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Research Article

Pre-extension Demonstration and Popularization of Silk Production Technologies in South Ethiopia

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Abstract

The study was conducted in Shebadino, Tula and Wondogenet districts of Sidama regional state of southern Ethiopia from 2018 to 2023 with the objectives of to evaluate the performance of silk production technologies at various levels of silk production with stakeholders/beneficiaries. The study also aimed to create awareness and develop confidence among silkworm producers, development agents, agricultural experts and policy makers for wider dissemination. Nine kebeles' (the lowest administrative level), were selected from three (3) districts for the purposes of this study. Five (5) farmers from each kebele were selected, totaling 45 farmers, for technology pre-scale up and promotion. Three rounds of theoretical and practical training were given to these farmers after they were selected. Training in the third round focused on managing row silk and cocoons after harvest, with a first round that covered broad knowledge and the importance of sericulture. Of the farmers who were chosen and trained, 95.6 percent were women who began raising silk worms, producing cocoons, and processing row silk. Each farmer received 30 kilograms of castor seed and 50 disease-free adult moths for pre-scaling up and promotion of the technology. During the first year of the study period, 90%, 50%, and 40% of the disease-free moths that were disseminated laid eggs and developed into cocoons at Shebadino, Tula sub city and Wondogenet districts respectively. Sericulture is very beneficial to young people, particularly women, in terms of providing a variety of employment options and viable income without affecting their regular agricultural activities or the existing sociocultural equilibrium. Sericulture technology with its package used, knowledge and skill of the farmers (users) on the technology upgraded, continuous follow up assured by DAs and experts. This study highlights the significance of sericulture for rural development and offers insightful information for its dissemination.

Keywords

Pre Scaling up, Promotion, Sericulture, Technology

1. Introduction

Sericulture is a cottage industry based on agriculture and environmentally friendly, with significant potential for employment and foreign exchange [1]. The process involves the cultivation of silkworms for the production of raw silk [2].

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Known as the "queen of textiles," silk is esteemed for its softness, sheen, smoothness, strength, and durability, derived from silk worms [1]. Silkworms are among the most valuable insects that have been domesticated, with their growth and development being heavily impacted by climatic conditions. The success of silkworm breeds relies largely on their ability to adapt to the specific environment in which they are to be cultivated. Historically, sericulture played a crucial role in the economic advancement of ancient China [3]. This industry holds promise for significantly enhancing the economies of various nations with abundant labor, low production costs, and a readiness to embrace new technologies [4]. Research [5] has indicated a favorable outlook for the development of sericulture, not only in East Asia but also in Eastern Europe, Central Asia, Latin America, and the Africa Region, based on various socio-economic and agro-climatic factors such as rainfall, soil quality, temperature, humidity, light availability, and air circulation. Conversely, a large segment of the global population resides in developing countries and relies on agriculture as their primary source of livelihood [6].

Sericulture, a longstanding agro-industrial practice in numerous Asian nations, represents a relatively recent venture in Ethiopia. Throughout the early era of the Kingdom of Axum, silk held significant cultural and religious importance within Ethiopian society. The procurement of silk involved substantial imports from India, Arabia, and China, which were then stored in vast caverns located in the central highlands of Ethiopia. Since its inception in the country, sericulture has been actively endorsed in various regions such as SNNP, Tigray, Oromia, and Amhara, aiming to enhance household income diversification and rural livelihoods. Its adaptability to be integrated into small-scale agricultural plots, along with its capacity to generate employment opportunities for youth, women, and other family members across the value chain, underscores its economic appeal in rural communities within the nation [7].

Lessons gleaned from recent experiences suggest that in order for sericulture advancement to achieve success, it is imperative to focus on various aspects such as cocoon production, the collection of cocoons, the manual spinning of high-quality yarns, and the establishment of connections to the market. Silk has been recognized as a promising novel fiber with great potential for expediting the growth of export-oriented textile industries across the nation, which can be facilitated through both the engagement of commercial smallholder farmers and substantial investments from large-scale private enterprises [8].

This aligns with the objectives set forth by the GTPII regarding export-focused agro-processing and industrialization. The production of silk plays a role in reducing poverty, generating employment, and increasing income. In Ethiopia, the abundance of labor, soil suitability, favorable climate for growing feed plants, and raising silkworms have all played a part in advancements in sericulture.

In addition, the processing of silk encompasses a variety of tasks including reeling, spinning, dyeing, wrapping, weaving, finishing, and processing of silk textiles, which could generate job opportunities for a significant population.

