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Income and employment generation potential of Uganda's sericulture industry: An economic analysis

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Abstract

Sericulture, an agro-based cottage industry involving mulberry cultivation, silkworm rearing, and silk reeling, plays a crucial role in Uganda's rural economy by generating employment and improving livelihoods. With a low capital requirement, quick return on investment, and high employment potential, sericulture offers significant opportunities for rural development. Uganda's favorable climatic conditions support year-round mulberry growth and silkworm rearing, contributing to the country's growing silk production. As of 2021, Uganda ranked second in Africa in raw silk production, contributing to the global silk market valued at $15.6 billion. The industry provides direct employment to thousands, with opportunities for labor-intensive activities such as silkworm rearing, cocoon production, and silk yarn processing. A cost-benefit analysis of silk cocoon and yarn production reveals significant income potential, demonstrating sericulture's capacity to improve economic conditions for rural households. By adopting innovative technologies, Uganda's sericulture industry can expand, meeting domestic and export market demands while enhancing socio-economic conditions for the rural poor.

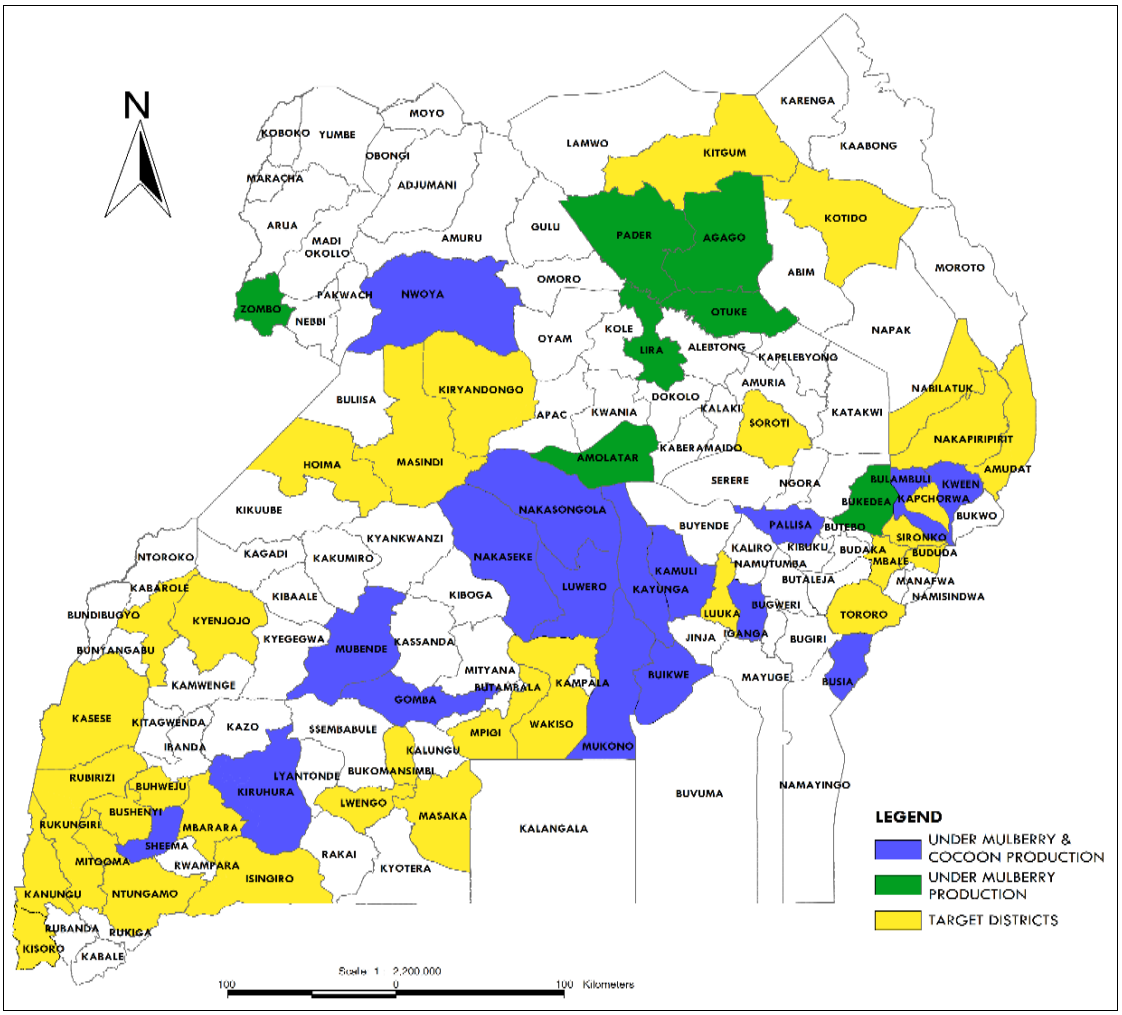
Keywords: Cost benefit analysis, income generation, economic development, employment generation, mulberry cultivation, rural development, sericulture, silk production, silkworm rearing, Uganda

