ADOPTION OF SERICULTURE IN SELECTED WOREDAS OF OROMIA AND SOUTHERN REGIONAL STATES, ETHIOPIA

M.Sc. Thesis

BY

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ADOPTION OF SERICULTURE IN SELECTED WOREDAS OF OROMIA AND SOUTHERN REGIONAL STATES, ETHIOPIA

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DEDICATION

I dedicate this thesis manuscript to my families for their continuous contribution throughout my life.

STATEMENT OF AUTHOR

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BIOGRAPHICAL SKETCH

The author was born in Gimbichu town Hadiya Zone of Southern Nations Nationalities and People's Regional State in February, 1984. He completed his elementary and junior secondary school education at Gimbichu Junior secondary school and high school at Wachemo comprehensive high school. He joined Hawassa University in October 2003 and graduated with Degree in Horticulture in July, 2006.

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ABBREVIATIONS AND ACRONYMS

ARD	Agriculture and Rural Development
ATVET	Agricultural Technical Vocational Education and Training
CC	Contingency Coefficient
CIAT	Centro International de Agricultural Tropical
CIMMIYT	International Center for Wheat and Maize Improvement
CSA	Central Statistic Authority
DAs	Development agents
ETB	Ethiopian Birr
FDRE	Federal Democratic Republic of Ethiopia
GDP	Gross Domestic Product
GOs	Governmental Organizations
HH	Household head
IIRSH	International Institute of Research for Small-scale Household
ILRI	International Livestock Research Institute
MARC	Melkassa Agriculture Research Center
MLE	Maximum Likelihood Estimation
MoA	Ministry of Agriculture
NGOs	Non-Governmental Organizations
OECD	Organization for Economic Cooperation and Development
PAs	Peasant Associations
PLC	Private Limited Company
PRA	Participatory Rural Appraisal
RBoA	Regional Bureau of Agriculture
RuMEI	Rural micro-enterprise initiative
RuSACO	Rural Saving and Credit Cooperatives
SD	Standard deviation
SNNPR	Southern Nations, Nationalities and People's Regional State
SPSS	Statistical Package for Social Science
SSA	Sub-Saharan Africa
TLU	Tropical Livestock Unit
T&V	Training and Visit
UAE	United Arab Emirates
USA	United Sates of America
VIF	Variance Inflation Factor
WoA	Woreda Office of Agriculture
WoARD	Woreda Agricultural and Rural Development
ZoA	Zone Office of Agriculture

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ABSTRACT

Silkworm production in Ethiopia is basically started recently in Oromia and Southern regional states. The production status of silk (cocoon) in these areas was 3.36 tons with annual average income of 360000 ETB. From the total of 396 farmers 190 and 206 adopters and non-adopters were selected purposively and simple random sampling technique and interviewed to generate data for the study. 64 focus group and 17 key informant discussions were held to generate qualitative data. A binary logit model for the factors influencing adoption of silk and silkworm production was employed and among the total 7 explanatory, 5 variables were found significant to affect the adoption. These include; sex, age, total land size, total livestock, active family labor force, frequency of contact with DAs and participation on training. But educational status and access to credit were non-significant to sericulture adoption. The major silkworm production challenges were lack of feed source, primitive and unscientific "reeling and weaving" technique, lack of knowledge and skills among the farmers and extensionist, lack of host plant and silkworm seeds, lack of market information, the presence of disease and adverse condition. Despite all the challenges, there are enormous prospects to boost production and quality of silkworm production in the two regions (environmental conduciveness and human capital growth). Enhancing silkworm feeds through introducing improved mulberry and castor plant, establishing seed center and creating proper market are recommended.

Key words: *adoption, challenges, silk, silkworm*

1. INTRODUCTION

1.1. Background of the Study

Silk and silkworm production is a labor oriented, low investment and small scale industry which suits both marginal and small land holders because of its high income, short conception period and creates opportunity for own family employment round the year. Sericulture serves as an important tool for rural reconstruction through benefiting the weaker sections of the society (Lakshmanan and Geethadevi, 2005). Sericulture industry brings gainful opportunities and it is a viable practice for rural industry because it gives remunerative employment to family labor throughout the year and ensures periodic income to small and medium holdings (Trivedi and Sarkar, 2015).

Sericulture is an art and science of rearing silkworms, and biological process of getting textile fiber from animal origin (Rahaman *et al.,* 2013). Silk is a natural protein fiber secreted by arthropods especially lepidopteran insects called silkworms (Chowdhary, 2006). It is very soft, lustrous, smooth, strong and durable than any natural or artificial fiber. The industrial use of silk and its economic importance of production finely contributed to the silkworm promotion all over the world (Ramesh-Babu *et al*., 2010). This opens ways for integrating agricultural practices with silk production as with animal husbandry, dairy, fisheries and horticulture, which will improve the overall productivity of the societies (Tzenov, 2007).

Silk farming is an eco-friendly agro-based venture with a great potential for environmental amelioration, employment and income generation, diversification of agriculture, and expansion of export earnings (Kioko *et al*., 2007; Ntaanu, 2007). Silkworm production can be undertaken as a rural micro-enterprise initiative (RuMEI) by resource poor farming communities which depend on the forest for their livelihoods. This will reduce the pressure on the natural forest and conserve biodiversity (Raina *et al.,* 2011).

According to Mote and Sananse (2014), many countries have been involved in sericulture industry development in the world. In world the China is the leading country by producing 474,008 (79.9%) tons/year followed by India which produce 88,517 (14.9%) raw silk from mulberry silkworm.

Tzenov (2007) indicated that there is a good potential for sericulture development, not only in the East Asia, but also in Africa based overall socio-economic and agro-climatic conditions (rainfall, soil, temperature, humidity, light and air). Hence, developing countries are directing their development strategies on productivity levels in rural areas (Hajare *et al*., 2007). The potential of African silk production has been well documented (Mbahin *et al*., 2008) and other central and southern African countries.

According to Kedir Shifa (2016), silk played important part in social and religious life of Ethiopia from the earliest days of its history. Thus silk has been imported in large quantities from India, Arabia and China, and Ethiopian Emperors has been making prodigious gifts from silk to churches and honored guests (Spring and Hudson, 2002). Recently, silk production from eri silkworm (*Samiacynthia ricini*) is commonly practiced in Ethiopia (Metaferia *et al*., 2007).

According to Habthyimer and Deressa (2004), sericulture is one of the sectors re-initiated in Ethiopia for enhancing sustainable agriculture. It is highly suited to small and marginal farm holdings with less capital investment. Cocoon production involves two distinct activities namely, silkworm and host plant leaf production. The host plant leaves are the sole feed for silkworm and silkworm rearing. It involves rearing silkworms for the production of raw silk, which is the yarn obtained out of cocoons spun by certain species of insects. The major activities of sericulture comprise of food-plant cultivation to feed the silkworms which spin silk cocoons and reeling the cocoons for unwinding the silk filament for value added benefits such as processing and weaving. Silkworm production has advantages like high employment potential provision of economics, women friendly occupation, ideal program for weaker sections of the society, and the satisfaction of equity concerns (Habthyimer *et al.*, 2008).

Ethiopia is settled with diversified climate, vegetation and topography. This is factual for diversified options of sericulture industry which are adopted on different vegetation (for rearing of silkworms) and different species of silkworms. However, there were no known records of silk being produced in the country until 1930's (Period of colonization). In 1930's, however, the Italians realized the suitability of climatic condition for rearing of silkworms and availability of necessary resources and conducted silkworm rearing at 11 sites though this had

been stopped immediately when they left the country the possibility of silkworm rearing in different parts of the country if worms are protected against night cold (Teweldebrhan, 1991).

Silkworm production is the earliest activity in Ethiopia as a result the production of raw silk in country level reported as an average 3 tons/year from SNNP, Oromia, Amhara and Tigray national states (MoA, 2014). The production of the silk in country is very low it compared with that of the world production amount.

1.2. Statement of the Problems

Oromia and Southern Nations, Nationalities and People's Regional States are the two regional states in which sericulture sector involved. However, there are a little investigation and documentation done and therefore less is known about the status and challenges of sericulture in these states. The amount of production and challenges of production, processing, knowledge and skill gap and income generated from this sector are not well documented. These have hampered the development of sericulture strategic plan and objectives.

Therefore, this study was conducted to assess adoption of technologies, production status, and major challenges of the silkworm production in Oromia and Southern Nations, Nationalities and People's Regional State of Ethiopia.

1.3. Research Questions

1. What is the estimated quantity of silk cocoons produced in the study area?
2. Why sericulture is not widely produced in the study area?
3. What are the challenges related to marketing of sericulture in the study areas?

1.4. Objectives of the Studies

1.4.1. General objective

- To assess the adoption and production status of sericulture in Oromia and Southern Nations, Nationalities and People's Regional States of Ethiopia thereby contributing to the overall think thank of sericulture in the country.

1.4.2. Specific objectives

- To explore factors that affect adoption of sericulture technologies in the study areas
- To identify marketing challenges of sericulture products

1.5. Significance of Study

Silkworm is the most economic/industrial, income generating source that fulfills the food insecurity gap in developing countries. The main problems of silkworm production includes seed, mulberry varieties, reeling and weaving, low knowledge and skills gaps of farmers and extensionist, lack of mulberry and silkworm seed and multiplication centers (ILRI, 2004). According to GTP II, the country projected a major target to increase the total production of silk cocoon from 3 to 7 tons by the end of the plan period.

Although its production status, adoption scale, challenges and benefit are not well known and documented in Ethiopia.

Despite the ability of the sector to assist the quest for poverty alleviation in the country in that it is highly relevant to the development process of the country, opportunities, factors that challenge the production and product marketing activities are not well identified. Hence, it is quite challenging to integrate scientific recommendations to the exiting production status. Thus, the research output from the study will assist in production and adoption of silk and silkworm production and marketing.

2. LITERUTURE REVIEW

2.1. Origin of Sericulture

In ancient days, Chinese farmers found some wild silkworm feeding on leaves of natural mulberry trees. They removed them out of curiosity from the native woods, brought home and observed their behavior. According to their old chronicle, the domestication of silk-producing worms occurred in Central China during the period of around 2640 BC with control over their breeding habit (Chowdhary, 2004). Actually rearing of the worms began about 4500 years ago along the bank of river Huang Ho known as the "Nucleus Area of North China". There appeared complex cultures, of which the domestication of silkworm was one (Roberts, 1984). China is an ancient country with a very early agricultural history and the concomitant development of knowledge of entomology took place over a long period of time (Zou, 1981).

Sericulture is one of the great inventions of the ancient Chinese. The mulberry silkworm, *Bombyx mori* Linaeus (Lepidoptera: Bombycidae) was successfully domesticated to produce the raw silk used for weaving by Chinese farmers about 5,200 years ago. Many people have heard of the mulberry silkworm, however few know much about the Chinese oak silkworm, *Antheraea pernyi* Guérin-Méneville (Lepidoptera: Saturniidae) that also originated in China (Goldsmith, *et al.,* 2004).

2.2. Definition of Sericulture

Sericulture is the process of rearing silk producing insects in captivity or collecting their silk cocoons in the field for human use, mainly leading to the production of fabrics (Peigler, 1993). It can be broadly classified into two, namely mulberry silkworms feeding on mulberry leaves only (mulberry sericulture) and eri-silkworm which is multivoltine and polyphagous species called non-mulberry sericulture. Eri-silkworm feed on primarily castor plant (Fening, 2008). Castor (*Ricinus communis* L.) is the primary food plant, which can ensure production of good quality cocoons. However, *Manihot utilissima*, *Heteropanax fragrance*, *Curica papaya*, *Evodia falxinifolia*, *Sapium eugenifolia*, *Jatropacurcas*, *Gomelina arborea*, etc. are secondary and tertiary host plants during unfavorable seasons (Hajarika *et al.,* 2003).

Sericulture is composed of activities such as breeding and maintenance of silkworm races, mulberry breeding and cultivation, silkworm egg production, silkworm rearing and mounting, cocoon drying, silk reeling, testing of raw silk quality, the production of silk products by manufacturing and weaving, as well as the silk thread and fabric production (Ntaanu, 2007).

2.3. Importance of Sericulture

2.3.1. Economic Importance of silk

Sericulture has provided the basis for economic development of ancient China. It has the potential to make significant contribution to the economy of many other countries where there is surplus labor, low-costs of production and willingness to adopt new technologies (Hajare *et al.*, 2007).

Sericulture plays important role in creating global levels of economic development in various countries. It has been identified as employment oriented industry. For example, China is the first and largest silk producing country, where about 1 million workers are employed in the world. India is the second highest silk producers of raw silk and consumer of pure silk in the world level. The other major silk producers countries include; Brazil, African, Thailand, Vietnam, Indonesia, Egypt, Iran, Srilanka, Philippines, Bangladesh, Nepal, Myanmar, Turkey, Mexico, Uzbekistan, the United States and etc. But the most silk consumers of the world developing countries are China, India, USA, Japan, Italy, France, United Kingdom, Switzerland, Germany, UAE, Korea, Vietnam etc. At present, increasing consumption of silk and silk products witnessed in most of the developed countries leads to high demand in global level market. It plays an important role in foreign exchange earning opportunity for the developing countries in the world (Siddappaji *et al.*, 2014).

Quality and quantity of host plant materials increase quality and value of silkworm product (silk and cocoon) acceptances in the markets. The races of the mulberry silkworm are known not only for their significant differences in the yield and the quality characters of the silk produced by them, but also for response of the silkworm to the physical environment and food quality (Sabhat *et al.*, 2011). Therefore, the quality and quantity of castor leaves plays an

important role in growth and development of eri silkworm, particularly during adult and larval stages, which in turn influence the cocoon productivity and the economic traits of the cocoon.

Good quality and sufficient quantity castor leaves feeding to the developing worms leads to an increase in body size and dry weight of cellular mass which are dependent on the rate of metabolism, absorption of nutrients, and stage of development (Rajanna, 1991).For instance, with an effective quality mulberry host feed, linking mulberry sericulture with other subsidiary enterprises has always been found to be complementary. A number of enterprises can easily be combined with mulberry sericulture for effective crop diversification. There is every scope for improving the economic efficiency of resources too. Hence various components of the farming system are clubbed together to effectively simulate the conditions of enterprise diversification (Nagaraja *et al.*, 2004). According to Ravikumar (1988), the quality of feed plays a remarkable role for growth and development of the silkworm and ultimately on the economic traits of cocoon.

2.3.2. Socio-economic importance of silkworm

Silkworm production can generate employment for a large number of unemployed people especially females partially or fully in its various stages of activities. As a labor intensive activity practiced throughout the year it is identified as a means for rural employment generation and as a remedy for seasonal unemployment (Rajesh, 2013). The scope is increased further when proper sericulture and textile industries are undertaken on scientific and commercial lines. Thousands of people can be engaged directly or indirectly in various sericulture activities like cultivation of host plants, maintenance of plants, plucking of leaves from the planted and wildly grown trees, feeding and rearing of silkworm up to cocoon stage, spinning of yarn, weaving of fabrics, marketing of cocoons and cloth etc. During the rearing period of eri and mulberry worms, constant watch is not necessary. The family members engage themselves in works connected with rearing, e.g., collection of leaves, cleaning of leaves and rearing trays (Romesh and Kakoti, 2012).