Therefore, the production of silkworms is highly suitable for the conditions in Ethiopia due to various factors. The labor necessary for cocoon production can be effectively managed at the household level, and the essential technical expertise can be obtained through fundamental training. The minimal capital investment needed to establish cocoon production at the household level, along with the possibility of constructing much of the required equipment locally, further enhances its viability. Additionally, the perennial nature of the feed plants, characterized by excellent green foliage cover and root spread, plays a significant role in soil conservation, particularly in vacant lands, hillsides/degraded lands, and watershed areas. The utilization of stalks, twigs, and branches as a fuel source instead of firewood helps alleviate pressure on vegetation and forests. Moreover, the byproducts from silkworm rearing can be repurposed as fertilizer for gardening purposes. This practice proves to be highly beneficial for resource-constrained farmers, enabling them to generate income and provide gainful employment opportunities to the expanding labor force in rural and peri-urban regions. Importantly, it contributes to enhancing the living standards of producers and serves as a means of earning foreign currency for the country.

Hence, scaling up of sericulture technology will be carried out to address this emerging need with emphasis on promoting smallholder-based silkworm farming to generate economic and environmental benefits and improve the livelihood of the community.

Objectives

1) To evaluate the performance of silk production technologies at various levels of silk production with stakeholders/beneficiaries.
2) To create awareness and develop confidence among silkworm producers, development agents, agricultural experts and policy makers for wider dissemination.

2. Materials and Methods

2.1. Description of Study Area

2.1.1. Wondogenet

The investigation was carried out in Wondogenet district, situated in the Sidama Region of southern Ethiopia. This district is positioned 270 km to the South of Addis Ababa, 14 km southeast of Shashemene, and 34 km east of Hawassa. Geographically, it can be located at coordinates 70 19’N and 38 0 38’E, with an elevation of 1780 meters above sea level. The average annual minimum and maximum precipitation levels are recorded at 709mm and 2062mm correspondingly. In terms of temperature, the district experiences an average maximum of 26°C and an average minimum of 12°C. Wondogenet exhibits a bimodal pattern of rainfall distribution, character-

ized by short rains from March to May and long rains from July to October. The district is home to 41,244 local breed cattle, 10,694 crossbreed cattle, totaling 51,938 cattle. Additionally, it houses 22,736 sheep and 12,018 goats. The area covered by Wondogenet spans a wide range of altitudes, from 1600 to 1950 meters above sea level [9].

2.1.2. Shebadino

Shebedino Woreda is situated within the Sidama National Regional State, located approximately 27 km away from Hawassa, the regional capital. It shares borders to the North with Hawela Woreda, to the South with Dale Woreda, to the East with Gorche Woreda, and to the West with Boricha Woreda. The elevation of this particular Woreda ranges from 1500 to 3000m above sea level. The area under investigation encompasses two distinct agro-climatic zones, namely Woyina Dega (84.4%) and Dega (15.6%). The temperature in this region fluctuates between 16°C and 25°C annually, while the annual rainfall ranges from 800mm to 1600mm. Shebedino Woreda spans a total area of 276.9 sq.km. According to the Central Statistical Agency (CSA) census data from 2007, the estimated total population of the Woreda stands at 233,922, with 118,026 being male and 115,896 female. There are a total of 37,152 households in the study area, which is further subdivided into 35 Kebele administrations. Notably, three of these Kebeles are classified as urban, with the remaining 32 being rural. In this region, over 90% of the population derives their livelihood from agricultural activities and livestock rearing, while the remaining fraction, approximately 10%, engage in petty trade and other forms of livelihood. Shebedino Woreda experiences two distinct cropping seasons [10].

2.2. Agriculturalist Selection and Sampling Methodology

For the purposes of this research project, the Tula sub-city, Shebedino, and Wondogenet Woredas were specifically chosen to be targeted for the initial implementation and advancement of this technological package. This selection was made under the premise of the perceived capacity of these locations, the presence of suitable facilities both currently in use and recently established for the purpose of silkworm cultivation, unexplored territories, and diligent supervision.

A team of scaling up process comprising different people (researchers, agricultural experts, development agents, silkworm producers, farmers) from different partners was Concerned partners within zonal and district office of animal and fishery resource was involved in the technology promotion activity.

Technology Transfer Approaches and Methods

From three kebeles in each district, a sum of nine kebeles was chosen for the study. A total of 45 farmers, five from each kebele, were selected for the implementation of technology promotion and transfer. The practical training was conducted thrice, in the first, second, and third years, to facilitate the transfer of knowledge and skills.