1. Introduction

Sericulture, the integrated practice of mulberry cultivation, silkworm rearing, and silk reeling, is a labor-intensive agro-based cottage industry that has significant socio-economic potential, particularly in rural areas. In Uganda, sericulture has emerged as a viable economic activity, offering numerous opportunities for employment and income generation. With its low capital investment requirements, short gestation period, and high return on investment, sericulture has proven to be a sustainable livelihood for rural communities in several parts of the country (Sharma & Kapoor, 2020; Eswarappa, 2009) [14, 5]. The practice not only contributes to household incomes but also promotes rural development through the creation of various jobs, including those in silkworm rearing, cocoon production, and silk processing (Dasar *et al*., 2021) [4].

Globally, four main types of silkworms are reared for silk production: the mulberry silkworm (Bombyx mori), Eri silkworm (Philosamia ricini), Tassar silkworm (Antheraea mylitta), and Muga silkworm (Antheraea assamensis) (Malo, 2022) [8]. In Uganda, the mulberry silkworm is predominantly reared, with sericulture activities spread across 24 districts, including Bulambuli, Busia, Iganga, Kamuli, Kayunga, Kiruhura, Kween, Luweero, Mubende, Mukono, Nakaseke, Nwoya, Sheema etc. (TRIDI, 2021) [18]. The favorable climate of Uganda supports year-round mulberry growth, facilitating continuous silkworm rearing and silk production. According to TRIDI (2021) [18], Uganda's sericulture activities are currently being conducted on 1,548 acres of land, with projections of expansion as demand for silk grows both domestically and internationally (Figure 1).

The global silk industry is a dynamic sector with immense potential for growth. In 2021, global silk production was estimated at 86,311 metric tons, with China and India contributing to over 95% of the world's mulberry silk production (International Sericultural Commission [ISC], 2021) [6] (Table 1). Uganda holds a strategic position in the African silk market, ranking second after Madagascar, and plays a key role in fostering socio-economic development through sericulture. The increasing global demand for silk, projected to reach $34.1 billion by 2031 (Allied Market Research, 2022) [1], presents significant opportunities for Uganda to scale up its sericulture industry. By integrating modern technologies and practices, the country could increase its production of raw silk and silk textiles, creating further economic opportunities and boosting its export market share.



Source: Tropical Institute of Development Innovations (TRIDI), 2021[18]

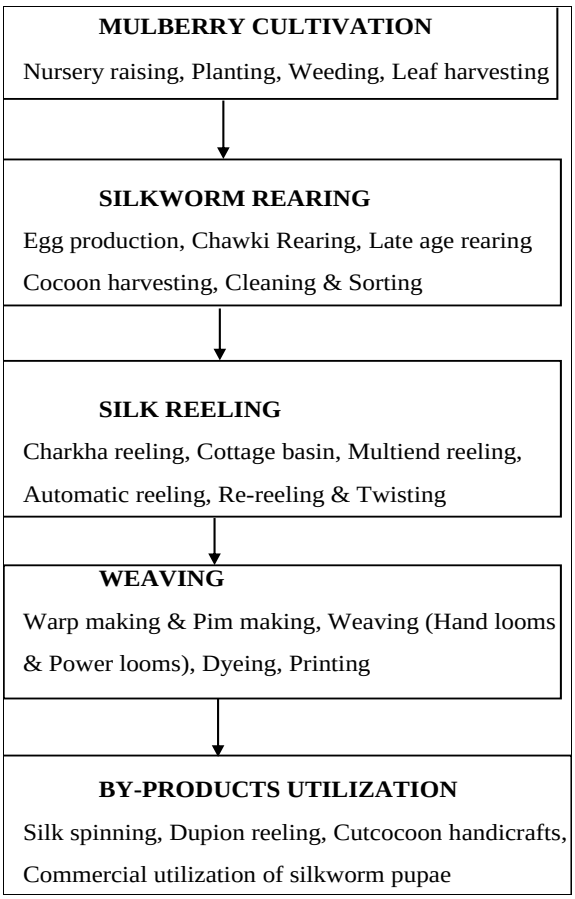
Fig 1: District-Wise sericulture production in Uganda