According to Mote and Sananse (2014), many countries have been involved in sericulture industry development in the world and more than half of these countries are situated in Asia

and more than 97 percent of raw silk or silk yarn is produced by the five major silk producing countries: China, India, Uzbekistan, Brazil and Thailand recently. On the other hand, a greater portion of the world's population lives in developing nations and depends on agriculture, the primary sector for livelihood. However, the productivity levels in the agriculture sector are low. This is not only because of pressure on land, but agriculture in these nations is also often characterized by poor organization, limited capital and investment. Hence, the developing countries are directing their development strategies on the productivity levels in rural areas (Tzenov, 2007).

Farmers from rural area were facing the typical problems of volatility of agricultural markets affecting the returns from their agriculture produce, such as cereals and vegetables, diminishing farm productivity due to soil degradation from over-erosion and poor water quality, and labor shortages. This situation triggered the search for alternative, agriculture-based, sources of rural incomes to assure better livelihood options for marginal and small-scale farmers in the area. The introduction of sericulture and using it as an alternative source of income can reduce the migration of youth and small scale holders to urban through search of business and household income generation. This can help the stability of farmers and most rural population in the rural area and reduce overcrowded of population number in the urban area through migration (Patil *et al.*, 2009).

2.3.3. Cultural importance of sericulture

Silk is a Nature's gift to mankind and a commercial fiber of animal origin other than wool. Being an eco-friendly, biodegradable and self-sustaining material; silk has assumed special relevance in present age. Promotion of sericulture can help in ecosystem development as well as high economic returns. Sericulture is practiced in India and the second largest producer of silk next to China in the World. All the sections of sericulture industry, viz. mulberry cultivation, silkworm seed production, silkworm rearing, reeling and weaving of silk and collection of byproducts and its processing provide a large scale employment, thereby a source of livelihood for the rural and tribal people (Spring and Hudson, 2002).

Silk has played an important part in the social and religious life of Ethiopia from the earliest days of the Kingdom of Axum. This silk was imported in large quantities from India, Arabia and China and stored in vast caverns in the central highlands of Ethiopia and Ethiopian Emperors would make prodigious gifts of silk to other churches. Ceremonial umbrellas, binding of sacred books, covers for wooden altars and spectacular hangings have all been produced from silk over the centuries (Metaferia *et al.*, 2007). Apart from some historical traditions along the Kenyan coast, Ethiopia has long been the only major silk weaving region in eastern Africa. The silk yarns used for both art and function were imported from China (Spring and Hudson, 2002).

2.4. Concepts of Adoption

2.4.1. Definition of adoption and innovation

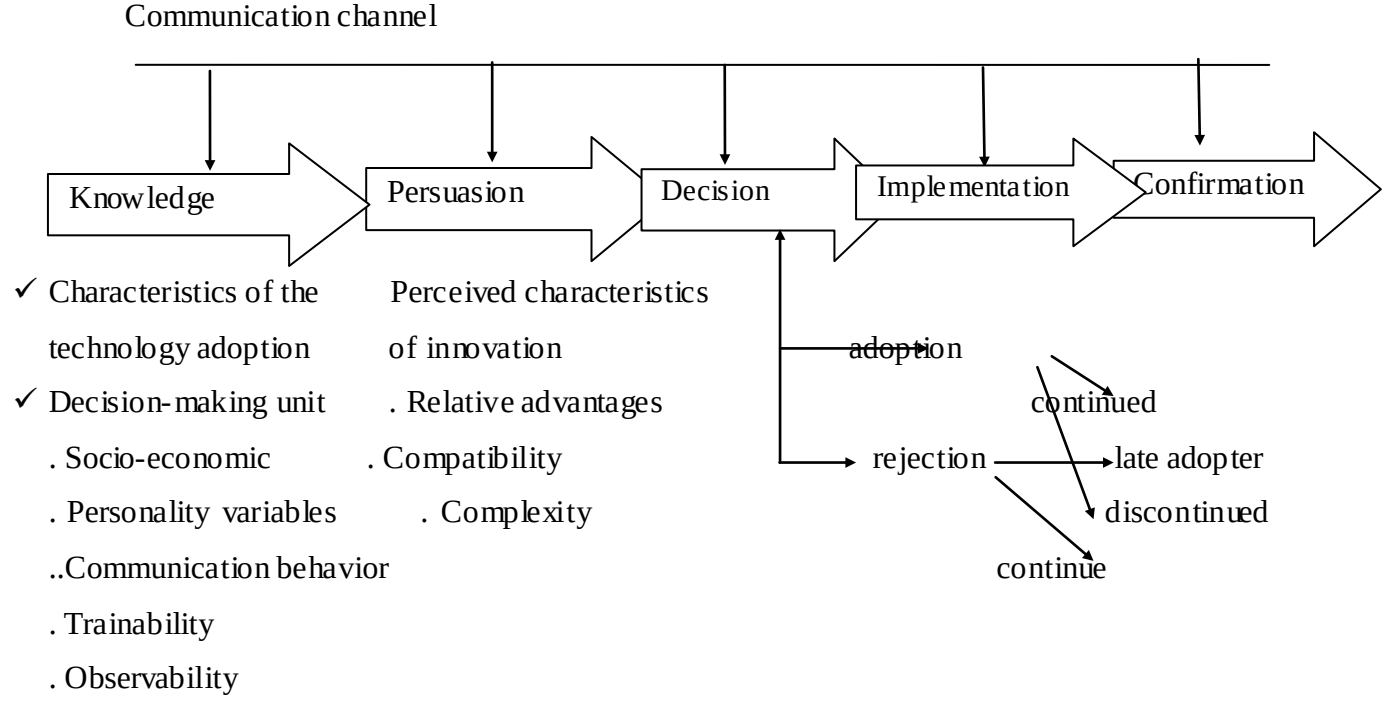
Adoption may be defined as the integration of an innovation into farmers' normal farming activities over an extended period of time. Adoption, however, is not a permanent behavior. An individual may decide to discontinue the use of innovation for a variety of personal, institutional, and social reasons one of which might be the availability of another practice that is better in satisfying farmers' needs (Feder *et al.* (1985). Accordingly he classified adoption as an individual (farm level) adoption and aggregate adoption. Adoption at the individual farmers' level is defined as the degree of use of new technology in long run equilibrium when the farmer has full information about the new technology and it's potential. In the context of aggregate adoption behavior, diffusion is defined as the spread of new technology within a region. This implies that aggregate adoption is measured by the aggregate level of specific new technology with a given geographical area or within the given population.

2.4.2. Adoption decision process

According to Rogers (1983), the innovation decision is the process through which individual or other decision making unit passes from first knowledge of an innovation, to forming attitude towards innovation, to decision to adopt or reject, to implementation of the decision, and to confirmation of this decision. This process consist a series of actions and choices over time through which individual or organization evaluates a new idea and decides whether to

incorporate the new idea in to ongoing practices. An individual's decision about innovation is not an instantaneous act, rather it is a process. Based on this, the innovation decision process conceptualization consists of five stages:

i) Knowledge occurs when an individual (or other decision making unit) is exposed to the innovation's existence and gains some understanding of how it functions;
ii) Persuasion occurs when an individual (or other decision making unit) forms a favorable or unfavorable attitude towards the innovation;
iii) Decision occurs when an individual (or other decision making unit) engages in activities that lead to a choice to adopt or reject the innovation;
iv) Implementation occur when an individual (or other decision making unit) puts the decision to adopt or reject into practice; and
v) Confirmation occurs when an individual (or other decision making unit) seeks reinforcement of an innovation decision already made, but he/she may reverse this previous decision if exposed to conflicting messages about the innovation.



Source: Rogers, 1983

Figure 1 Innovation decision process

2.4.3. Concept and Diffusion of technologies

According to Rogers (1983), diffusion of an innovation is the process by which innovation is communicated through certain channels over time among the members of a social system. People do not just welcome every innovation that is put in front of them. Every person reacts differently in the ways that he/she hears about, understand, and finally accept or do not accept an innovation. There are four main elements to the diffusion of innovations: (1) the innovation, (2) its communication, (3) in a social system, (4) over a period of time.

- Innovation: any item, thought, or process that is viewed to be new by the consumer.
- Communication: the process of the new idea traveling from one person to another
- Social System: the group of individuals that together complete a specific goal.
- Time: how long it takes for the group to adopt an innovation as well as the rate of adoption for individual.

The diffusion process is not a mathematical equation or a chemical reaction but rather a natural progression of peoples' attitudes, opinions, and feelings towards accepting a new idea. All four elements have many different factors that affect the outcome of the process as well as act intimately to affect each other (Rogers, 1983).

2.5. Knowledge Network

Knowledge can be understood as both information and skills that are acquired through individual experience and trial and error, within an organization or a learning community, or from outsiders adapting it to local contexts. Knowledge that rural and farming communities are typically interested in includes cultural management practices; new agricultural technologies, market information on inputs and sales and government policies etc. (Harwich *et al.*, 2007).

According to Paul (1997), knowledge is not simply that is possessed and accumulated, it emerges out of process of social interaction and should be looked at in terms of social relationships. What people know and how they go about learning is intrinsically woven into their life as social beings. Knowledge emerges as a result of social efforts to come to grips

with the demands, the social and physical environments in which individuals and groups are immersed. Knowledge includes the ideas, concepts routines and skills people acquire over time to support their livelihood.

Since knowledge is dynamic, it is constantly produced and reproduced, shaped and reshaped and yields many types of knowledge, differentiated within and between localities (Mango, 2002) . Knowledge continuously evolves as farmers learn both by evaluating the outcomes of previous actions and by observing the environment. This means knowledge that enters a locality is not simply internalized, but becomes transformed by various actors to suit their circumstances (Joshi *et al.*, 2004).

Farmers use many different sources including their own, to obtain knowledge and information they need to manage their farms and that new knowledge is developed not only by research institutes but also by many different actors (Ray, 1999).

Social and informational networks do exist within the farming community; they exert a significant influence on farm-level decision making; and such networks affect different decision domains in different ways. Small-scale producers often rely on informal mechanisms of information exchange and knowledge sharing to address agricultural problems and challenges. Given the limited scope of formal extension programs, informal exchange is often the primary source of information about new technologies in Sub-Saharan Africa (SSA). The increasing role of informal mechanisms for information sharing has been recognized in the literature through farmer-to-farmer models of agricultural development (Eveleens *et al.*, 1996).

Information exchange in social networks also provides important economic benefits. For example, dense networks with the dominance of strong ties enable a 'thick' information exchange that makes new knowledge quickly available for all actors in the network. On the other hand, loose networks composed by a large number of weak ties give access to a large amount & novelty of information that might, however be less detailed and strategic than provided by the strong ties (Agapitova, 2005).

2.6. Empirical Studies on Factors Affecting Adoption of Technologies

A number of empirical studies have been conducted by different people and institutions on the adoption and diffusion of agricultural innovations both outside and inside Ethiopia. But, the studies are mainly conducted around major cereals crops and practices and due to this fact the studies conducted on the area of sericulture production technologies are very limited. As a result of this, the review mainly included such studies conducted in different contexts.

For ease of clarity the variables so far identified as having relationship with adoption are categorized as personal/demographic, economic, institutional and social variables.

2.6.1. Personal and demographic variables

Household's personal and demographic variables are among the most common household characteristics, which are mostly associated with farmers' adoption behavior. From this category of variables, education and age were reviewed in this study.

Education is associated with adoption because it is believed to increase farmers' ability to obtain, and analyze information that helps him/her to make appropriate decision. For instance, Bekele *et al.* (2000) and Tesfaye and Alemu (2001), indicated positive relationship between education and adoption.

Farmers' age can either generate or erode confidence in new technology. In other words, with more experience, a farmer can become more or less risk-averse when judging new technology. This variable could thus have a positive or negative effect on a farmer's decision to adopt sericulture technology.

2.6.2. Economic variables

Economic variables influence household's adoption decision of agricultural technologies. In this study economic variable active family labor force is assumed to play a great role in determining the willingness and ability to invest in adoption of sericulture technologies.

A study conducted by Kidane (2001) on factors influencing the adoption of new technologies revealed that shortage of active family labor force affected the adoption of that technology. On the contrary, Yishak (2005) reported that active family labor force availability did not affect adoption of improved Maize and Integrated Striga Management technologies, respectively.

2.6.3. Institutional variables

Household's institutional factors are one category of the variables which are mostly associated with farmers' adoption behavior. From this category of variables, contact with extension agent, attendance in extension events, access to credit, mass media exposure and frequency of contact with extension agents were selected as variables in this study.

Extension provides farmers with information related to agricultural technologies. The relationship between farmers' access to extension services and adoption has been repeatedly reported as positive and significant by many authors. For instance, Teferi (2003) had shown that extension contact affect adoption of new technologies positively and significantly. Similarly, Kebede (2006) found that a positive and significant relation between extension contact and adoption of maize varieties and Integrated Striga Management, respectively.

Regarding frequency of contact with extension agent, different studies reported positive and significant relation with adoption. Degnet *et al.* (2001) reported that, frequency of contact with extension workers positively and significantly affected farmers' adoption decision. Similarly, study conducted by Kidane (2001) have shown that frequency of contact with extension agent positively and significantly contributed to adoption.

Access to credit is one of the institutional variables that farmers need to get to improve production and productivity (credit utilization). Capital and risk constraints are key factors that limit the adoption of high value crops by small scale farmers. In line with this, study conducted by Minyahel (2007) also found that the use of credit had positive and significant influence on adoption and intensity of adoption of the technologies.

Another institutional variable is mass media exposure. The role of information in decision-making process is to reduce risks and uncertainties to enable farm households to make right decision on adoption of improved agricultural technologies. Mass media play the greatest role in provision of information in shortest possible time over large area of coverage. However, as compared to other institutional channels, its effect on behavioral change is weak as it is limited to awareness creation than skill development. Many studies reported the positive and significant relationship of mass media with adoption of agricultural technologies. In line with this, Yishak (2005) in his study indicated that ownership of radio had positive influence on adoption of improved maize technologies.

2.7. Evaluation of Improved Technology by Farmers

Farmers' criteria vary greatly between households, depending on the productive resources controlled by the household. However, the criteria also vary within a household. The division of responsibilities and tasks is socially defined according to gender and age. This means that different household members evaluate a technology according to different criteria, which are related to their role and functions in the household (Bunders *et al*., 1996).

Farmers identify and select type of technology most likely to do well in their areas and selection is normally preceded by extensive discussions both within the farm family and with neighbors. Any family member may make observations of technology performance, looking on the field and other criteria after harvest and good stand is noticed by neighbors and becomes a subject of conversation within the community (Bunders *et al*., 1996).

Characteristics of the technology play a vital role in adoption of improved technology. Accordingly, if the characteristics of the technologies satisfy the need and interest of the farmers they eventually adopt the improved technology. Farmers' technology evaluation criteria include growth habit, yield, color of product, ease of harvesting, storage, qualities, marketability, cost, ease of sale, desirability for home consumption, compatibility with existing practices, and resistance to pest and disease (Bunders *et al*., 1996).