First round Training was given on the general importance of this technology, disinfection of the rearing house, proper handling of silkworms, manipulation of temperature and relative humidity, providing mountage for matured worms. Second round training was given on timely harvesting of cocoon, postharvest handling and yield grading. Third step was given stifling and obtaining of row silk from cocoon and how to manage manual reeling machine. Follow up supervision and monitoring was carried out to ascertain proper implementation of the practices.

After training to transfer technology suitable and verified technology such as disease free silk worm seeds and planting materials which developed through Melkassa agricultural research center with respective centers was guaranteed to farmers. About 50 moths were provided for each farmer hence a total of 1500 moths were providing to the farmers.

2.3. Techniques for Gathering Data

Primary data regarding the quantities of sites and farmers that were chosen; individuals such as farmers, development agents, and experts who received training (both male and female);Number of moths distributed, number of feed plant, performance of silk worm, amount of silk cocoon produced, types of disease technology, orientation of employment opportunities and generating supplementary income. Secondary data was also gathered from the livestock office of the respective Woreda, as well as from existing literature, research reports, and online sources.

3. Results and Discussions

Within this subject area, the primary findings regarding the education of agricultural workers and involved parties, the distribution of technological advancements, the quantity of silk generated, and the financial advantages experienced by farmers prior to expanding operations are examined.

3.1. Capacity Building

The capacity of the chosen farmers, Development Agents (DAs), and experts to implement the selected sericulture technology package is enhanced through a series of three rounds of theoretical and practical training sessions held at the respective Woreda. The training provided predominantly emphasized the significance of managing sericulture technology practices, as well as pre- and post-harvest handling of cocoons and the rearing of silk worms. In addition to the training sessions, chosen farmer members, agricultural development agents, and experts actively took part in ongoing seasonal follow-up activities related to silk worm rearing during the course of the research study.

Table 1 illustrates the capacity development involving 45

Farmers, 9 DAs, and 6 experts, achieved through a five-day training and practical demonstration of the sericulture technology package. The pre-scaling up phase included the participation of technical staff from Wondo gent Research Center and Malkassa Agricultural Research Centers, along with six researchers, two technical assistants, and four field assistants. They were involved in activities such as establishing feed plants, managing silk worms, conducting feeding, inspections, harvesting, and handling of cocoons at various sites during the project's duration [11].

The production of silk presents numerous advantages, such as bolstering economic prosperity in rural regions, offering women a viable source of employment, and functioning as an efficient initiative for underprivileged groups within society, thus mitigating issues related to fairness. Developing rural sectors like sericulture has the potential to significantly diminish poverty due to its labor-intensive nature and its contribution to rural progress [12].

Sericulture offers advantages to women by enabling them to have control over their earnings, facilitating their learning process, enhancing their ability to interact with individuals beyond their immediate circle, and fostering the development of their personality, all of which can be done from the comfort of their own homes. Moreover, silk production, in particular, presents women with various economic opportunities [13].

As shown in table 1 blow in the current study more than 95.6% of users were women. They started rearing of silk worm, cocoon production and processing of row silk from cocoon by using manual realer.

Table 1. *Illustrates the quantity of Farmers, Development Agents, and Experts who were involved in training sessions and preliminary scaling-up activities.*

Districts	Farmer		DA	Experts	Wondogenet Agricultural research center		
	Male	Female					
Shabadino	0	15	3	2	Researcher	TA	FA
Tula sub city	1	14	3	2	6	2	4
Wond/G	1	14	3	2			
Total	45		9	6	6	2	4

FA= Field assistant; TA= Technical assistant; DA= Development agents

3.2. Technology Dissemination

For sustainable technology transfer continuous supply of verified technologies such as the production of disease-free and high-yielding silkworm seeds is imperative in the sericulture industry. Planting materials which developed through Melkassa agricultural research center and multiplied by wondogenet Agricultural Research center was used for farmers. After members of farmers trained 50 diseases free laying of moth or larvae hence, 750 per district and a total of 22850 and 30kg of caster seed were provided at the first year to the producers (farmers). From the distributed 50 diseases free laying, most of moths' laid eggs or 90% at Shebadino, 50 at Tula sub city and 40% at wondogenet districts during first year of study. The number of users after 2nd year at Tula sub city and wondogenet become decrease year after a year but it highly increases at Shebadino districts. This variation was due to nature of silk worm, understanding of farmers, shortage of knowledge and lack attention by the government to the sector at the time. All farmers were planted caster and feed their worms for first years.