Table 1: Global Silk Production, 2015-2021 (In Metric Tonnes)

Countries	2015	2016	2017	2018	2019	2020	2021
Bangladesh	44	44	41	41	41	41	41
Brazil	600	650	600	650	469	377	373
Bulgaria	8	9	10	10	10	10	9
China	170,000	158,400	142,000	120,000	68,600	53,359	46,700
Columbia	-	-	-	-	1	1	1
Egypt	1	1	1	1	2	2	2
India	28,523	30,348	31,906	35,261	35,820	33,770	34,903
Indonesia	8	4	3	3	3	3	3
Iran	120	125	120	110	227	270	272
Japan	30	32	20	20	16	16	10
Madagascar	5	6	7	7	8	8	8
North Korea	350	365	365	350	370	370	370
Romania	-	-	-	-	1	1	1
Philippines	1	2	2	2	2	2	2
South Korea	1	1	1	1	1	1	1
Syria	-	-	-	-	1	1	1
Thailand	698	712	680	680	700	520	503
Tunisia	3	2	2	2	2	2	2
Turkey	30	32	30	30	5	5	5
Uganda	-	-	-	-	3	3	3
Uzbekistan	1,200	1,256	1,200	1,800	2,037	2,037	2,037
Vietnam	450	523	520	680	795	969	1,067
Total	202,072	192,512	177,508	159,648	109,114	91,768	86,314

Source: International Sericultural Commission, 2021

In addition to its potential for economic growth, sericulture in Uganda provides substantial employment opportunities (Figure 2). It is estimated that the silk industry in Uganda employs approximately 2,000 people, most of whom come from economically disadvantaged backgrounds (Vijaykumar *et al*., 2007) [19]. The sector also promotes the equitable distribution of income, transferring wealth from urban consumers to rural artisans. Activities such as silkworm rearing, cocoon production, silk reeling, and weaving contribute to the livelihoods of many households, positioning sericulture as a powerful tool for rural development and poverty alleviation (Sime & Siraj, 2020; Jayaram *et al*., 2022) [16, 7].



Source: Modified from Bhattarcharjya *et al*. (2020)

Fig 2: Employment opportunities in the sericulture industry

Despite the promising outlook, there is a need for a detailed economic analysis of the costs and revenues associated with sericulture practices in Uganda to assess its full potential. The present study aims to evaluate the economic viability of cocoon and silk yarn production in Uganda, providing critical insights for stakeholders interested in investing in the sericulture industry.

2. Materials and Methods

This study assessed the economic viability of cocoon and silk yarn production in Uganda. A thorough examination of production costs, revenues, and profitability was carried out, using data from both primary field surveys and secondary sources.

2.1 Study Area and Sample Selection

The study was conducted in Uganda's Eastern, Western, and Central regions, where sericulture operations have steadily increased. The study concentrated on sericulture operations in three main districts: Mukono, Sheema, and Kamuli, which are known for their long-standing silkworm farming traditions (Jayaram *et al*., 2022; TRIDI, 2021) [7, 18]. A stratified random sampling strategy was used to pick 50 sericulture farmers from the designated districts. The farmers were classified according to their farm size, silkworm raising experience, and participation in various stages of silk production, such as cocoon harvesting and silk spinning.

2.2 Data Collection

A variety of structured questionnaires, interviews, and field observations were used to collect both qualitative and quantitative data. Farmers were given structured questionnaires to collect specific information about their production practices, including silkworm rearing costs (e.g., feed, labour, inputs) and revenue from cocoon and silk yarn sales. In-depth interviews with local sericulture specialists and extension officers were performed to get insight into the sector's issues and potential (Vijaykumar *et al*., 2007) [19]. Field visits were performed to observe silkworm rearing methods, silk reeling procedures, and mulberry cultivation practices.

Economic data, such as the cost of inputs, labour, and capital investment for silkworm farming and silk production, were obtained directly from local farms, while market pricing for silk and cocoon sales were acquired from project reports and market surveys done in the designated locations. The data gathering period ran from January to June 2023, covering both dry and wet seasons to account for seasonal differences in silkworm rearing.