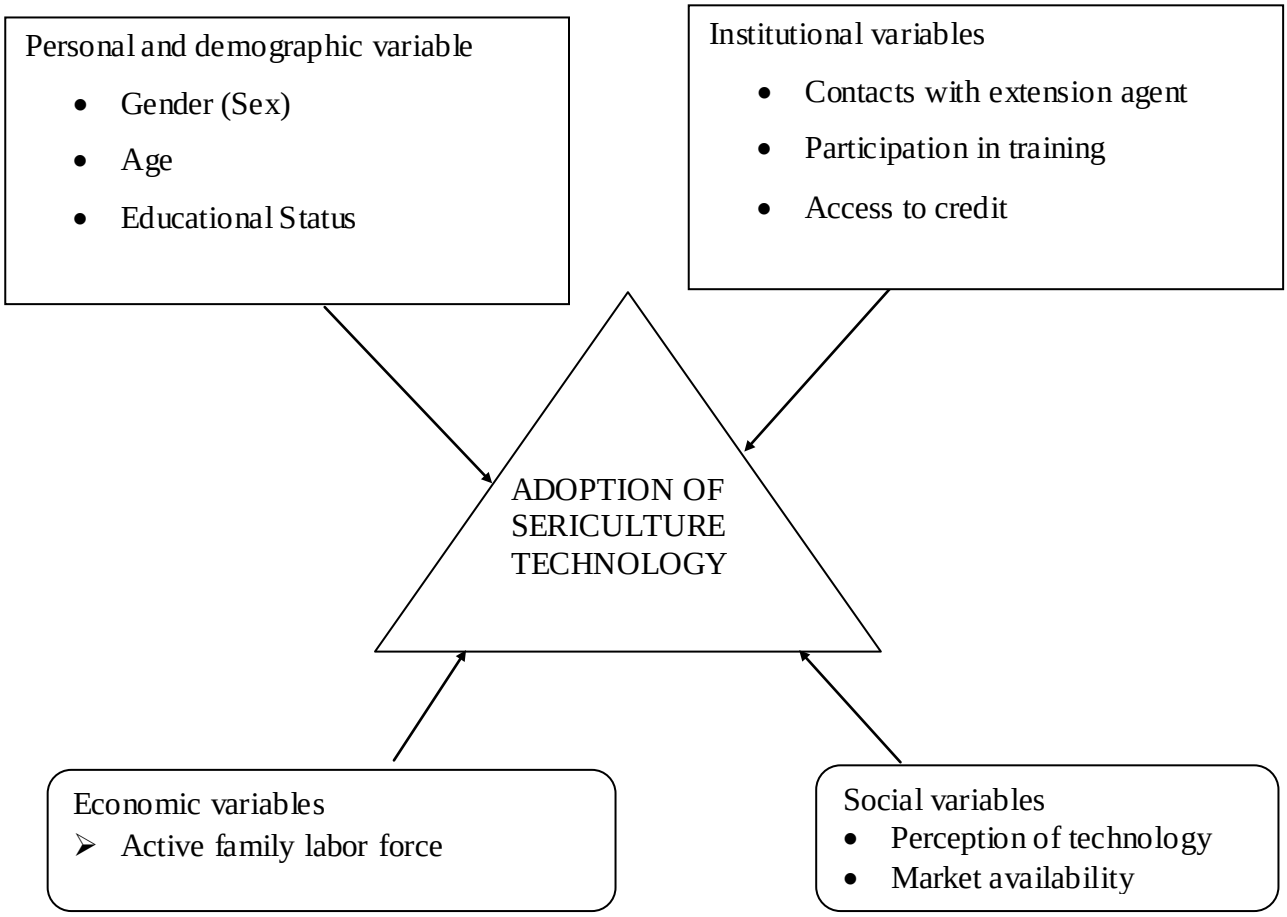
The choice of one technology/practice over others is greatly influenced by the balance between its positive and negative characteristics. Depending on the preferences, resources,

and constraints that individual farmers face, a beneficial characteristic for one farmer may be a negative one for another, or the balance between positive and negative traits may be acceptable for one farmer but not for another. Any new technology presented to farmers will either improve or substitute for the technological options they currently have. It is fundamental to identify these options and understand perceptions about the advantages and disadvantages of each one then researchers be able to assess the appropriateness of potential new technologies or practices, evaluate the likelihood that they will be adopted, and if necessary modify them to suit farmers' needs better (Bunders *et al.*, 1996).

2.8. Conceptual Framework of the Study

Agricultural technology adoption and diffusion patterns often vary from location to location. In general, the variations in adoption patterns proceed from the presence of disparity in agro-ecology, institutional and social factors (CIMMIYT, 1993). Moreover, farmers' adoption behavior, especially in low-income countries, is influenced by a complex set of socio-economic, demographic, technical, institutional and biophysical factors (Legesse, 1998).

The conceptual framework of this study is based on the assumption that a number of influences on adoption of sericulture production technology namely, personal and demographic, economic, institutional and social variables. It was also developed based on the theoretical model of adoption and diffusion discussed in the previous sections. As clearly illustrated in the following diagram, the two categories of variables are explanatory and dependent variables. Hence, the conceptual framework presented in (Figure 2) shows the most importance variables expected to influence the adoption of sericulture technology in the study areas of Oromia and Southern Nations, Nationalities and People's Regional State.



Source: Shiferaw and Holden, 1998

Figure 2 Conceptual Framework of the study

3. RESEARCH METHODOLOGY

3.1. Description of the Study Area

This study was conducted in Oromia and Southern Nations, Nationalities and People's Regional States, of Ethiopia.

Geographically Oromia region is located between $7^0$59'21"N latitudes and $39^0$22'52"E longitudes. It is bordered in the South by Kenya, West by South Sudan, Gambela and SNNPR, North by Amhara, Afar and Benishangul regions and on the East by Somalia region. It has area of 284,538 Km² and its capital city is Addis Ababa. It lies between 500 and 4377 m altitude and it is the most populated region in the country with total population numbers of 27,158,471 (CSA, 2009) of 13,676,159 men and 13,482,312 women; and average 95 person per Km². According to Oromia Regional Bureau of Agriculture (2014), the region has the average annual minimum and maximum rainfall of 450 mm and 1800 mm, the mean annual minimum and maximum temperature of 10 and 30°C.

Also Southern Nations, Nationalities and People Regional States are located between $4^0$43' – $8^0$58'N latitudes and $34^0$88' – $39^0$14'E longitudes. It is bordered in the South by Kenya, Southwest by South Sudan, Northwest by Gambela and Northwest, North and East of the Region by Oromia regional state. It has area of 110,931.9 Km² and its capital city is Awassa. It lies between 376 and 4207 m altitude and it is the most densely populated region in the country with the total population of 15,336,328 of which 7,626,840 are men and 7,709,489 are women (CSA, 2009); average 138 persons per Km². According to SNNP Regional Bureau of Agriculture (2014), the regions have the average annual minimum and maximum rainfall of 400 and 2200 mm, the mean annual minimum and maximum temperature is 11 and 27°C respectively. The region is classified in to Woina-dega (34%), Dega and Wurch (8.6%) and most part of the region (57.4 %) lies under Kolla and sub-bereha type of agro-climatic zones. From the total area 110,931.9 km^2 of the regions, 8.6% is highland, 34% is intermediate highland and 57.6% is lowland (BoA, 2014). The surveyed areas were Shebedino and Awassa Zuria woredas from Sidama zone, and West-Abaya and Arbaminch Zuria Woredas from

Gamo-Gofa Zone of SNNPRs; and Ambo Zuria Woreda from West Shewa zone and Sayo woreda from Kelem Welega zone of Oromia regional sates (Figure 3).

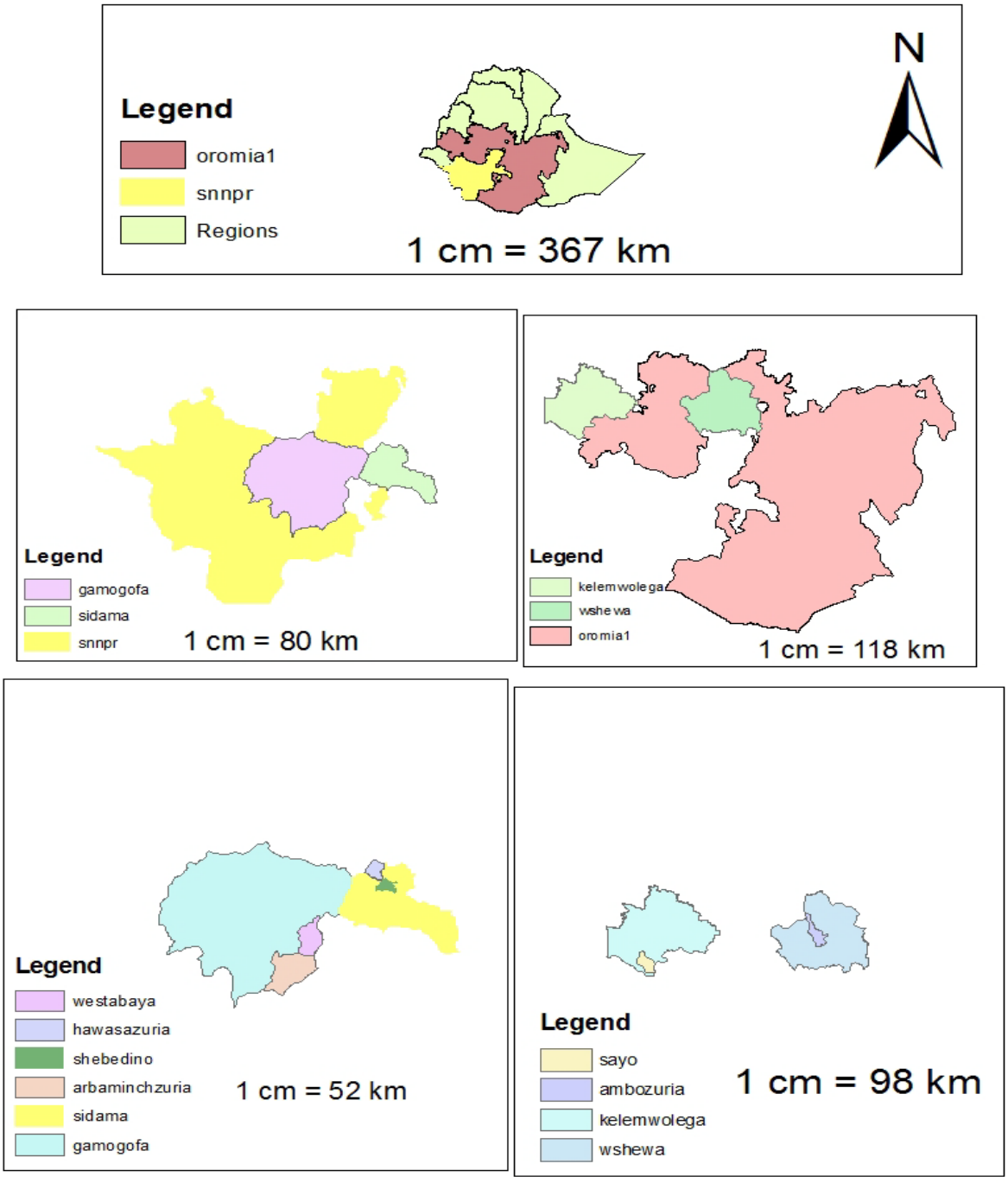


Figure 3 Map of the Study Areas (SNNP and Oromia Regional States)

3.2. Types and Sources of Data

3.2.1. Qualitative Data Collection

Qualitative data were collected through discussions with focused groups and key-informants, field visits and observations. Out of 81 total participants 54, 10 and 17 were key informants, woreda officials and DAs, respectively. In the focused group discussion (FGD), a skill moderator guided the discussion among a small group of eight to ten members of the community using open-ended check list. The facilitator introduced a list of topics and encouraged the participants to discuss issues and forward their opinions. In addition, discussion with kebele and woreda officials, DAs and concerned woreda Agricultural office experts were held.

3.2.2. Quantitative data collection

The primary data were collected from respondents using direct observation, survey and pre-tested semi-structured interview. Finally, the survey was conducted under close supervision of the researcher.

Secondary data were collected from reports of Regional Bureau of Agriculture, Zonal and Woreda Agricultural and Rural Development Office, Research Centers, ATVET and Privet Company.

3.3. Sampling Methods and Survey procedures

3.3.1. Sampling methods

Preliminary information about the study area was obtained from Regional Bureaus of Agriculture (RBoA) and Woreda Office of Agriculture (WoA) to generate important information for questionnaire preparation for the formal survey and to select sample peasant associations (PAs). An attempt was made to select representative samples in the selection of sampled PAs (sericulture producers). The surveyed PAs were Holisa, Dobetoga, Gonogabelo and Tula from Sidama zone, and Ugayehu and Chano-Chalba from Gamo-Gofa Zone of

SNNPR; and Sanqalle from West Shewa zone and Humbikaro from Kelem Welega zone of Oromia regional sate of producing peasant associations.

3.3.2. Sampling techniques

Multistage mixed sampling procedure was used to select the sample PAs and household farmers. First, purposively Oromia and SNNP regions were sampled because they are most potential for the production of sericulture. Second stage: from 18 and 14 zones available in Oromia and SNNPRS, respectively, four zones (two from Oromia and other two from SNNPRS) are selected respectively in simple random sampling. Third stage: a total of six Woredas (two each from SNNPRS and one each from Oromia region are selected purposively. Fourth stage: Eight PAs (six from SNNPRS i.e. four from Sidama, two from Gamo-Gofa) and two PAs from Oromia (one from West Shewa and one from Kelem Welega) are selected purposively. Fifth stage: farmers are stratified in to adopters and non-adopters. Sexth stage: among the selected PAs, the farmers were stratified into adopters and non-adopters of silkworm production. For this study due to having small number of silkworm producers in each kebeles, all the 190 adopters are selected purposively and depending on the number of household heads in each kebeles 206 non-adopters are selected by using simple random sampling methods, and total size for the study is 396 farmers (Table 1).

Adopters are those farmers who practiced silkworm rearing for at least up to research study years and non-adopters are farmers who did not practiced any silkworm rearing during the study period.

Table 1 Sample respondent selection across Peasant Associations.

Peasant Associations	Total number of sampled house hold						
	Adopters	n	Non-Adopters	n	Total HH	Tn	n%
Holisa	13	13	650	26	663	39	9.85
Dobetoga	7	7	578	23	585	30	7.58
Gonogabelo	14	14	702	28	716	42	10.6
Tula	9	9	503	20	512	29	7.32
Ugayehu	47	47	620	25	667	72	18.18
Chano-Chalba	20	20	574	23	594	43	10.86
Sanqalle	43	43	796	32	839	75	18.94
Humbikaro	37	37	722	29	759	66	16.67
Total	190	190	5145	206	5335	396	100

Note: AD= adopter; n= sample; NAD=non adopter; THH = Total household head; Tn = total sample

3.4. Methods of Data Collection

Sixteen enumerators were recruited and trained for data collection at their respective Woreda. Before data collection, the questionnaire was pre-tested to evaluate the appropriateness of the design, clarity and relevance of the questions and time taken for an interview. The appropriate modifications and corrections were made on the questionnaire accordingly. Data were collected under continuous supervision of the researcher.