The current study was supplementary to previous research findings [14, 15], which indicated that significant obstacles in silkworm rearing included insufficient knowledge, inadequate training, outdated rearing facilities, limited market access, insufficient support from both governmental and non-governmental sources, and a scarcity of materials for silk production. These challenges have the potential to result in substandard quality and reduced silk output. The lack of suitable food plants and limited knowledge in silkworm husbandry are factors that detrimentally impact the silk production capacity of these organisms.

Table 2. *Number and percentage of egg laid moth at first year.*

Districts	Number of moths laid eggs	Percentage of moth laid eggs
Shabdino	675	90
Tula sub city	375	50
Wondo genet	300	40

3.3. Cocoon and Row Silk Yield and Socio-Economic Benefit

In this investigation, the sole cocoon and raw silk yield obtained from scaling up during last 4 years was computed. The amount of the cocoon and row silk produced during the scaling up period was presented blow in table 3. The sericulture industry has successfully integrated into the socio-economic framework of rural areas and has the potential to function as a powerful mechanism for rural revitalization [16]. The utilization of silk has held significant significance within the societal and religious spheres of Ethiopia since the inception of the Kingdom of Axum.

The current study revealed that [17] which states that, sericulture proves to be highly advantageous for the youth, especially women, as it offers a diverse range of job opportunities and sustainable income, while preserving their usual agricultural engagements and the current sociocultural balance. During first year all farmers from all districts was earned cocoon from distributed silk worm moths. The amounts of cocoons vary from 5 kg to 15kper harvesting seasons during technology pre-scaling up. This variation was due to farmer handling of larvae, feeding and other management practice. The number of farmer and the amount of cocoon produced during pre-scaling up was decreasing from year to year at Tula sub city and Wondogenet district but dramatically increases at Shabadino district. The annual mean of cocoon produced was 63.8, 12.9 and 11kg for Shabadino, Tula sub city and Wondogent respectively. In Shebadino the number of farmers within selected kebele (the smallest administrative unit) and other kebeles was increased in number, consequently the amount of cocoon produced was higher mean than the other districts. This study was in line with [18] which state that sericulture is a form of agricultural enterprise that can be seamlessly integrated with various other farming practices. It plays a significant role in restoring degraded landscapes, while also making direct financial contributions to household incomes.

Regarding benefits of the farmers from the sericulture technology, farmers benefit from cocoon and row silk produced and sold an average of Ethiopian birr (ETB) 11,502 (80birr/kg), 2,322 ETB, and 1,980 ETB for Shabadino, Tula sub city and Wondogenet districts respectively. This study was in line with [18] which say that Birhan is a prominent youth collective engaged in the sericulture venture within the vicinity of Kolabarena Kebele, located in Mirab Abaya Woreda, exhibiting proficiency in leveraging the myriad benefits inherent in this trade. Their initial venture yielded an estimated sum of 85,000 Ethiopian Birr during the inaugural year, concurrently marking the commencement of silk yarn production.

Table 3. *Average of cocoon and row silk produced during study period.*

Districts	Cocoon produced (Kg)					Amount of row silk (kg)			
	Year1	Year2	Year3	Year4	Mean (kg)	Y1	Y2	Y3	Y4
Shebadino	40	35	80	100	63.8		2	2	2
Tula sub city	20.5	15	8	8	12.9				
Wondogenet	20	15	5	4	11				

Y=Year

4. Conclusion and Recommendations

Silkworm farming can be deduced as a straightforward pursuit that presents considerable opportunities to both male and female individuals. The practice of sericulture proves to be highly advantageous for the youth, especially females, by furnishing a range of job opportunities and sustainable earnings, all while preserving the continuity of their usual agricultural undertakings and the established sociocultural balance.

Sericulture offers environmental benefits such as soil conservation through perennial feed plant cultivation, reduction of pressure on vegetation through alternative fuel sources, and recycling of waste from silkworm rearing as fertilizer. Sericulture technology, with the utilization of the package, alongside the utilization of knowledge and skills by the farmers (referred to as users), aimed at enhancing their proficiency in the upgraded technology, with continuous support provided by DAs and experts. Challenges were encountered in the adoption of the technology package (processing) by specific members, particularly in Wondogenet and Tula districts, highlighting the necessity for heightened awareness efforts. The key outcome of this research primarily emphasized the significance of extension services for sericulture farmers, ensuring ongoing technical assistance until the farmers gain confidence in the sericulture technology pack-

age.