2.3 Data Analysis

In the current study, a cost-benefit analysis approach was used to assess the economics of cocoon and silk yarn production, as described by Sharma and Kapoor (2020) [14]. The resources used to produce silk cocoons from 300 DFLs and silk yarn from 8,000 kgs of cocoons were calculated using production estimates. The data was estimated for a one-year period of six silkworm rearing cycles and 250 working days of silk yarn production per unit.

The analysis factored in both fixed and variable costs, such as labour, mulberry cultivation, silkworm feed, and processing costs, as well as revenue from cocoon and silk thread sales. The net farm income was determined specifically for the purposes of this study. The gross income per unit for silk cocoon and silk yarn manufacturing was estimated using the current market price.

2.4 Costs and Returns associated in sericulture

Sericulture is a labour-intensive agricultural activity that consists of numerous stages, each with its own set of costs. Silk production is normally separated into many stages: mulberry farming, silkworm rearing, cocoon harvesting, and silk yarn processing. Farmers incur both fixed and variable costs at each stage, which ultimately influence enterprise profitability (Reddy *et al*., 2017) [13]. Understanding these costs and returns is critical for determining the economic viability of sericulture, especially in poor countries where it is frequently considered as a key driver of rural

development.

2.4.1 Cost Structure of Sericulture

Sericulture costs are usually divided into two categories: fixed costs and variable costs (Tirtha *et al*., 2016) [17]. Fixed costs are those that remain constant regardless of production volume, such as investments in infrastructure (rearing houses, storage facilities), equipment (spinning tools, reeling machines), and mulberry growing area. These costs are often incurred at the start of the manufacturing process and decrease over time. The purchase value and life span of equipment and buildings are considered when calculating annual depreciation or maintenance.

Variable costs, on the other hand, are directly proportional to production levels and include labour, mulberry saplings, silkworm eggs, fertilisers, insecticides, and irrigation water. Silkworm eggs and feed, in particular, account for a sizable share of variable costs because they are required for each production cycle (Pandit *et al*., 2021) [10]. Labour costs, particularly during the rearing and harvesting phases, constitute a significant component of variable costs.

Mulberry Cultivation Costs

Mulberry trees, the main food supply for silkworms, are critical to sericulture and necessitate an initial investment in seedlings, soil preparation, and irrigation systems. Mulberry cultivation costs vary according to land acreage, inputs, and geographical location. For example, in India, the cost of establishing one acre of mulberry cultivation is estimated to be over USD 1,200, which includes saplings, fertilisers, labour, and irrigation (Reddy *et al*., 2017) [13]. Mulberry trees, once established, can produce leaves for several years while requiring relatively little upkeep.

Silkworm Rearing and Cocoon Harvesting Costs

Silkworm rearing entails a variety of activities, such as preparing rearing trays, feeding, monitoring temperature and humidity, and disease prevention. Labour costs are high during this stage due to the necessity for regular supervision. For example, a study conducted in India discovered that labour expenses accounted for roughly 40% of total variable costs in silkworm rearing (Rani *et al*., 2015) [12]. Silkworm eggs are also an expensive item, as they must be obtained from specialised breeders or sericulture centres. Farmers harvest the cocoons of silkworms when they have finished rearing them. This procedure necessitates more labour and equipment to handle the cocoons, which are then weighed and graded. Quality cocoon production is crucial for profit maximization since higher-quality cocoons command a higher market price (Das *et al*., 2019) [3].

Silk Yarn Processing Costs

Silk reeling, which involves boiling the cocoons to remove silk strands, comes after cocoon harvesting. The reeling process is energy-intensive, requiring water, fuel for boiling, and spinning instruments. Farmers often experience additional costs associated with reeling equipment maintenance and energy usage (Tirtha *et al*., 2016) [17]. The cost of silk yarn processing, including labour and material handling, varies according to the operation's size. These costs are generally high in small-scale enterprises due to inadequate mechanisation, but large companies benefit from economies of scale (Patel *et al*., 2019) [11].

2.4.2 Revenue Generation from Sericulture

Sericulture revenue is mostly determined by the number and quality of cocoon production, as well as prevailing prices of silk. Cocoon market prices fluctuate seasonally and are impacted by domestic and international demand and supply dynamics. Similarly, the price of raw silk yarn varies with quality, market conditions, and global demand for silk products (Bhattacharya & Mishra, 2018) [2]. In general, sericulture farmers make more money by producing high-quality cocoons and silk, which are more valued in both domestic and global markets.