3.5. Method of Data Analysis

Following the completion of data collection, data were coded and entered into Statistical Package for Social Science (SPSS version 20.0) and (STATA version 12.0) computer program for analysis.

3.5.1. Qualitative data analysis

Qualitative data were analyzed using different qualitative statistical procedures and methods. Descriptive tools were supplemented by qualitative analytical methods (mainly for those data acquired through the participatory/qualitative methods) like interpretation and explanation of various opinions, views and concepts, summarizing, categorizing, and presentation of these in convenient forms.

3.5.2. Quantitative data analysis

Descriptive statistics were used to summarize and categorize data by using means, percentage, frequency, standard deviation, chi-square and t-test. The degree of association or correlation between two variables X and Y was answered by using of correlation analysis (Kothari, 2003).

Binary logit model was used to analyze factors influencing the decisions of households to adopt silk and silkworm production or not.

3.5.3. Model specification

Following Green (2008) the logistic distribution for adoption decision of silk and silkworm production can be specified as:

$$\mathbf{P_i} = \frac{\mathbf{1}}{\mathbf{1+e^{-z(i)}}} \quad \text{..... (1)}$$

Where, P_i is a probability of adoption of silk and silkworm production for the i^{th} farmer and ranges from 0 to 1. e^- represents the base of natural logarithms and Z_i is the function of a vector of n explanatory variables and expressed as:

$$Z_i = ß_o + \Sigma ß_i X_i \quad \text{..... (2)}$$

Where $ß_o$ is the intercept and $ß_i$ is a vector of unknown slope coefficients.

The relationship between P_i and X_i, which is non-linear, can be written as follows:

$$\mathbf{P}_i = \frac{1}{1+e^{\beta_0+\beta_i X_i+ \ldots+\beta_n X_n}} \quad \ldots\ldots (3)$$

The slope s tell how the log-odds in favor of adopting the technology changes as independent variables change. If P_i is the probability of adopting given technologies, then 1 - P_i represents the probability of not adopting and can be written as:

$$\mathbf{1 - P_i} = \frac{1}{1+e^{-zi}} = \frac{e^{-zi}}{1+e^{-zi}} = \frac{1}{1+e^{-zi}} \quad \ldots\ldots (4)$$

Dividing equation (1) by equation (4) and simplifying gives:

$$\frac{P_i}{1-P_i} = \frac{1+e^{z_i}}{(1+e^{-z_i})} = e^{z_i} \quad \ldots\ldots (5)$$

Equation (5) indicates simply the odd-ratio in favor of adopting the technologies. It is the ratio of the probability that the farmer will adopt the technology to the probability that he will not adopt it. Finally, the logit model is obtained by taking the logarithm of equation (5) as follows.

$$L_i = \frac{P_i}{1-P_i} = Z_i = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n \quad \ldots\ldots (6)$$

Where L_i is log of the odds ratio, which is not only linear in X, but also linear in the parameters: Thus, if the stochastic disturbance term U_i is taken into account, the logistic model becomes:

$$Z_i = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \ldots. + \beta_n X_n \quad \ldots\ldots (7)$$

This econometric model is estimated using the Maximum Likelihood Estimation (MLE) procedure due to the nonlinearity of the logistic regression model. The MLE procedure yields unbiased, asymptotically efficient, and normally distributed regression coefficients (parameters).

3.5.4. Multi-collinearity test

As Gujarati (1999) indicated, multi-collinearity refers to a situation where it becomes difficult to identify separate effects of independent variables on dependent variable because of existing

strong relationships among them. In another word, multi-collinearity is a situation where explanatory variables are highly correlated. This creates estimation/prediction problem in logit model. Variance inflation factors (VIF) and contingency coefficient (CC) are used to test the existence of multi-collinearity situation. VIF is used to check multi-collinearity of continuous variable. As R_i increase towards 1, that is as the collinearity of regressors (explanatory variable) X_i with other regressors increases its VIF_i also increases and in the limit, it can be infinite. The larger the value of VIF_i, the more troublesome or collinear is the variable X_i. As a rule of thumb, if the VIF of a variable exceeds 10 (this will happen if R_i^2 exceeds 0.90), that variable is said to be highly collinear. Multi-collinearity of continuous variable also can be tested through tolerance. When tolerance is 1 if X_i is not correlate with the other regressors, where as it is 0 if it is perfectly related to other regressors. A popular measure of multi-collinearity associated with VIF (X_j^2) is defined as:

$$\text{VIF } (X_j) = \frac{\mathbf{1}}{\mathbf{1}-\boldsymbol{Rj^2}} \quad \ldots\ldots (8)$$

Where, R_j^2 is the coefficient of multiple determinations when the variable X_j is regressed on other explanatory variables. A rise in the volume of R_j^2 that is an increase in the degree of multi-collinearity, does indeed lead to an increase of the variances and the standard errors of the estimators. Contingency coefficient is used to check multi-collinearity of discrete variable. It measures the relation between the row and column variables of a cross tabulation. The value ranges between 0 and 1, with 0 indicating no association between the row and column variables and value close to 1 indicating a high degree of association between the variables. The decision criterion is that variables with CC closer to 1would be avoided from further consideration in the multivariate analysis. The CC is computed as follows:

$$\text{CC} = \sqrt{\frac{\boldsymbol{x^2}}{\boldsymbol{n}+\boldsymbol{x^2}}} \quad \ldots\ldots (9)$$

Where, CC=coefficient of contingency, X^2= a chi-square value and n=total sample.

3.6. Definition of Variables

Dependent variable: The dependent variable in this study was adoption of silk and silkworm production and it is a dummy dependent variable. In this study, adoption refers to silk worm production practicing at least 3 years and a value of 0 otherwise not practiced.

Independent variables: These are variables which are hypothesized to affect farmers' adoption decision as follows:

1. Age of household head: This variable refers to the chronological age of household head at the time of the survey, measured in years. As the age of the household head increases, the probability of using technologies is likely to decrease. Because, with age, a farmer can become more risk adverse and then tend to be reluctant to new technologies (Kidane, 2001). Therefore, it is hypothesized that age of household head are more likely to affect silk and silkworm production negatively.

2. Sex: Gender difference is found to be one of the factors influencing adoption of new technologies. Due to many socio-cultural values and norms, females more likely spent their time at home consequently have greater access to rear and manage of silkworm. Therefore, it is hypothesized that female farmers are more likely to adopt than males. The expected outcome of sex (female) over adoption of silk and silkworm production is positive.

3. Education level of the household heads: This is a continuous variable and it represents the level of formal schooling completed by household head. It is assumed that formal schooling is expected to enhance farmer's ability to perceive, interpret and respond to new events. Furthermore, education level increases farmer's ability to process and use information and thereby increase farmers' willingness to adopt new technology. Therefore, it is hypothesized that education influences adoption of silk and silkworm production package positively (Girmachew, 2005).

4. Active family labor force: Family labor between 15 and 64 years of age is measured in Man Equivalent. A household with larger number of workers is more likely to be in a position

to try and continue to use a potentially profitable innovation. In addition, it is expected to influence adoption positively (Kidane, 2001).

5. Contact with extension agents: This refers to the number of contacts per year for sericulture technology that the respondent made contact with extension agents and it is a continuous variable. Contact with extension agent is hypothesized to increase farmers' likelihood of adopting the technology (Habtemariam, 2004). The higher number of contacts the farmer had with extension personnel the higher the exposure to sericulture technology, and the more likely the adoption.

6. Participation in training on silkworm rearing: Training is a dummy variable and takes value 1 if he has got training and 0 otherwise. It is one of the most essential extension methods used to transfer information, knowledge, and skills for improving silkworm management practices. Thus, farmers who have participated in training about the management and application of new technologies are more likely adopt the technology than those who are not participated in training. Previous study also shows positive influence of training on adoption (Rahaman, 2007). Therefore, it is hypothesized that obtaining training on the technology has positive influence on the adoption of the technology.

7. Access to credit: This variable is measured in terms of whether respondents have access to credit, in-terms of availability of credit sources and possibility of getting credit. It is a dummy variable, which takes a value 1 if the farm households have used credit or 0, otherwise. Farmers who have access to credit may overcome their financial constraints and therefore be able to buy inputs. Farmers without cash and do not have access to credit may find it very difficult to attain and adopt new technologies (Minyahel, 2007). Hence, access to credit is expected to increase the probability of adopting sericulture technology.

8. Access to market for the products: Input and output markets are known to positively influence the adoption of improved agricultural technologies (Augustine and Mulugeta, 2008). It is dummy variable and was measured using 1 if the respondent has access to market for their product and 0, otherwise. Availability of the market for the silkworm products

determines the decision of adopting the technology. So, it was anticipated that there is positive relationship between market and adoption of the sericulture technology.

9. Perception of the technology: The perception of sericulture technology on each component is taken and measured in a range, from 1 to 5 scales, 1= very poor, 2 = poor, 3 = intermediate, 4 = good and 5 = very good. In this study, weighted average of individual positive (advantages) and negative (disadvantages) was calculated and total advantage and disadvantage was calculated. Then total perceived attribute of the technology would be taken as the difference between the two. Perception about a technology directly influences adoption of a technology at HHs level. HHs has different perception on the same technology and this might affect adoption positively.

4. RESULTS AND DISCUSSIONS

This chapter deals with the analyses and interpretation of major findings of the study on the adoption and production status of sericulture technology in Oromia and Southern Regional States of Ethiopia. These are demographic variables of farm households, adoption of sericulture technology, knowledge sharing among farmers in adoption of sericulture and description of factors influencing sericulture technology based on the interpretation of the model output of binary logit of the study and leading to the conclusion and recommendations made in the final chapter.

4.1. Types of silkworm and Production Status of Silk in Study Area

4.1.1. Types of silkworm and food plants

Eri silkworm was more practiced indifferent part of Ethiopia than mulberry silkworm. Because of its wider adaptation to the environmental situations of the country and it delivers a great silk than the mulberry silkworm. In addition, farmer's awareness about eri-sericulture and the congeniality of climatic conditions to the insect have increased in the regions.

a) Eri-silkworm b) Mulberry silkworm

Figure 4 Types of Silkworm in the study areas

Castor for eri-silkworm (figure 4 at the right) and mulberry silkworm (figure 4 at the left) were the feed plants identified as the major source of feed for the silkworms in the two regional studied (Table 2). The availability of feed or host plant has a great role for increasing the production potential of silkworm (Kedir Shifa *et al.*, 2014).

Source: Own survey 2015

Figure 5 Feed plants of silkworms: right-castor and left-mulberry

Table 2 Types of silkworm reared their adoption and feed plants cultivated in Ethiopia.

Type of Silkworm	Status	Food plant	Remark
Eri Silkworm	Well adapted	Castor	Most produced
Mulberry Silkworm	Well adapted	Mulberry	Only at one privet farm

Source: Own survey 2015

4.1.2. Production status of silk in study areas

The average annual silk production potential of Oromia and SNNP regions were 660 and 2700kg of silk, respectively (Table 3). The price of 1 kg of silk on an average was 100 and 120 Ethiopian birr (ETB) from eri and mulberry silkworms, respectively. Eri silkworm produces higher kilograms of silk and income per year than mulberry silkworm. This might be due to the well adaptability of eri to environmental condition of the study areas. It was estimated that a silkworm cocoon producer could get about 2160 kg of cocoon or 216,000 ETB gross benefit annually from eri silk worm while 1200 kg of cocoon or 144,000 ETB from mulberry silkworm (Table 3). Silkworm rearing contributes to the income of individuals and the economy of the country. Silk production through silk rearing could be a useful avenue for improving economy (Peigler, 1993).

Current silk production of the areas 3.36 tons/year was very low as compared with other parts of the world. It is also agreed to (McKinney and Eicher, 2009). This might be due to the ecological variation, rearing capacity or farming technique, awareness of people and availability of food plants to silk worms.

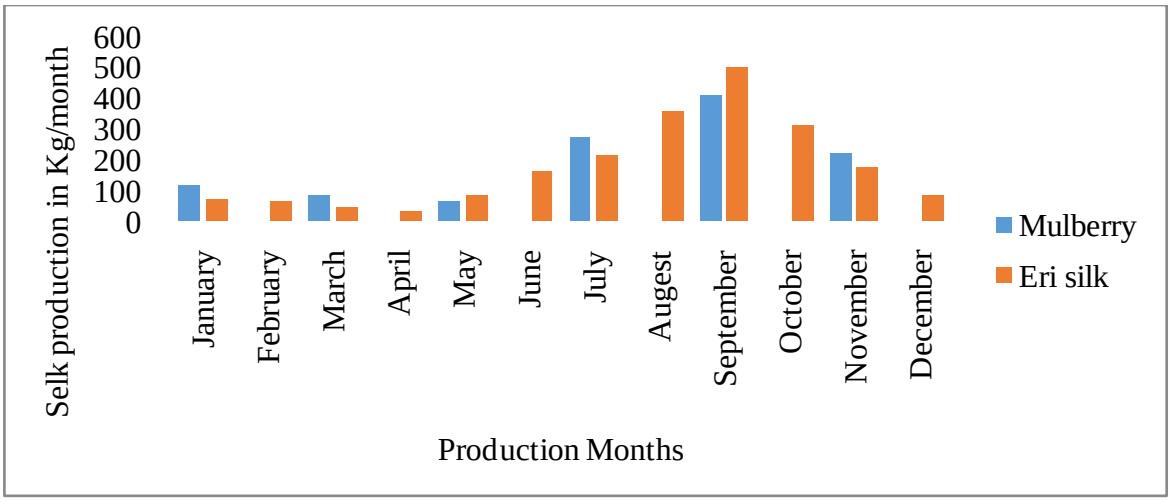
Regarding the annual silk production potential among the study areas (woredas), the highest was produced in Arbaminch Zuria Woreda, i.e., 1800 Kg (53.57%) for adopters followed by West Abaya with 480 kg (14.29%), Ambo Zuria 390 kg (11.6%), Shebedino 360 kg (10.7%) and Sayo with 270 kg (8%) while the lowest amount of silk was produced in Awassa Zuria Woreda, i.e., 60 kg (1.8%) of silk production areas (Table 3). This variation was due to rearing or farming differences, support, host plant availability, interest and exposure to the sector, land size, lack of rearing room, and other facilities variations among the producers in the silk production areas. For instance, in Arbaminch Zuria and West-Abaya woredas, this sector was supported by Bere Sericulture Production Private Company, and this Company deliver silkworm seeds to farmers that helps for high production of silk, whereas Shebedino and Awassa Zuria woredas were being supported by Melkassa Research Center, Ambo Zuria by International Institute of Research for Small-scale Household (IIRSH) program, and Sayo woreda was supported by Ethiopian Evangelical Mekane Yesus church collaborated to German-protestant supporting group (missionary).The higher silk production in Arbaminch Zuria Woreda might be due to availability of different silk production facilities like the presence of feed plant in open field, silkworm production material, best farming techniques and other factors have contributed for high production of the silk in this woreda.