In light of the foregoing conclusion, the following recommendations were made:

1) Apart from research facilities, every concerned entity, such as the district and zonal agricultural offices, should focus on enhancing the provision of extension services to silk producers and consumers of sericulture technology.
2) Since technology was still in its infancy, there is a need for persistently raising awareness and persuading farmers to use the wondogenet and Tula sub city.
3) Prioritize the ongoing provision of farmers with proven technologies, such as planting materials and silkworm seeds resistant to disease. To increase the capacity of farmers, development agents, and specialists in sericulture management techniques, training programs should be strengthened.
4) Encourage the creation of connections between the silk industry and the market to guarantee farmers' steady income. Promote the establishment of textile companies focused on exports in order to take advantage of the possibilities for economic expansion associated with silk manufacturing.
5) Invest in research and development projects to tackle issues including silk processing value addition, disease management, and modernizing sericulture methods. Work together with agricultural research centers to provide creative solutions that are adapted to regional circumstances.
6) Encourage the development of policies that will help sericulture become a thriving industry at the local and national levels. Sericulture projects should be supported with incentives and subsidies, with a focus on smallholder farmers and rural communities.
7) Encourage community involvement and ownership in sericulture projects by including stakeholders and creating inclusive decision-making procedures. Encourage gender parity by giving women the tools they need to take an active role in sericulture and take advantage of its financial prospects.

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Abbreviations

a.s.l: Above Sea Level
AD: Development Agent
ETB: Ethiopian Birr
FA: field Assistant
KM: kilo Meter
SNNP: Southern Nations and Nationalists Peoples
TA: Technical Assistant

Conflicts of Interest

The authors declare no conflicts of interest

Appendix

I some pictures during study period

Figure 1. *Theoretical training at Wondo genet and Tula.*

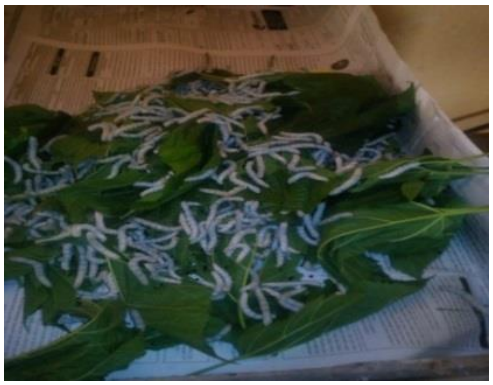
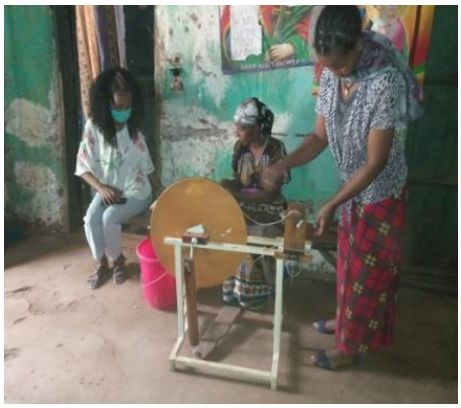
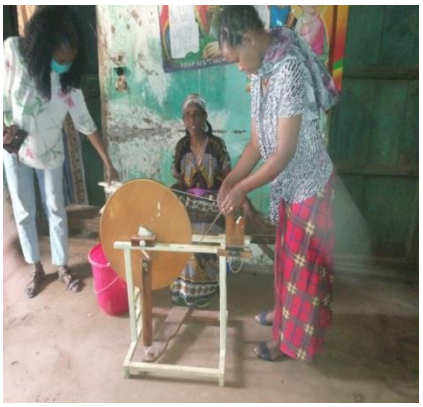


Figure 2. *Larvae of silk worm.*

Figure 3. *Cocoon produced at Shabadino.*





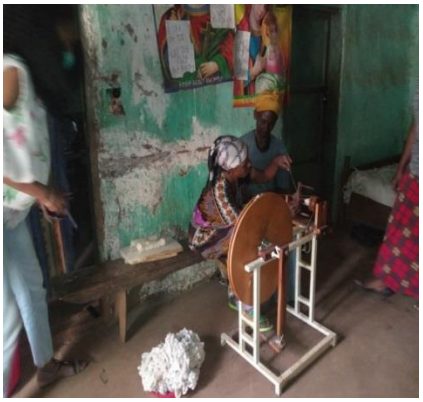


Figure 4. *Manual reeling machine and row silk Yarn produced at Shabadino.*

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