2.4.3 Measure of Profits from Sericulture

According to Singh (1993) [15], there are vital measures of farm profit which can be termed as net farm income, farm investment income, and farm business income. For the benefit of the current study, the net farm income has been calculated. The estimates of gross income per unit for silk cocoon and silk yarn production have been estimated based on the current market price. The measures of farm profits are computed as below:

Gross Farm Income/ Gross Income = Gross Value of output including the by-product

Net Farm Income/Net Income = Gross Income – Cost C

While computing the net income, all the associated production costs (Cost-C) are considered.

3. Results and Discussion

An analysis of the estimated costs and revenue associated in the cocoon and silk yarn production have been computed as shown in the tables 2 and 3 below:

Table 2: Economics of silkworm rearing

A	Establishment of Mulberry Garden	UoM	Qty	Unit Cost (Ugx)	Total Cost (Ugx)
	First ploughing	Acre	1	122,500	122,500
	Second ploughing	Acre	1	95,000	95,000
	Harrowing	Acre	1	73,750	73,750
	Mulberry Cuttings	Bags	8	30,000	240,000
	Planting	Acre	1	82,500	82,500
	Weeding	Months	6	80,000	480,000
	Chemicals (pesticides, insecticides and fungicides)	Assorted			100,000
	Total Establishment Costs				1,193,750
B	Rearing house & equipment (Depreciation Cost)	No. / Qty required	Cost (Ugx)	Life Span	Depreciation Value (Maintenance)
Buildings					

	Late age rearing house and shoot store room (20ftx50ft)	1	13,000,000	25	520,000
	Total		13,000,000		520,000
	Equipment				
	Sprayer	1	70,000	5	14,000
	Room heater (Local stove)	1	40,000	2	20,000
	Charcoal (bags)	5	250,000	1	250,000
	Plastic basins each at Ugx 5000	2	10,000	4	2,500
	Leaf collecting basket each at Ugx 20,000	2	40,000	2	20,000
	Wooden Shoot rearing rack/Rearing Bed (45ft x 5ft, 4 tier) each at Ugx 50,000	6	300,000	8	37,500
	Nylon net	1	20,000	2	10,000
v	Plastic collapsible mountage each at Ugx 5000	120	600,000	8	75,000
	Plastic buckets each at Ugx10,000	2	20,000	2	10,000
	Hand thermometer	1	20,000	5	4,000
	Total Equipment Maintenance Cost		1,370,000		443,000
	Total Maintenance Cost on Rearing House and Equipment		14,370,000		963,000
C	Silkworm rearing costs (Variable costs)	UoM	Qty	Unit Cost (Ugx)	Total Cost (Ugx)
	DFLs	Boxes	36	20,000	720,000
	Materials (paraffin paper and newspaper) and disinfectants (bleaching powder, chlorine dioxide and bed disinfectant `lime')	Assorted			700,000
	Labour for rearing	Cycles	6	400,000	2,400,000
	Transportation and marketing	Assorted			600,000
	Total silkworm rearing costs (Variable costs)				4,420,000
	Total Establishment Costs-A				1,193,750
	Total Maintenance Cost on Rearing House and Equipment-B				963,000
	Total silkworm rearing costs (Variable costs)-C				4,420,000
D	Total Cost of cocoon production (A+B+C)				6,576,750
E	Income from silkworm rearing				
	Income from cocoons (Cocoon Yield=180kg per box/1080 kgs from 6 boxes)	Kgs	1080	13,000	14,040,000
	Income from by – products				702,000
	Total Income				14,742,000
F	Net Income				8,165,250
	Benefit: Cost Ratio				1.24

Note: Rearing capacity: 300 DFLs (6 boxes) per year for 6 cycles; Area: 1 acre

The estimates of costs and returns from rearing 300 DFLs is computed and presented as shown in Table 2 above. Based on the estimates, the cost of silk worm rearing including the cost of mulberry establishment, depreciation cost and the annual variable costs equal to Ugx. 6,576,750 per year, while the gross revenue from the sale of silk cocoon and the by-products equals to Ugx. 14,742,000 per year. The net income is thus computed at Ugx 8,165,250 per year with a cost benefit ratio of 1:1.24. This shows that silkworm rearing for cocoon production for six cycles enables an individual to earn a sensible income.