Table 3 Annual silk production and average income from silk in study area, 2015

Woreda	Types of silkworm	Average Silk production /one time (Kg)	Production cycle/year	Average production per year (Kg)	Price/Kg of silk	Annual Average Birr/year
Shebedino	Eri-silk	60	x6	360	100	36000
Awassa Zuria	Eri-silk	10	x6	60	100	6000
West Abaya	Eri-silk	80	x6	480	100	48000
Arbaminch	Eri-silk	100	x6	600	100	60000
Zuria	Mulberry	200	x6	1200	120	144000
Ambo Zuria	Eri-silk	65	x6	390	100	39000
Sayo	Eri-silk	45	x6	270	100	27000
Total		560	x6	3360		360000

Source: Own survey 2015

The response of the respondents shows that the availability of food or host plant has a great role for increasing the production potential of silkworm as well as the annual production of silk. Accordingly, figure 3 shows that the status of average annual production of silk during 2014. In this year silk cocoon production ranged from 40 kg to 502 kg for Eri-silk cocoon, and from 69 kg to 412 kg for mulberry silk cocoon, respectively. The production of silk was reduced during winter season (from January to end of March) because the limited availability of the host plant due to shortage of rain fall. On the other hand, the production of silk was increased during the other month of the year pick in the month of September due to increased availability of feed or host plant in the study areas.



Source: Own survey 2015

Figure 6 Graphical representation of annual average silk production in study areas

4.2. The role of farmer-to-farmer knowledge sharing

The most important sources of knowledge for the study sample were friends (380), and this is probably due to friends shared knowledge for most practices during their meeting and at group work. As another key source, Friends and Neighbors provided knowledge on most practices. Farmers groups and Development agents were third and fourth respectively which indicate that farmer's social networks used for knowledge sharing of most new practices among them. These findings agree with the finding of Dereje (2005).

Table 4 Knowledge sources in terms of practices of silkworm production (n=396)

Practices of Knowledge								
Knowledge sources	Most practices		Some practices		None practice		Score	Rank
	N	%	N	%	N	%		
Friends	207	52.2	148	37.4	25	6.3	380	1
Neighbors	179	45.2	142	35.9	33	8.3	354	2
Farmers groups	123	31	90	22.7	120	30.3	333	3
Development Agents	162	40.9	118	29.8	46	11.6	326	4
Woreda Agriculture office	112	28.3	164	41.4	32	8.1	308	5
Informal social groups	13	3.3	37	9.3	97	24.5	147	6
Pamphlets	1	0.25	3	0.76	86	21.7	90	7
Radio	0	0	4	1.0	25	6.3	29	8

The less important in sourcing practices of knowledge are pamphlets and not at all radio, in sericulture, probably due to their less access to NGOs, researchers and less educational status of the farmers. The findings suggest that attention should be given to provide relevant information through NGOs and available media to farmers which are practicing silkworm production as well.

As indicated in Table 4, friends stood first in frequency of knowledge sharing; probably they had more opportunity to contact frequently, followed by neighbors and farmers group respectively. This finding showed that farmers got more information easily from their friends and neighbors than other sources available in the area. Similarly, Tigist (2010) reported that most farmers shared their knowledge from friends and neighbors this might be because most of the time they contact with each other's frequently and exchange experiences among them.

4.3. Description of Factors Affecting Adoption of Sericulture Technology in Study Area

4.3.1. Demographic Characteristics of the respondents

4.3.1.1. Age of the household head

The mean age of household head for adopters and non-adopters is 41.27 and 47.4 years with the standard deviation of 5.3 and 6.8, respectively (Table 5). The result shows that the adopters' mean age is smaller than non-adopters. It implies that silkworm producers are reluctant to new technology as they get older. The result agrees with Yohannis (1992) who indicated that age of household head negatively influenced adoption.

4.3.1.2. Sex

Among the respondents of adopters 23.2% and 76.8% were male and female respectively, and non-adopters 51.5% and 48.5% were male and female respectively (Table 5). The study finding revealed that sex was found to be positive and significant with ($\chi^2 = 33.64$, $p = 0.000$). This is because except Bere Sericulture Production Private Company in Arbaminch Zuria Woreda of SNNPR state which had constructed separate silkworm rearing house, in all other study area silkworm was reared in living house. As the result female spent most of the day

time around their homestead area that made more chance to feed and manage their silkworm easily.

4.3.1.3. Educational status of the respondents

Most of the households are different in their status of education. Before the survey was conducted education was classified into four categories; illiterate, only read and write (grade 1 - 4), primary school (grade 5 to 8) and secondary and above (grade 9 and above). After actual data collection the respondent farmers fall in two categories.

The results of this study showed that from total of 171 Illiterates 65 (34.2%) were adopters and 106 (65.8%) were none adopter. Out of 225 literates 125 and 100 were adopter and non adopter, respectively. In general, from total of 396 respondents, adopters 65.8% literate and 34.2% were illiterate, and from non-adopters 48.5% were literate and 51.45% were illiterate. In this study, levels of education have highly significant association with adoption of silk and silkworm production (Table 5).

This is in line to (Sreenivasa and Hiriyanna, 2014) who declared that education level of the farmers had high significant influence on adoption amongst small, medium and large scale farmers. The regression coefficient (χ^2 = 11.9 and p = 0.001) for education was found to be positive and significant. Similarly, Tesfaye *et al*., (2001) reported a positive and significant relationship of education with adoption of improved bread wheat varieties and inorganic fertilizer by small scale farmers, and Tesfaye and Alemu (2001) indicated positive relationship between education and adoption of improved maize technologies and inorganic fertilizer.

Table 5 Mean distribution of by personal related variables with silkworm production

Variables		Adopters N (%)	Non-Adopters (N %)	p-value
AGEHH	Mean	41.27	47.4	0.000***
	SD	5.3	6.8	
Sex				
Male		146 (76.8)	100 (48.5)	0.000***
Female		44 (23.2)	106 (51.5)	
Total		190	206	
Educational Status				
Illiterate		65 (34.2)	106 (51.5)	0.001***
Literate		125 (65.8)	100 (48.5)	
Total		190	206	

Source: Own survey 2015

4.3.2. Economic variables

The man equivalent (ME) family labor availability was calculated for the sample respondents (Appendix Table 1). The survey result on active labor force availability across adopter categories in (Table 6) shows that, the average number of active labor force in terms of man equivalent for non-adopters was 4.25 with standard deviation of 1.5 and for adopters 4.5 with standard deviation of 1.5.

The size of active labor force in the household is expected a prior to contribute for variation on adoption decision of sericulture technology. This study shows slight significant difference with regard to the size of labor force between adopters and non-adopters. This is evident from the result of independent simple t-test (t= -1.9, p= 0.047) which shows slightly significant mean difference between adopter and non-adopters at 5% significance level (Table 6). Similarly, a study conducted by Kidane (2001) on factors influencing the adoption of new technologies revealed that shortage of active family labor force affected the adoption of that technology. The result of this study is different from the earlier finding of Yishak (2005).

Table 6 Mean distribution of sample respondents by socio economic related variable n=396

Variables		Adopter (n = 190)	Non-Adopters (n = 206)	t-value	P - value
Active labor force	M	4.5	4.25		
	SD	1.5	1.5	-1.9	0.047**

Source: Own survey 2015M=Mean, SD= Standard Deviation

4.3.3. Institutional variables

4.3.3.1. Contact Development agents (DAs)

The study result reveals that 73.2% of the adopters and 51.9% of non-adopters had contact with extension agents. From the total of 396 respondents 246 (62.1%) had contact with the extension agents frequently. The chi-square result (χ^2 = 18.9 and p = 0.000) shows there was statistical significant difference between adopters and non- adopters (Table 7). The result indicated that, contact with extension agent is influencing adoption positively. This agrees with prior expectation and confirms the study carried out by Teferi (2003).

4.3.3.2. Training Participation

The result on farmers' participation on training indicates that 26% of sampled farmers have participated on sericulture technology and majority of the farmers (74%) did not attend in training (Table 7).

According to the finding, high proportion of adopters (40.5%) and only 12.6% of non-adopters have attended sericulture training (Table 7) and the difference was statistically significant at less than 1%. Participation on training has difference significance with (χ^2 = 39.9 and p= 0.000) between adopters and non-adopters.

The result of this study is in agreement with the findings of many authors. Similarly, Yishak (2005) also reported attending extension events brought positive and significant relation with adoption of new technologies.

4.3.3.3. Access to Credit

It was observed that there was no fungiblity problem as the producers used the credit for the intended purpose. The finding of this study showed that the availability of credit to farmers in the study areas positively significant difference in adoption of sericulture technology with respect to non-adopters with (χ^2 = 9.08 and p= 0.003) (Table 7). Similarly, the study conducted by Ebrahim (2006) reveal that access to credit can positive and significant influence on adoption of technology package.

The loan has to be repaid within five years. However, credit alone by itself is not guarantee for technology adoption. It was found that 63.9% of the respondents were not the beneficiaries of the existing credit opportunity (Table 7). This was mainly to avoid risk of repaying the loan from other sources, if expected amount of silkworm seeds and rearing materials are not obtained (Table 7). The remaining 43.7% and 29.1% of adopters and non-adopter respondents had used the credit, respectively.

In relation to this during group discussion, one of the participants said “there is no guarantee to receive credit and engage in silkworm production because if absconding occurs no yield is obtained to repay the loan and one is enforced to repay the loan from other sources”. This implies that the silkworm producer lacks confidence in the technology and silkworm management. Once the silkworm producer is equipped with skill in improved silkworm production management, it is possible for the producer to manage absconding problem and other production management practices.

Table 7 Association Institutional variables with adoption of silkworm production

Variables	Adoption Category						χ^2	p-value
	Adopters		Non-adopters		Total			
	N	%	N	%	N	%		
Contact with DAs								
Yes	139	73.2	107	51.9	246	62.1		
No	51	26.8	99	48.1	150	37.9	18.9	0.000***
Total	190		206		396			
Training								
Yes	77	40.5	26	12.6	103	26		
No	113	59.5	180	87.4	293	74	39.9	0.000***
Total	190		206		396			
Access to credit								
Yes	83	43.7	60	29.1	143	36.1		
No	107	56.3	146	70.9	253	63.9	9.08	0.003***
Total	190		206		396			

Source: own survey 2015

Availability of credit facilitates technology adoption for farmers. Omo micro-finance and Rural saving and credit cooperatives provide funds in small amounts. Omo micro-finance provided to the maximum of 5000 Birr in 15% and 9% interest rate for regular extension and package, respectively, while Rural saving and credit cooperatives (RuSACO) provide to the maximum of 3500 birr with regular interest of 12% for requires and membership of their cooperatives with 3 years repayment interval (Table 8), and it is not that much functional. The interest rate of regular extension is high due to transaction cost and risk of repayment. With regard to package, ARD supports in facilitating credit and its repayment. As a result, its interest rate is minimal compared to regular extension.

Table 8 Sources of access to credit

Sources of credit	Types of credit	Amount of credit in ETB	Interest rate (%) per year	Duration of repayment
Omo micro-finance	Regular	5000	15	5 years
	Package	5000	9	5 years
Rural saving and credit cooperative	Regular	3500	12	5 years

Source: own survey 2015

In relation to access to credit during data collection, 80 (42.1%) of the participants said "there is no guarantee to receive credit and engage 64 (33.7%) and 46 (24.2%) have confidence and no problem, respectively in silkworm production because if absconding occurs no yield is obtained to repay the loan and one is enforced to repay the loan from other sources. This implies that silkworm producer lacks confidence in the technology and silkworm management. Once the silkworm producer is equipped with skill in improved silkworm production management, it is possible for the producers to manage absconding problem and other production management practice.

Among the adopters, 40% were repaying their loan by selling the silkworm product (silk cocoon) and 60% of the respondents were repaying their loan from silk product or other sources (Table 9).

Table 9 Sources for loan repaid (N = 190)

Source of credit repay	Adopters		Remark
	N	%	
Silk (cocoon) sell	76	40	
Other sources	114	60	Due to lack of enough silk to repay the loan
Total	190		

Source: own survey 2015

4.3.4. Social Variables that affect technology

4.3.4.1. Market availability

The availability of market for the silkworm products enhances the adoption of sericulture technology. In the study area, 59.5% of adopters replied that there was market for their silk (Table 10). However, there was no ready market that absorbs the silk produced in sustainable way. It was observed that the respondents were supplying their silk to market in nearby towns (Awassa, Arbaminch, Ambo and Dembidolo). In the study area, the following silk marketing channel was also observed.

Producer ⟶ processor

Producer ⟶ collector ⟶ processor

During the study period, there were few silk collectors that did not purely engaged in silk collection activities. As observed, the collectors are those individuals engaged in trading consumer goods. The activity of silk collection was few parts of their major role.

The second channel was the dominant in all study areas, whereas, the first silk marketing channel was observed at Ambo Zuria, Ugayehu and Sayo woredas which is weak due to inefficient and few number of participants, i.e., they do not collect silk in large quantity and supply to other areas. The second silk marketing channel was observed at Arbaminch Bere Sericulture production private Company and Addis Ababa Saba har-handmade enterprise, Shebedino and Awassa Zuria woredas at initial stage and this can be strong when fully operated.

Table 10 Responses of sample respondents on Market availability (n = 190)

Adopt ion category	Market availability			
	Yes		No	
Adopters	N	%	N	%
	113	59.5	77	40.5

Source: Own survey 2015 bargain

The group discussion was made at Chano-Chalba Peasant Association in Arbaminch Zuria Woreda with seven silkworm producers. Wizero Etalemahu Tadesse was one of the silkworm producers in Arbaminch Zuria woreda. She also said, “Bere Sericulture Production Private Limited Company is collecting silk from the area. It is a good opportunity for us to get market for our silk production”. During the study period, Private Limited Company silk processing machine was testing its machine efficiency and for this purpose, it collected 200kg of silk from Chano-Chalba PA. Bere Sericulture Production Private Limited Company purchases silk from producers at market price of the area. The producers get an advantage of sustainable market for their product. The company also makes physical assessment on the quality of silk during its collection. This leads the producers to produce quality silk to get market for their product. To utilize the opportunity organizing producers is desirable. As an initial step, organizing informal groups which can engage in collective marketing would be a good start. By realizing the benefits of collective marketing, well organized formal co-operatives can develop in due course. Once the producers are organized, the PA can support them in providing production site; from financial organization they can get credit and other technical support. They can also get bargaining power and sell their silk at attractive price.

Similarly, the group discussion was made at Shebedino, Awassa Zuria, West Abaya, Ambo Zuria and Sayo Woreda with silkworm producers. The discussions were focused on silk marketing situation of the areas. In Shebedino and Awassa Zuria most of the discussion participants expressed about silk marketing as “so far, we were selling our silk to one collector individual bases and we do not have bargaining power” and the price is determined based on the existing demand during the market day by the collector. It was also observed that the collector was not official and he collect silk by hindering the producers in the area. This indicates that there was no ready market that activates the producers.

According to woreda participants of the discussion in Ambo Zuria woreda Sanqalle kebele, silk marketing was held by collecting the silk at one place from producers and selling their products to employee of Saba har-handmade enterprise once in three to four months’ intervals and the price is determined based on the existing demand during the market day by the enterprise. It would be a constant collector of silk product and needs frequent receiver of silk. The establishment of rural saving and credit cooperative at Ambo and Dembidolo town in

Ambo Zuria and Sayo woredas respectively may attract silk producers. By finalizing the benefits of collective marketing, well organized formal co-operatives can develop in due course.

