment for 200-300 days annually, while male labourers typically work for around 150-200 days. This demonstrates that farmers provide continuous employment opportunities, benefiting both male and female labourers in the sericulture activity.

Likewise, sericulture activities, starting from managing mulberry farms, harvesting leaves, and rearing silkworms, are more effectively undertaken by women. Their qualities, such as maternal instincts and loving care for those under their charge, prove to be very helpful in successfully rearing silkworms. Consequently, women are able to find an entire year of employment in silkworm rearing and earn a good income from this work. Women receive 201-300 days of employment in sericulture activities annually and, due to the availability of daily work, they can generate a substantial income. This leads to their economic empowerment, resulting in many changes within the family. Women gain the ability to make their own decisions, earn respect within the family, attain knowledge about the market, and improve their communication skills. With income, they can effectively manage households and experience a sense of empowerment. Therefore, this form of

farming contributes to the improvement of women’s status both within the family and society.

Social participation and institutionalization of farmers play a significant role in sericulture farming. This form of farming has reduced the wealth disparity among farmers and promoted group harmony among themselves. In the study area, it has been observed that farmers collaborate in their work, and actively engage in learning and teaching sericulture farming techniques to one another. They collectively bring Disease-Free Layings (DFLs) and sell cocoons in groups. Moreover, they frequently visit the Ramanagaram market in Bangalore together. Farmers willingly share their rearing materials and also occasionally even exchange mulberry leaves. It has been found that farmers work in unity, extending support to each other regardless of caste or class. Every village farmer’s group participates in various training programs conducted at the Central Sericulture Research and Training Centre (CSR and TC) in Mysore. Consequently, sericulture farming has positively transformed the social standing of farmers in the district.

*Economic sustainability*

Sericulture is an income-generating activity; it provides satisfactory income to the farmers. In the past two years, farmers have been able to earn an average of 5 to 6.50 lakh rupees. It has been observed that through sericulture, farmers receive higher income in the Osmanabad district from one-acre

land. Furthermore, sericulture farming requires considerably less investment. The Government also provides 100 per cent funding under schemes such as MGNREGS in each phase to support farmers. The initial investment cost, which includes infrastructure and other rearing materials, is one-time only. However, sericulture can yield high returns within a period of less than a month.

Additionally, sericulture farming gives fodder for livestock. Mulberry plants are highly nutritious for animals, contributing to increasing milk quantity and overall healthiness of the livestock. While only tender leaves are required for silkworm rearing, the remaining hard leaves are typically considered waste. However, in the study area, farmers utilize these hard leaves as fodder for their livestock. This practice not only saves money for livestock fodder but also allows farmers to generate additional income by selling milk and milk products. It has also been observed that in the study area, every sericulturist farmer owns at least one cow or buffalo. Furthermore, after the mulberry plantation, those who previously did not have any cattle they purchased cows or buffaloes because the remaining leaves could be utilized to feed cattle and enable them to generate additional income.

Agricultural integration has proven to be beneficial for farmers as it mitigates the risk of total losses in case one activity fails due to abiotic or biotic stresses. Mulberry plantation allows for intercropping with grass, which can serve as animal feed, as well as the cultivation of vegetables and other crops for generating income. Intercropping mulberry offers several advantages, such as enhancing soil fertility, conserving water, and promoting environmental sustainability. In the study area, farmers cultivate various food crops and vegetables alongside mulberry plants using natural manure. This practice reduces their expenses towards food crops while enabling them to obtain residue-free fresh produce from the same land.

#### *Environmental sustainability*

In silkworm rearing, silkworms generate black-coloured waste, known as silkworm litter, from their bodies after feeding. This waste material resembles and can be utilized as organic manure for the soil. Farmers in the study area collect this waste from the rearing racks/stands on a daily basis and use it to make natural manure. This manure proves to be beneficial in enhancing the soil fertility of the land. In addition to using this manure for mulberry cultivation and farmers also utilize it for other crops. Furthermore, some farmers have even started vermin compost plants using this silkworm waste as source material.

Sericulture is an eco-friendly activity. Because as a perennial crop with good foliage, mulberry plantation contributes to soil conservation and provides greenery. Compared to other crops, mulberry requires less water for its growth. Additionally, waste generated from silkworm rearing can be recycled and used as inputs for farms or compost. Also, the remaining shoots and leaves of the mulberry plant are used as valuable fodder for livestock. In sericulture farming, each component is used in one or other agricultural activities. Thus, sericulture farming represents an environmentally sustainable agricultural practice.

## CONCLUSION

Sericulture has emerged as a significant cash crop due to its low initial investment, high employment potential, and high returns. Its major potential is the generation of income, particularly for rural people, especially small and marginal farmers. In Osmanabad district, sericulture farming plays an important role in the economy, especially in the drought-affected regions. Over the last ten years, sericulture farming has made substantial progress in the district, with 1747 farmers currently engaged in sericulture activity and 1897 acres of land under mulberry plantations. The growth of sericulture in the district over the last five years is evident from the increase in mulberry plantation acres, DFLs supplied, and cocoon production. The block-wise data of sericulture explains the inclination of farmers towards sericulture activity. The success of sericulture in Osmanabad has not only generated income for farmers but also provided employment opportunities and contributed to the overall socio-economic development of the region. Therefore, sericulture has the potential to contribute to farm livelihood, women's empowerment, and sustainable farming. The Triple Bottom Line (TBL) framework of sustainability provides a comprehensive way to evaluate the sustainability of sericulture farming. The TBL analysis reveals that sericulture farming has a positive impact on people, the planet, and profit. It provides employment opportunities for both men and women, improves social coordination and equity, and generates satisfactory income throughout the year. Therefore, sericulture farming can be a feasible solution for the socio-economic development of the rural population in drought-prone areas. With appropriate support and policies from Governments and stakeholders, it can continue to flourish as a sustainable production.

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#### *Author contributions*

*All authors contributed to the manuscript's creation, including title design, results analysis, and manuscript preparation. The corresponding author proposed the title, which was edited and approved by the other authors. All tasks were equally shared among the authors.*

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*The datasets used during the current study are available from the corresponding author on reasonable grounds and request.*

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