Furthermore, using the bivoltine cocoons, 1kg of silk yarn is equivalent to 6kgs of cocoons. Therefore, if 1080 kgs of cocoons are harvested from 6 cycles of silkworm rearing, 180kgs of silk yarn (raw silk) will be produced per year using our innovations. At an average rate of USD 50/Kg of yarn, this results into USD 9,000 equivalent to UGX 33,750,000 from one acre of mulberry per annum.

Table 3: Economics of silk yarn production using an automated reeling machine (40 End)

A	**Reeling equipment & facilities (Depreciation Cost)**	**No. / Qty required**	**Cost (Ugx)**	**Life Span**	**Depreciation Value (Maintenance)**
i.	Reeling Equipment and facilities	1	700,000,000	25	28,000,000
	Total Maintenance costs				28,000,000
B	Procurement of Cocoons	Unit	Qty	Price/Unit (Ugx)	Total Cost (Ugx)
i.	Cocoons	Kg	8,000	13,000	104,000,000
ii.	Packing materials	Pcs	100	1,500	150,000
iii.	Loading/Unloading	Assorted			200,000
iv.	Transportation cost of cocoon	Kg	8,000	1,000	8,000,000
	Total				112,350,000
C	**Processing of cocoons (Monthly Labour charges)**				
i.	Reeling	Nos	8	200,000	1,600,000
ii.	Sorting and Grading	Nos	2	200,000	400,000
iii.	Wastage and Cleaning	Nos	2	150,000	300,000
iv.	Winding	Nos	4	200,000	800,000
v.	Cooking	Nos	2	200,000	400,000
vi.	Brushing	Nos	4	200,000	800,000

vii.	Supervisor	Nos	1	250,000	250,000
viii.	By product and packing	Nos	2	150,000	300,000
ix.	Electricity				2,000,000
x.	Water				500,000
	Total				7,350,000
D	**Marketing cost of raw silk**				
i.	Transportation cost of raw silk	Kgs	1,333.33	1,000	1,333,333
ii.	Packing materials	Pcs	20	1,500	30,000
iii.	Loading and unloading				200,000
	Total Marketing costs of raw silk				1,563,333
	Total costs of silk yarn production(A+B+C+D)				149,263,333
E	Income from silk yarn production	Unit	Qty	Price/Unit (UGX)	Total Cost (UGX)
i.	Income from Raw silk	Kg	1,333.33	187,500	249,999,375
	Income from by-products				
ii.	Crushed Pupa in preparation of cooling cloth	Kg	130	56,250	7,312,500
iii.	Wastages of silk	Kg	333	37,500	12,487,500
iv.	Defective Cocoon	Kg	433	18,750	8,118,750
	Total Income				277,918,125
F	Net Income				128,654,792
	Benefit: Cost Ratio				1.86

Note: Production capacity= 67 kgs of raw silk yarn per day (16MT per year); 1USD= UGX 3,750

The estimates of costs and returns from silk yarn production using an automated reeling machine (40 End) are computed as shown in Table 3. Based on the estimates, the total cost of silk yarn production, including the depreciation cost of reeling equipment and facilities, procurement of cocoons, cocoon processing, marketing cost of raw silk totals to Ugx 149,263,333 while the gross income from the sale of silk yarn totals to Ugx 277,918,125 annually. The net income is therefore calculated at Ugx 128,654,792 annually with a cost benefit ratio of 1:1.86. This implies that silk yarn production enables companies to earn a sensible income.

Furthermore, silk yarn production using an automated reeling machine (40 End) can employ individuals for about 250 working days producing approximately 67 kgs of raw silk yarn can be processed per day equivalent to 16MT annually.

4. Conclusion and Policy Recommendations

The estimates of cocoon and silk yarn production show that sericulture has the potential of creating employment opportunities for the rural households as well as improving their livelihoods. The models discussed above can also be adopted in other countries practicing sericulture imparting necessary skills and knowledge. The sericulture industry thus provides good prospects for the poor households of Uganda by creating lucrative job opportunities and revenue, utilizing the available resources.

The study's findings indicate that government support, innovative technological adoption, proper extension services, and market linkages are required to improve sericulture's income and employment creation potential.

4.1 Limitations of the Study

Due to time and resource constraints, the sample size was limited to 50 farmers, which may not accurately represent Uganda's sericulture community. Furthermore, some farmers refused to give their entire financial information, which may have influenced cost estimates. However, every attempt was made to reduce bias by triangulating data from several sources, including project reports and expert comments.

5. Acknowledgements

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