4.3.4.2. Farmers' perception on silk and silkworm production

It was found that important to identify perceived relative advantage of silkworm production and its relative disadvantage so as to get the general perception of silkworm producers.

Table 11 Perception of respondents towards silkworm production (n = 190)

List of advantages	Preference criteria (%)					Score	Rank
	Very poor	Poor	Intermediate	Good	Very good		
Early maturity	-	-	-	24.7	75.3	75.3	1
Silk color	-	-	13.2	17.9	68.9	68.9	2
Storability	7.5	12.1	6.8	6.8	66.8	66.8	3
Price advantage	-	1.5	15.3	23.2	60	60	4
List of Disadvantages							
Unavailability of technology	77.9	10	-	12.1	-	77.9	1
Lower yield size	63.2	18.4	13.2	4.7	0.5	63.2	2
Need of high skill	62.1	20	17.9	-	-	62.1	3

Source: Own survey 2015

The respondents were provided with both categories of relative advantages and disadvantages to rate on scale of five (Table 11). As the result shown, early maturity (75.3%), silk color (68.9%); storability (66.8) and price advantages (60%) are the major relative advantages of silkworm production, which were identified by the majority of producers. On the other hand, unavailability of technology (77.9%), lower yield size (63.2%) and need of high skill (62.1%) are the main relative disadvantages of silkworm producers.

4.4. Results of the Econometric Model

The model explained about 73% of the total variation in the sample for use of sericulture production. Correctly predicted figures for adopters were about 72.6%; while correctly predicted sample size for non-adopters were 73.3%. Among the explanatory variables used in the model, 5 variables were significant with respect to adoption of silk and silkworm production with less than 10% of the probability level (Table 12).

1. Sex: - It revealed that sex of the household head increase the probability of adoption significantly. The increase of female farmers by a unit has a probability of 2.6 times more likely to adopt of silk and silkworm production than male farmers.
2. Age: - The result shows, the increase in age of HHs head negative effect on adoption probability which is significant at 1% probability level. The change in age by a unit has lowered the probability of adoption by 1.13 times.
3. Active family labor force: -The result of the logistic regression shows that positive and significant at 1% level relationship between active family labor force and adoption of technology. This implies that HHs with high family number of productive ages is more likely to adopt new technology than HHs with lower number of active family labor force.
4. Frequency of extension agent: As expected frequency of extension agent contact has significantly influenced the likelihood of adopting silk and silkworm production at 1% significant level and the odds ratio in favor of adoption increases by 0.356 times more likely as frequency of extension contact increases by one unit of frequency.
5. Training: - Participation on training of silk and silkworm production has positive significant effect on adoption probability at 1% probability level. The change from participant to non-participant on training will change probability of adoption by 1.62 times.

Table 12 Results of binary logit estimation for adoption of sericulture technology

Variables	Coefficient	S. E	Wald	Sig.	Odds ratio
SEX	0.988	0.261	14.366	0.000***	2.685
AGEHH	0.107	0.020	29.437	0.000***	1.113
EDU	-0.086	0.255	0.115	0.735	.917
Active Labor	-0.252	0.085	8.681	0.003***	.777
DA Contact	-1.034	0.266	15.133	0.000***	.356
Training Participation	-1.706	0.302	31.868	0.000***	.182
Access to Credit	-0.252	0.264	0.909	0.340	.777
Constant	4.119	0.976	17.800	0.000***	61.509
-2 Log likelihood ratio = 41.8					
Chi-square value = 148.67***					
Correctly predicted overall sample = 73.0					
Correctly predicted adopter = 72.6					
Correctly predicted non-adopters = 73.3					

Source: Model output. ***Significance at 1%, **Significant at 5% and *Significant at 10%.

4.5. Challenges of Silk and silkworm production in Study Areas

Silkworm production in all the study areas was the one of the income generator throughout the year in the study area during the study period. The environmental condition and the motivated practice to produce silk and silkworm production was the best strong side of the farmers to adopt new agricultural technology. However, they have encountered many production problems including variable product quality, poor product quality, and lack of silk production management to meet quality requirements and market standards due to primitive and unscientific "reeling" and "weaving" techniques, use of poor quality seeds, lack of bivoltine seeds, use of non-graded and diseased seeds, poor knowledge of production amongst farmers, poor supply and seed management, high production cost, recurring droughts, price fluctuation, absence of proper market, lack of transport facilities, absence of storage facilities, poor information on market trend and lack of finance.

4.5.1. Production challenges of Silk and silkworm production in study area

The main challenges for the production of silk and silkworm in both regional states were: lack of mulberry tree varieties adapted to local agro-climatic conditions, lack of suitable silkworm races, and lack of knowledge and skills among the farmers. Moreover, management practices were poor, leading to diseases and low productivity.

During the study period respondents identified lack of silkworm seeds (42.9%), absence of both market information and price (27%), lack of feed seed specially, mulberry plant (17.9%), presence of diseases (8.1%) and lack of land for feed development and rearing house construction (4.1%) as the primary challenges those limiting the work from further expansion (Table 13).

Table 13 Production challenges of Silk and silkworm production in study area (N =396)

List of Challenges	Number of respondents	%	Rank
Lack of silkworm seeds	170	42.9	1
Absence of market information and price	107	27	2
Lack of fed seed (host plant)	71	17.9	3
Presence of diseases	32	8.1	4
Lack of land	16	4.1	5
Total	396	100	

Source: Own survey 2015

4.5.1.1. Source of Silkworm Seeds

The finding of this study indicate that Melkassa Agriculture Research Center (15.3%), Bere sericulture production private company (18.9%), International Institute of Research for Small-Scale Household (17.4%) and German Protestant Missionaries (15.2%) were the intermediates to deliver and cascade the seed from MARC and Alagie ATVET Colleges to the silkworm producers. There remaining 33.2% of the producers obtained seeds from their respective neighbors, in both Oromia and Southern Nations, Nationalities and People's Regional states (Table 13).

Table 14 Source of silkworm seeds (N = 190)

No	Woreda	Total Producers	Producers get seed support		Source of Silkworm Seed
			N	%	
1	Shebedino	34	23	12.1	Melkassa RC
2	Awassa Zuria	9	6	3.2	Melkassa RC
3	West-Abaya	47	27	14.2	Bere Sericulture PLC
4	Arbaminch Zuria	20	9	4.7	Bere Sericulture PLC
5	Ambo Zuria	37	33	17.4	IIRSH
6	Sayo	43	29	15.2	German Protestant M.
Total		190	127	66.8	

Source: Own survey 2015

The finding of this study shows that Melkassa Agriculture Research Center and Alagie ATVET Colleges also play a great role for multiplying and distributing the seed for users in Oromia and SNNPRs level and for other willing regions and woreda.

On the other hand, Saba har-handmade Ethiopians silk processing Company also introduces better performing both Eri and mulberry silkworm seeds from India and provide to Melkassa Agriculture Research Center and other producing organizations for further multiplication and distribution.

4.5.1.2. Rearing house construction for silkworm

During the study period except institutions such as ATVET colleges, Agriculture Research Centers and Bere Sericulture Production Private Limited Company, all producers in both regions do not have separate rearing house for silkworms. They used a part of their own house especially floor and a seating chair (Figure 7a and 7b). For some of the producers in Sidama Zone of Shebedino Woreda the construction materials were provided due to the support of thirty corrugated iron roof from the Melkassa Agriculture Research Center for three producing groups ten for each. Only Bere Sericulture Production Private Limited Company

has built its own separate rearing house from cement sealed wall, concrete (asphalt) floor and corrugated iron roof (Figure 7c).

(a) Silkworm reared on the chair(b) silkworm reared on the floor

(c) Concrete (asphalt) floor and corrugated iron roof house

Figure 7 Methods of silkworm rearing in study areas

4.5.1.3. Feeds and Feeding for Silkworm

The respondent indicated sericulture production was started in 2014, in SNNPRs and Oromia regions, respectively, mainly by Eri type silkworms which were highly dependent on caster plantation as feed source which is well adapted and grows in most part of the farm yard as a hedge plant at the border of the two farms (Figure 7a). Mulberry plantation in 2.5ha farm grown highly and mulberry silk production was started in 2011 at Bere Sericulture Production Private Limited Company and the silk production was still limited there in Arbaminch Zuria Woreda of SNNPRs to feed *Bombyx mori* breeds; but even if it was under the multiplication

in both MARC and Alagie ATVET College, not yet distributed to the near around producers due to lack of feed plant because the seed of mulberry plant were not available in both regions (Figure 7b).

(a) Caster plantation (b) Mulberry plantation

Figure 8 Feeds and feeding for silkworm

As respondents indicated, feeding for all growth stages (instars level) of the silkworm was performed separately. Different leaf growth stages were fed accordingly as the instars levels such as the softest (tender and succulent) part of the leaf was fed for the first and second instars level; and the harsh (well developed and matured) part of the leaf for $4^{th}$and 5^{th}instars. Eri have high feed intake ability and they feed 3-5 times a day, as producers responded during the study period. As respondents indicate they feed silkworms by chopping for 1^{st} and 2^{nd} instars level and by cutting individual leaves and by collecting the leaves with their branches for 4^{th} and 5^{th} instars level.

4.5.1.4. Presence of disease and adverse conditions

The survey result reveals that in some areas of both regions there was an adverse health problem related with silkworm production. Accordingly, 8.1% out of the total producer respondents (Table 13) in both regions started disease problem. To avoid this disease and contamination, Alagie ATVET colleges, Melkassa Agriculture Research Center and Bere Sericulture Production Private Limited Company clean those utensils used for production, rearing house and silkworms in all growth stage; and they prepared a footbath to prevent

further disease and/or contamination outside the door before entrance into the rearing houses. But the rest of the producers in study areas were not yet used these mechanisms.

4.5.1.5. Silkworm pest problems

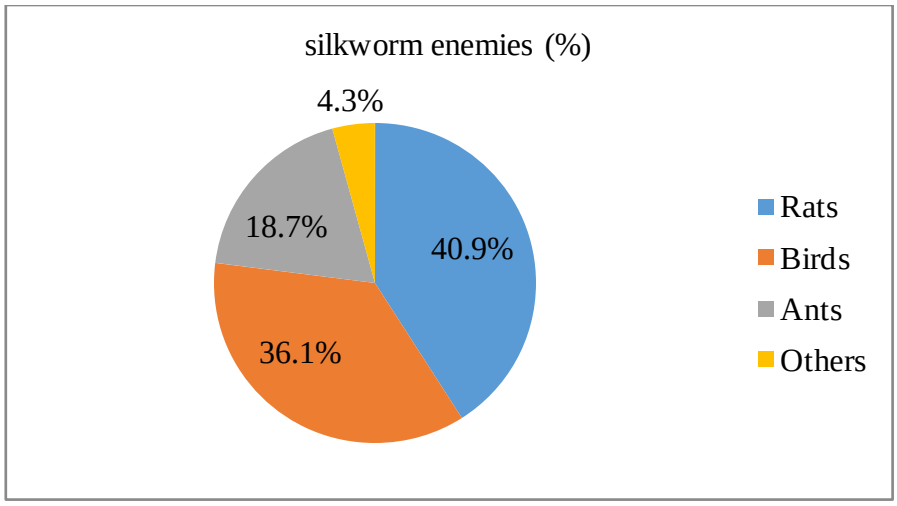
The existences of silkworm pests can create obstacle for adopting sericulture technology as they attack silkworm and their products. The occurrence of silkworm pests in Table 19 summarizes among the producer respondents, 72.1% replied the existence of pest problem in the neighbor silkworm farm while 27.9% did not affect their products. Hence, pest problem is a common problem in the study area for silk producers (Table 15).

Table 15 Silkworm pest problem occurrence by sample respondents (n=190)

Response	The presence of pests	
	Adopters (n=190)	
	N	%
Yes	137	72.1
No	53	27.9
Total	190	100

Source: Own survey 2015

The major silkworm` pests that exist in the study areas were identified and prioritized by the producer respondents based upon the damage they cause on to the silkworms and their products (Figure 8).According to the magnitude of the damage the pests cause to the silkworms and the prioritization of farmers, rats causes a serious problem with frequency of (40.9%), followed by birds which occurs as (36.1%). However most of the respondents used spraying against ants with ant's effective chemicals around the silkworm rearing area and some of them also used traditional ant protection method i.e. putting ash under the silkworm containers. However, the overall number of respondents that used improved ant protection and pest management options was minimal.



Source: Own survey 2015

Figure 9 Graphical representations of the respondent for silkworm affecting insects and birds

In all areas where the assessment was addressed, there was production seasonality that limits the ability of the silkworm to produce cocoon. Producer respondents indicated that in hot and cold areas of the regions, December to January and end of May to September were the better production seasons for silkworm, respectively. In extremes of the temperatures too hot and too cold, the silkworm ceases to feed and, death occurs leading to lower production and productivity. When the temperature is too cold during October and November, the worms cease feeding resulting to delayed growth and cocoon formation. To overcome this coldness and to maintain normal production temperature, farmers use a charcoal fire and electric lamb. For example, Alagie ATVET College uses charcoal fire and electric lamp to heat the rearing room during cold season. On the other hand, when the temperature is too hot, the worm cease to feed again, become restless and heavy to manage ultimately they die. According to the survey result to Upper Awash, Awash Melkassa and most eastern part of the Oromia regions were dry and hottest during most months of the year. As a result, it was not suitable for the production and multiplication of silkworm. To control increased temperature, it is recommended to provide aeration through windows, and spraying water in the floor modifies the microclimate.

Experts from regions, zones, woredas, ATVET colleges and Research Centers who have experiences in silkworm production indicated the advantages and disadvantages of both Eri (*Philosamiyarecini*) and mulberry silkworm (*Bombyx mori)* breeds (Table 16).

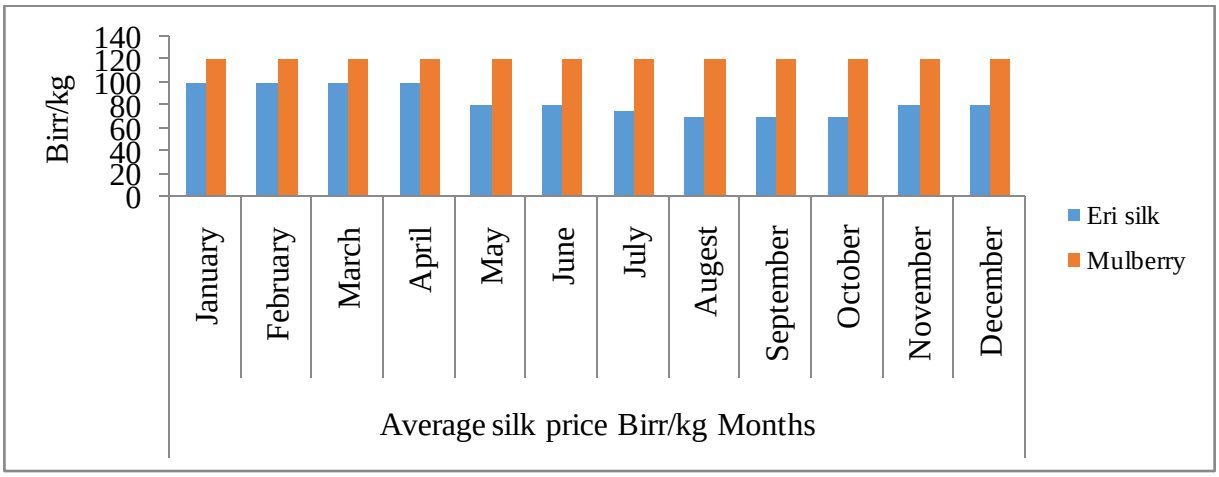
Table 16 Advantages and disadvantages of eri and mulberry silkworms

Silkworms	Advantages	Disadvantages
Eri-silkworm (*Philosamiyarecini*)	- Easily handled or manageable worms - Withstand hardship environment and better disease tolerant - Have shorter generation interval (from 46 – 60 days) better productive - Fractured threads can be easily assembled together - Their feed is easily adaptive and available in all areas of the regions - Quality cocoon can be produced if they are well managed - The wastage from the larvae before starting to make cocoon is used as a fertilizer - Surplus and unproductive worms can be used for poultry feed to increase poultry production (egg production)	- Low quality cocoon - Cheap Cocoon price (80 – 100 Birr/Kg)
Mulberry silkworm (*Bombyx mori)*	- Reel able cocoon is produced - Better know how in all countries (internationally known) - Better cost of the cocoon - The wastage from the larvae before starting to make cocoon is used as a fertilizer - Surplus and unproductive worms can be used for poultry feed to increase poultry production (egg production)	- Need more management - Have longer generation interval; less productive - Are more susceptible to poor management, and disease - Can't assemble the thread if it is once fractured.

Source: Own survey 2015

4.5.2. Silk worm cocoon purchasers and price fluctuation

The response of the producer respondents shows that the availability of constant market price has a great role for increasing the production of silkworm as well as the annual production of silk. Accordingly, (Figure 10) shows that the average annual price of silk during 2014, silk cocoon price ranged from 70 Birr/kg to 100 Birr/kg for Eri-silk cocoon, and 120 Birr/kg constant price for mulberry silk cocoon, respectively. The price of cocoon except mulberry one's which produced only in one farm was reduced from end spring and autumn season (May to October) because the limited availability of income due to shortage food and other consumption materials for the household family. On the other hand, the price of cocoon was increased slightly in the winter (from November to April) in the study areas.



Source: Own survey 2015

Figure 10 Graphical representation of average market price of cocoons in the study areas

The survey result in both Oromia and SNNPR states show that there were three types of cocoon price depending on the purchasers' scale. The first and the better price was Saba-har handmade Ethiopian silk price which was 100 ETB and 120 ETB for Eri and mulberry, respectively per four cocoons (1 kilogram of silk) all around the country with supervision of their single employee who is the professionals in production and processing of sericulture form Saba har-handmade Ethiopia who purchases cocoons and silk directly from the producers in all the Oromia regions with organization price. The second price type was the one that is made by single informal collector in Awassa town bought at 70 birr/4 cocoons

(1kg of silk) from the producers around Awassa and Shebedino woreda of Sidama zone. The third price type was also the one that made by formal collectors in Arbaminch who was purchased the same amount of cocoons and silk from 80-100 Birr/kg.

There were a few actors in cocoon market. Sabahar-handmade enterprise at Addis Ababa and private enterprise and company in Awassa and Arbaminch were silkworm cocoon purchasers in the SNNPR region and they were also price determinants for the product. Saba har-handmade Ethiopian silk was solely enterprise which export finished silk product to abroad market. But now Bere Sericulture Production Private Limited Company import Sericulture manufacturing machine from India and it will begin in the short period of time.

4.5.3. Institutional challenges of silk and silkworm production in study area

4.5.3.1. Limitation of knowledge

Focus group discussion result reveals, 42 (51.8%) of ATVET College, key informants and woreda expert respondents rank limitation of knowledge as number one problem (Table 16). Both experts and producers have limited by knowledge and skills about modern silkworm rearing techniques as primary challenges in the study area. Even though 20 and 32 from Zones and woredas (Table 17) respectively participated and trained on silkworm production and management techniques in practice at Alagie ATVET College from 2014 for two terms, the support given to producer farmers from this trained man power is very limited.

Table 17 Institutional challenges of sericulture in study area (N = 81)

List of institutional challenges	Number of respondents	%	Rank
Limitation of Knowledge	42	51.8	1
Limitation of seed sector	28	34.7	2
Lack of feed (host plant) seed	11	13.5	3
Total	81	100	

Source: Own survey 2015

The limitation of knowledge occurred due to overturn of experts from one office to another followed by change of work place was ranked as first line. Fluctuation of the trained

professionals from year to year and non-considering about silkworm and its production from Bureau of Agriculture to Woreda governmental organizations were also identified as the second line. According to ATVET colleges and Woreda experts, for continuous production and productivity of silkworms, producers and experts must have better skill and knowledge on the technology.

4.5.3.2. Limitation of seed sectors

According to focused group discussion, 28 (34.7%) of the participants indicate lack of silkworm seeds mainly *Bombyx mori* was listed in the second line next to knowledge as a challenge in both regions (Table 17). This is because the limitation of mulberry silk seed multiplication in Melkassa Agriculture Research Center and Alagie ATVET College without delivering and distributed to near around producers. On the other hand, the distribution and multiplication of Eri-silkworm was begun from last seven to eight years up to now, it was not fulfilled the demand of the producers in the study areas.

Another seed sector challenge was the limitation of improved seed of feed plants. From (Table 17), 11 (13.5%) of the focus group identified lack of silkworm feed and host-plant was the third challenges of the different institutions. During the study period, producers feed indigenous castor plant for their silkworm as its availability in all the study area. As it was less in quality, the quality and quantity of the eri-silk was decreased.

Although the quality, quantity and price of mulberry silk was advanced from the eri one in the country level, the production and multiplication were still limited in three institutions (namely, MARC, Alagie ATVET College and Bere Sericulture Production Private Limited Company) without delivering and distributed to producers.

4.6. Future Prospect of Silk and Silkworm Production in Study Area

Silkworm is one of the most important domesticated insects, which produces luxuriant silk thread in the form of cocoon by consuming castor and mulberry leaves during larval period. The growth and development of silkworm is greatly influenced by environmental conditions. The biological as well as cocoon-related characters are influenced by ambient temperature,

rearing seasons, quality of castor and mulberry leaf, and genetic constitution of silkworm strains.

The eri-silkworm (*Samiacynthia ricini*) can be reared on variety of plants. The castor crop (*Ricinus communis*) is well known as oil seed crop but its potentiality for rearing eri silkworms is not tapped properly in both Oromia and SNNPRs regions. It has further significance being very hardy, resistant to drought and insect pest and very much suited as rain fed crop while many crops fail due to erratic rainfall/intermittent dry spells. If due weight age is given to this crop for ericulture, the economy of so called marginal and poor farmers associated with marginal lands will definitely increase. Not only farmers will be benefited but the availability of raw material (eri cocoons and silk wastes) for agro-based cottage industries will be ensured from neighboring regions at relatively cheaper rate.

The seasonal differences in the environmental components considerably affect the genotypic expression in the form of phenotypic output such as cocoon weight, shell weight, and cocoon shell ratio in Melkassa and Arbaminch due to hottest throughout the year. The variations in the environmental conditions emphasize the need of management of the temperature and relative humidity for sustainable cocoon production.

Environmental conditions such as biotic and abiotic factors are of particular importance. Among the abiotic factors, temperature plays a major role on growth and productivity of silkworm larvae in both Oromia and SNNPRs. The average temperature of most parts of the study areas in both regional states were 18 – 28 ^{0}C, which plays the important role in potentially increase the production rate and quality of silk. Because according to Datta (1992), good quality cocoons are produced within a temperature range of 22–27 ^{0}C and that cocoon quality is poorer above these levels. The survey result reveal that, silkworms were more sensitive to high temperature during the fourth and fifth stages. It is well understood that the majority of the economically important genetic traits of silkworms are qualitative in nature and that phenotypic expression is greatly influenced by environmental factors such as temperature, relative humidity, light, and nutrition.

During the study period it is identified that Oromia and SNNP regions have diversified in climate, vegetation and topography. This was also the best opportunities for diversified options of sericulture industry which are adopted on different vegetation (for rearing of silk-worms) and different species of silkworms. As a result of this the government of the country focused on the production and expansion of the sericulture sector by investing the foreign investors for development of sericulture sector industry in a short period of time. This was due to suitability of climatic condition for rearing of silkworms and availability of necessary resources. Due to favorable agro-climatic conditions (suitable temperature and humidity), traditional and modern skills and market potential, silk production is mostly confined to areas like Arbaminch, Shebedino in Sidama and Humbikaro in Sayo woreda of Kelem Welega zones. Even if the production amount of silk is very low from the world production, it had generated self-employment and remunerative livelihood opportunities for the most disadvantaged sections of society, especially for small and marginal farmers and the landless poor through silkworm rearing, reeling of yarn, weaving of fabric, and value-addition as non-farm activities.

The introduction of Sericulture manufacturing machine (figure 10) to Ethiopia by Bere Sericulture Production Private Limited Company and the existence of Sara har-handmade Ethiopia at Addis Ababa are the advantages of sericulture development in Ethiopia. In addition, the announcement of International Centre of Insect Physiology and Ecology (*icipe*), and The Master Card Foundation today announced above US$10 commitment towards creating employment opportunities for young people through beekeeping and silkworm farming. It is expected to benefit more than 12,000 unemployed and out-of-school youth, and provide opportunities to an additional over 20,000 people involved in the value chain from harvesting, to processing, packaging and marketing honey and raw silk would provide a big interest for the producers and increase export of raw silk to foreign by enabling them to expand their imports from the country (ICIPE, 2016).

In addition to above, Saba har-handmade Ethiopia was also another company and consumer already recognize the advantages of increased silk in Ethiopia, some have expressed concern. The production will prosper economically from the Ethiopian Growth and Development policy opportunity; will encourage transshipment of clothing produced in Asia.

Source: Own survey 2015

Figure 11 Sericulture manufacturing machine

The Ethiopian Growth and Developmental opportunity strategy is the best prospect for everyone. This will help to ensure that different companies, investment on the production of silkworm for silk products are able to provide the best quality silk to customers at the lowest possible prices. On a larger scale, as the Ethiopian economy emerges, this bill offers a great opportunity for foreign businesses to maximize trade and investment opportunities in Ethiopia.

5. SUMMARY AND CONCLUSION

This study was conducted in Oromia and SNNP regional states of Ethiopia. In the study area silkworm rearing was one of the income generating activity throughout the year during the study period. In the study area two types of silkworm namely, eri and mulberry silkworm were practiced to rear. The productions of silk in both regions were not more 3.36 tons per year. However, they have encountered many production problems including poor product quality and lack of silk production management to meet quality requirements and market standards due to primitive and unscientific "reeling" and "weaving" techniques, use of poor quality seeds, lack of bivoltine seeds, use of non-graded and diseased seeds, poor knowledge of production amongst farmers, poor supply and seed management, high production cost, recurring droughts, price fluctuation, absence of proper market, lack of transport facilities, absence of storage facilities, poor information on market trend and lack of finance.

Thus, selecting both regions as their setting the specific objectives of this study was (1) to assess production status of silk; (2) to explore factors influencing adoption of sericulture technology and (3) to identify marketing challenges of silk (cocoon) in the both regions.

Multistage mixed sampling procedure was used to select the sample PAs and household farmers. Oromia and SNNP regions were purposively identified based on the potential for the silk and silkworm production. In first stage 8 silk and silkworm producing g=kebeles were selected by help of Woreda Office of Agriculture (WoA). Finally, all 190 adopters and 206 non-adopters are selected for the study. The data included both qualitative and quantitative research design. Semi-structured interview schedule was used to collect data from the respondents.

Descriptive statistics such as mean, standard deviation, t-test and chi-square were employed to make a comparative analysis of the independent variables and binary logit to identify factors influencing adoption of the technology.

Result of descriptive statistics using t-test and chi-square indicated that sex, age, active family labor force, frequency of DA contact and participation on training variables influenced farmers' adoption behavior significantly.

The knowledge network analysis in this study confirmed that the main sources of new knowledge for sample farmers were, friends, neighbors and development agents in their social system. The analysis showed that experience sharing at work, interpersonal communication and during- market- day discussions, (rather than receiving from external organizations) were the mechanisms through which knowledge /information are shared.

On the other hand, results of the Binary logit model indicated the relative influence of different variables on adoption of silk and silkworm production. All 7 hypothesized explanatory variables were included in the model of which 5 of them had shown significant influence on adoption of technology. Accordingly, sex, age, active family labor force, frequency of contact with DAs and participation on training has positive and significant influence on adoption of silk and silkworm.

6. RECOMMENDATIONS

Development policies and program interventions designed to enhance agricultural productivity through promoting different agricultural technologies in general and sericulture technologies in particular. In the study area, there is a need to take into account the aforementioned variables and farmers' perception on the technology. More specifically, based on the empirical findings of this study, the following recommendations are forwarded:

- Skill training and technical back up for producers and experts is essential.
- Both silkworm and feed plant seeds development and multiplication centers in most production area of the country must be developed.
- Strengthening linkage and partnership among stakeholders.
- Strong and active market chain and market availability should be established.
- Scheduled monitoring and evaluation system towards the technology implementation must be designed and routinely implemented from upper to lower structure.

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8. APPENDICES

LIST OF TABLES IN TH E APPENDIX

8.1. APPENDIX

Appe ndix 1 Conversion factor used to compute man equivalent (Active Labor)

Age group (years)	Male	Female
Less than 10	0.0	0.0
10 – 13	0.2	0.2
14 – 16	0.5	0.4
17 – 50	1.0	0.8
Greater than 50	0.7	0.5

Source: Stork, *et al.,* 1991.

Appe ndix 2 Conversion factors used to estimate tropical livestock unit

Animal Categories	Conversion factors (TLU)	Total Number of TLU
Calf	0.25	26
Weaned calf	0.34	33
Heifer	0.75	102
Cow & Ox	1.00	851
Horse & Mule	1.10	10
Donkey (adult)	0.70	5.6
Donkey (young)	0.35	14.4
Camel	1.25	-
Sheep & Goats (adult)	0.13	142
Sheep & Goats (young)	0.06	19
Chicken	0.013	23
Total		1226

Source: Stork, *et al.,* 1991.

Appendix 3 Multi-collinearity test with VIF

Variables	Tolerance	VIF
Sex	0.777	1.287
Age	0.350	2.855
Educational status	0.341	2.932
Active family labor	0.902	1.108
DA contact	0.488	2.050
Participation on Training	0.727	1.375
Access to Credit	0.731	1.368
Total Mean	0.61	1.85

Source: Model result, 2015

Appendix 4 Contingency coefficient of dummy/categorized variables

Variables	CSWP	Sex	Education	DA contact	Training	Access to Credit
CSWP	1	0.230	0.17	0.56	0.86	0.35
Sex	0.230	1	0.65	0.43	0.35	0.78
Education	0.17	0.65	1	0.30	0.64	0.56
DA contact	0.56	0.43	0.30	1	0.11	0.11
Training	0.86	0.35	0.64	0.11	1	.230
Access to Credit	0.35	0.78	0.56	0.11	0.230	1

Source: Model result, 2015

Appendix 5 Correlation of explanatory variables with adoption of silk and silkworm production

	CSWP	SexHH	AgeHH	Edu	ACTF	DACOT	TRAP	Credit
CSWP	1	-.291***	-.346***	.223***	.100**	.219***	.318***	.151***
SexHH		1	.303***	-.066	.043	-.077	-.071	.009
AgeHH			1	-.274***	.093	-.022	-.066	-.078
Edu				1	.003	.053	.273***	.106**
ACTF					1	-.043	.022	.112**
DACO						1	.048	.273***
TRAP							1	.070
Credit								1

Source: Correlation output. *** Significance at 1% and ** Significant at 5%.

7.2. Appendices

7.2.1. Check list for key informants and Focal group discussion about silkworm production

Date of interview_____

Regional sector_____

Code_____

Section one: General information

1. Date of the interview_____2008 E.C
2. Region _____ Zone _____ Woreda _____
3. Is silkworm being produced in the Region/Zone/woreda? If yes, fill the table below.

No	Name of Zone/Woreda/Kebele/Private/Institution	Number of farmers participated on silkworm production			Types of silkworm	Year of started (E.C)	Average amount of product kg/year	Average price birr/kg
		M	F	T				
1								
2								
3								
4								
Average total								

2. Land using characteristics

2.1.What are the major crops grow during the cropping season (2004)?

No	Types of Major Crop	Yield in quintal		Price/quintal		Area of coverage (ha)
		Total yield gained	Total yield sold	Harvest time	Offseason	

2.2. What was the seed source (silkworm) in the Region/Zone/ Institution/Woreda or company? ----------

2.3. For your choice please briefly explain the source ----------

2.4. When did start the utilizing silk in the Region/Zone/ Institution/Woreda or company? _____E.C

2.5. If your Region/Zone/ Institution/Woreda or company, why improved silkworm production didn't practice? ----------

3. silkworm production practices

Silkworm holding by type and sex structure of the HH

Types silkworm	No of HH present		No of HH from whom silkworm died last year (2005/06 E.C)	
	Male	Female	Male	Female
Eri-silkworm				
mulberry				
others				

Section Two

The major challenge, issues, opportunities within the silkworm production system

1. What are the major challenges faced by Organization/Institution in the area with reference to silkworm production? Also what does Organization/Institution view/put forward as the solution to these identified challenges? (Fill in the table below).

No	Major challenges	Solutions to the stated problems
1		
2		

Section three: Access to services

4. Credit accessible to you

4.1. Are the Region/Zone/ Institution/Woreda or company obtained credit for silkworm production in the last three years?

a) Yes b) No

4.2.If your answer is yes to question number 14.1, from where you get and how much did you get?

1) From government amount of birr ----------
2) From non-government amount of birr ----------
3) Any other (specify)_____ amount of birr ----------

4.3.What is the repayment period of your credit? ----------

What is the interest rate----------?

4.4.How did producers repay their credit? Can producer repay their credit on time?----------

If they could not repay on time what do you do?----------

---

5. Extension services

5.1.Do you give advisory services for producers and extension agents? 1) Yes 2) No

5.2.How frequently did you visit? ----------

5.3.When did you visit them? ----------

5.4.Which silkworm types were first grown? 1) ---------- 2) ---------- 3) ----------

5.5.Why you preferred this type of silkworm production? ----------

5.6.Have you participated in field day/visit in the last five years? 1) Yes 2) No

If yes, how many times ----------

5.7. Have you ever received training in silkworm production in the last five years?

1) Yes 2) No

5.8.If yes, how many times ----------

5.9.Have you provided training to who may concern? A) Yes B) No

5.10. If your answer is yes to question number 5.8, who arranged for you?

1) OARD 2) Research 3) NGO

5.11. Silk worm rearing training participant information

No	Professional level	Number of participants			Year of training provided	Title of training
		male	female	total		

6. Market related variables

6.1.What was the average market price of the silk last year (2006/07 E.C)?

Types of silkworm	Price (Birr/Kg) at		*To whom you sell the product
	Farm get	market	
Eri			
Mulberry			
Any other			
*To whom 1) to whole seller 2) to retailer 3) to direct waiver 4) cooperative 5) farmers			

6.2.What is the trend in price in the last 3-4 years? (Decreasing, stagnant or increasing)

6.3.Do you expect low price in silk? 1) yes 2) No

6.4.When you expect low prices? ----------

6.5.What do you do when you expect low prices? ----------

6.6.In that light, how does it compare with alternative crops that you can grow? ----------

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6.7.What do you think the major marketing challenge with regard to silk production? ---------

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6.8.What do you think about silkworm production, as income generating activities for smallholder households? ----------

7. What do you think the adoption level of producer's interms of seed source availability, infrastructure, price, markets accessibility and policy issues for future prospect? ----------
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7.2.2. Semi-structured questioner for the respondents

General Instructions

I) Directive for Interviewers (Researchers)

1. Understand clearly all the questions before starting the interview;
2. Introduce yourself to the respondents and make clear objectives of the interview/the research;
3. Each question need to be clear to the respondents; use translator in case necessary;
4. Be patient during the interview and express yourself in understandable way to the respondents; and
5. Reliable information leads to right generalization. Hence, please write the Silkworm producers' response properly for each question.

II) Instructions to Enumerators

1. Make brief introduction before starting any question, introduce yourself to the farmers, greet them in local ways and make clear the objective of the study.
2. Please fill the interview schedule according to the farmers reply (do not put your own feeling).
3. Please ask each question clearly and patiently until the farmer gets your points.
4. Please do not use technical terms and do not forget local units.

III) Directive for Respondents (Farmers, DA, Agricultural Experts, etc)

Date of interview: _____

Peasant association or specific location: _____

Code_____

- The interview is only for research purpose and to understand the status, challenges and future needs of sericulture; and
- The name of the respondents will not be published anywhere.

Section one: General information

1. Date of the interview_____ 2008 E.C
2. Region _____ Zone _____Woreda _____ kebele _____
3. Landscape positions according to the farmer (high, mid or low land) underline one of the appropriate options inside the brace.
4. Name of the respondent: _____

   Sex: male ☐ female ☐ age ----------
5. Educational status 0. Illiterate 1. Read and write only 2. Primary school 3. Secondary school (encircle one of the above options)
6. Current involvement in sericulture: Yes or No (circle one)

Section two: Land using characteristics

1. Family size (including head of household) of the age household.

Household head	Number of family in the households		
	1 - 3 years	4 - 6 years	> 7 years
Male			
Female			
Total			

2. Land utilization
   a. Do you have your own land? ☐ ☐
3. If yes, what is the allocation? (fill in table)

No	Types of land use	Coverage by ha
1	Homestead/backyard	
2	Cultivated land including fallow	
3	Area under silkworm feed cultivation	
4	Closed plantation land	
Total		

4. If your answer is no in question number 2.1, how you produce crop? (Circle one). A. Hired land B. Crop sharing C. Land rent

5. What are the major crops you grow during the last cropping season (2006/07)?

No	Crop types	Yield in quintal					Price/quintal		Size in ha) (Only for Own)
		Own	Hired	Crop sharing	Total yield gained	Total yield sold	Harvest time	Off season	

6. Do you have your own livestock? Yes ☐ No ☐

If yes, what is the number of Livestock you own currently?

No	Types of livestock	Total number	Total number sold/year	Total income from sold (in Birr)
1	Oxen			
2	Cows			
3	Young bulls			
4	Calves			
5	Heifers			
6	Goats			
7	Sheep			
8	Camel			
9	Horse			
10	Mule			
11	Donkey			
12	silkworm			
	Grand total			

7. Silkworm rearing

7.1.Do you rear silkworm? (circle one) a) Yes b) No

7.2. If yes, what type of silkworm is you produce?

a) Eri-silkworm b) mulberry silkworm

7.3. When did you started silkworm rearing? _____Years

7.4.How did you start silkworm rearing?

a) By collecting the seeds (silkworm eggs) from research centers
b) By purchasing the silkworm from other farmers or any source
c) Through inheritance
d) Any other (specify)_____

7.5.Where do you rear your silkworm?

a) In separate rearing rooms around living area
b) In animal house along with other domestic animals
c) In living house

7.6.If you rear in the separate house, from what it made up of? (circle one)

a) mad
b) concrete
c) grass
d) wood
e) any other (Specify) ----------

7.7. Are you aware of silkworm rearing practices? (circle one)

a) Yes b) No

7.8. If your answer is yes to question number 5.7, from whom you learned about it?

a) Extension agent b) Radio c) Field day
d) Neighbor e) Chart and poster f) ETV

7.9. Have you ever used improved silkworm production practices? (circle one)

a) Yes b) No

7.10. If your answer is yes to question number 5.9, when did you start utilizing the silk? _____ E.C

7.11. If your answer is no to question number 5.9, why you didn't used improved silkworm production practices?

a) It is expensive
b) It is not available
c) It needs skill
d) Lack of awareness
e) Lack of seed

8. silkworm production practices

8.1.Silkworm holding by type, sex structure of the HH (house hold)

Types silkworm	No of HH present		No of HH from whom silkworm died last year	
	Male	Female	Male	Female
Eri-silkworm				
Mulberry silkworm				

8.2.Problem, issues, opportunities within the silkworm production system

Objective: - Find out any imminent or potential challenges that are likely to be major factors that limit silkworm cocoon production and if it is recognized by farmers then what they see as potential solution?

List the major problems faced by farmers in the area with reference to silkworm production and also what do farmers view/put forward as the solution to these identified problems?

Priority	Major problems	Solutions to the stated problems
1		
2		
3		
4		
5		

9. Income from participation in off-farm activities.

9.1. Do you have off-farm activities? Yes ☐ No ☐

9.2. If your answer is yes to question number 7.1, circle type of work below:

a) Business b) Laborer c) Carpenter d) Civil servant e) Other (specify)_____

9.3. For what purpose do you use the income from off-farm activities?

1) To purchase household items
2) to purchase farm inputs
3) to settle debts
4) to buy food

10. Access to services

10.1. Market centers accessible to you

No	Name of market	Distance (Km)	Mode of transport	Transport Cost (birr/Qt)	Commodities sold at market place

10.2. Credit accessible to you

10.3. Have you obtained credit for silkworm production in the last three years?

b) Yes b) No

10.4. If your answer is yes to question number 9.1, from where you get and how much did you get?

1) From governmental organization; amount of birr ----------
2) From nongovernmental organization; amount of birr ----------
3) From friends; amount of birr ----------
4) Any other (specify)_____ amount of birr ----------

10.5. What is the repayment period of your credit?

1. One year
2. Two years
3. Three years
4. Four years
5. Five years

10.6. How did you repay your credit?

a) By selling the cocoon/fabrics product from silkworm
b) From other sources

10.7. For what purpose did you use the income obtained from silkworm selling?

1) For purchasing fertilizer
2) For purchasing silkworm
3) For purchasing improved seeds
4) Other purpose (Specify) ----------

11. Extension services

11.1. Do you get advisory services from extension agents? 1) Yes 2) No

11.2. How frequently do the extension agents visit you?

1) Once in a week

2) twice in a week
3) monthly
4) yearly
5) Never

11.3. When doe s extension agent visit you?

a) During land preparation
b) During rearing
c) When disease/pest occur
d) during harvesting
e) From land preparation to harvesting

11.4. What are your other sources of information and how often you use/ have contact with the m?

Sources of information	How often you contact them					*Means of information exchange
	Never (1)	Once in a year (2)	Monthly (3)	Weekly (4)	Daily (5)	
Researcher						
PA leader						
NGO						
Cooperative						
Neighbors/friends						
Input dealers						
Agricultural professionals						
Other, if any						
*Means of information exchange: 1) Demonstration 2) Field day/visit 3) Training 4) Written materials (leaflets, manuals, and so on) 5) Others (Specify) ----------						

11.5. When have you first heard of silkworm rearing? _____

From who/which source? _____

11.6. Which silkworm type have you first grown? 1) ---------- 2) ----------

11.7. Why you preferred this type of silkworm production? ----------

--- ----------

11.8. Which type of silkworm you have reared so far? When you have grown them?

Types of silkworm	First reared Year	Duration of use (year)		* Reason for stopping if not using now
		From	To	
Eri				
Mulberry				
* Reason for stopping 1) Unavailability of better variety 2) Unavailability of seeds 3) High seed purchase price 4) Low yield in my field 5) Disease and pest problem 6) Lack of seed				

11.9. Have you participated in field day/ visit in the last five years? 1) Yes 2) No

11.10. If yes, how many times ----------

11.11. Who arranged for you? 1) Agri bureau 2) Research center 3) NGO 4) None of them

11.12. Have you ever received training in silkworm production in the last five years?
2) Yes 2) No

11.13. If yes, how many times ----------

11.14. Who arranged for you? 1) Agri bureau 2) Research center 3) NGO 4) None of them

11.15. Have you conducted demonstration in the last five years? 1) Yes 2) No

11.16. If yes, how many times? _____

11.17. With whom you conducted demonstration? 1) Agri bureau 2) Research center 3) NGO 4) None of them

12. Market related variables

12.1. What was the average market price of the silk last year?

Types of silkworm	Price (Birr/Kg) at		*To whom you sell the product
	Farm get	market	
Eri			
Mulberry			
*To whom 1) To whole seller 2) to retailer 3) to direct waiver 4) cooperative 5) farmers 6) other			

12.2. Have you changed to whom you sell the silk cocoon in the last 2-3 years?

1) Yes 2) No

12.3. If yes, is there change? 1) Yes 2) No

12.4. What was the change? _____

12.5. What is the trend in price in the last 3-4 years?

1) Decreasing 2) stagnant 3) increasing

12.6. Do you expect low price in silk? 1) yes 2) No

12.7. When you expect low prices? ----------

12.8. What do you do when you expect low prices? ----------

12.9. In that light, how does it compare with alternative crops that you can grow? ----------

12.10. In your view how do you see the selling price of the silk? ----------

Types of silk	Price condition				
	Very poor (1)	Poor (2)	Moderate (3)	Good (4)	Very good (5)
Eri-					
Mulberry					

12.11. Do you get market price information on silkworm product? 1) Yes 2) No

12.12. If yes, what are your sources of information and how often do you get access to it? (Fill in the table below).

sources of information	How often you contact them (tick)					Which source you prefer
	Never	Once in a year	Twice in a year	quarterly	Weekly	
DA						
Trader						
Neighbor						
farmer						
Others/specify/						

12.13. What do you think the major marketing problems with regard to silk production? ------

---

13. Membership of farmer's association

13.1. In which of the following organization are you member and leader? Please tick

Organization	Membership 1= member 0 = non member	Committee member 2= yes, 0 = No	Leader 3 = yes, 0 = No
Seed multiplication group			
PA leader			
Saving and credit group			
Marketing cooperative			
Other/specify			

14. silkworm preference criteria

14.1. Which silkworm you prefer and why? (Write number)

Types of silk	yield size (1)	silk color (2)	Early maturity (3)	Market demand (4)	Price advantage (5)	Storability (6)	Yield advantage (7)
Eri							
Mulberry							

* Preference criteria 1= Very Good 4= Poor
2= Good 5= Very poor
3= Intermediate

End of the interview

Thank you very much for responding to the questions.

Name of the Enumerator: _____ Date of Interview: _____