ASSESSMENT OF ADOPTION AND IMPACT OF SERICULTURE FARMING ON RURAL FARM HOUSEHOLD INCOME IN RWANDA

A CASE OF MEMBERS OF SERICULTURE COOPERATIVES IN KARONGI DISTRICT

BY

Bruce IRAMBONA

College of Agriculture, Animal Sciences and veterinary Medicine

School of Agriculture, Rural Development and Agriculture Economics

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February 2018

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BY

Bruce IRAMBONA

Reg.Number 215043059

A dissertation submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN AGRIBUSINESS

In the College of Agriculture, Animal Sciences and veterinary Medicine

Supervisor: Dr. Jean Chrysostome NGABITSINZE

February 2018

DECLARATION

I declare that this Dissertation contains my own work except where specifically acknowledged.

Signature…… Date…….

Bruce Irambona

Reg.Number 215043059

Declaration by Supervisor

This thesis has been submitted with my approval as the student Supervisor:

Signature …….Date……

Dr. Jean Chrysostome NGABITSINZE

SUPERVISOR

ACKNOWLEDGEMENT

My sincere appreciation and thanks goes to my supervisor, Dr Jean Chrysostome NGABITSINZE for his continuous professional guidance right from the beginning to the completion of this work. Successful accomplishment of this research work would have been impossible without his assistance.

I am also very grateful to the University of Rwanda for this masters program in agribusiness. Special thanks also go to College of Agriculture and Veterinary Sciences (CAVM) lecturers in the University of Rwanda for their valuable academic contribution throughout my studies. I extend my sincere appreciation to all my beloved colleagues (Masters of Agribusiness 2015) whose moral and material support during my coursework was most timely.

It is with heartfelt gratitude that I thank Mr. Dorian Banks for his support during this period. Successful and timely accomplishment of this study would have been very difficult without his assistance and support

I also acknowledge the members of sericulture cooperative in Karongi district who took time to respond to the questions and who assisted in tracing other farmers. Finally, I am profoundly indebted to my loving wife and son, parents, brothers and sisters for their affection and perpetual prayers during my studies.

Above all, let me praise and honor the Almighty God for the opportunity and capacity given to me to realize my aspiration. I thank God for His grace!

Abstract

Since 2005, sericulture has been introduced in Rwanda in order to increase highly the production from its scarce land and as source of high income and employment for Rwanda poor farmers in rural area. Because of the high value of silk yarn and the favorable climatic conditions for mulberry cultivation, sericulture was seen as a potential tool for poverty reduction and soil conservation. In this research we assess the factors influencing the adoption of sericulture farming and its impact on farmer's income.

In order to assess the impact of sericulture farming on rural household income, we used in this study the propensity score matching technique. It then assesses the factors that influence the adoption of sericulture farming through which it influences farm income.

Sericulture is a relatively recent phenomenon in Rwandan farming activities and its adoption is treated as an agricultural technological innovation. Our impact assessment indicates that the poverty reduction effects of sericulture adoption are still very low, but acknowledge the limitations of such estimation at an early adoption stage. As sericulture diffuses further among farmers, the availability of more data will enhance the accuracy of the impact assessment.

Our findings confirm the existing empirical evidence on agriculture technology adoption showing that the adoption of new crop varieties, which is usually conditional on its profitability with respect to traditional crops, contributes to enhancing household income and reducing poverty among adopting farmers. Because of the additional beneficial effects of sericulture farming on soil protection and water conservation, the social benefits of sericulture are even much larger than individual income enhancement.

The identified iincome benefit of the sericultureadoption, didn't allow its implementation to be more adequate to achieve appropriate skills to be proficient in this new technology to the point of its establishment in the Rwanda economy.

From the mentioned factors which are the human skills and other market factors, we have to consider also the necessity of appropriate and adequate infrastructures together with a proper incentive system which will allow to plan a fruitful and productive technology absorption in the country. In order to overcome the mentioned limitations, it is necessary to put together new technology adoption and long term objectives.

Finally, in order to promote increased adoption of sericulture farming and its impact on farm income; researchers, government, development bodies and investors have to establish a production system of silk worm eggs suitable for our tropical Rwanda condition and establish a silk processing company which will guarantee the market for cocoons produced by farmers.

Key Word

Adoption

Assessment

Cooperatives

Household

Income

Impact

Rural farm

Sericulture

List of Acronym

ATE: Average Treatment Effect

ATT: Average Treatment effect on the Treated

ATU : Average Treatment effect on the Untreated

CSRTI: Central Sericulture Research and Training Institute

ICRAF: International Center for Research in Agroforestry

JAICAF: Japanese Association for International Collaboration of Agriculture and Forestry

KBM: Kernel based Matching

KOICA: Korea International Cooperation Agency

MINAGRI: Ministry of Agriculture and Animal Resources

MINECOFIN: Ministry of Economy and Finance

NGOs: Non-Governmental Organizations

NISR: National Institute of Statistics of Rwanda

NNM: Nearest Neighbor Matching

PSM: Propensity Score Matching

RAB: Rwanda Agriculture Board

RM: Radius Matching

Rwf: Rwandan Francs

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CHAPTER ONE

GENERAL INTRODUCTION

1.0. Introduction

This chapter presents the background of the study, statement of the problem, objectives of the study, research questions, research hypothesis, and scope of the study, justification, significance of the study and organization of thesis.

1.1. Background of the study

A new agriculture technology is adopted with the objective of getting or providing a solution to the limitations and constraint from current method of production and from current resources.. One of the limiting factor in Rwanda is the high cost of transportation of both imports and exports because the country is a landlocked country. Rwanda decided to start producing silk because it is a high value commodity from its value to volume ratio but also as convenient approach to increase revenue to rural farmers.

Despite the notable success of some countries in the adopting sericulture, we can't ignore also that many other countries with stable and strong Economy like United State of America didn't succeed in this due to many factors such as skilled labor and country preference of tobacco which was more successful as a cash crop. It has shown that in sericulture sector there is a need of high technology, a considerable technical human skill and significant investment funds. These allow the production of a better quality of Silk which will be connected to other related national businesses Kiyokawa(1984).

For our case, Rwanda is a landlocked country in the Great Lakes region of central Africa covering roughly 26,338 km2 and as reported in the Provisional Results of the 4th Population and Housing Census as of "census night", August 15th 2012, give a total resident population of 10,537,222 people. This translates into an average density of 376 inhabitants per km^2;

making it among Africa's most densely populated country. Rwanda's economy is agrarian. Agriculture employs almost 80 percent of the population, accounting for more that 40 percent of gross domestic product GDP, (NISR 2017). Apart from unexploited gas reserves beneath Lake Kivu, Rwanda is poorly endowed with mineral resources. Subsistence food production is the dominant activity in the agriculture sector. Production of coffee, tea and flowers is still modest (Namata, 2012).

In the short and medium term, Rwanda intends to continue focusing its efforts on the traditional cash crops of Tea and Coffee and pyrethrum, as well as on the nascent, non-traditional horticultural crops & plants, including various Fruits & Vegetables; Flowers (mainly fresh roses); Essential Oils (Pyrethrum; Patchouli; etc.), Stevia, dairy, meat, poultry, and fish.

With a contribution of 31% to the GDP (NISR 2017), agriculture employs more than 70% of the Rwanda Population and is the principle driver in the Rwanda economy. Hence, any change in the agriculture sector will have a big impact on the country economy by siginifcanty reduce the poverty and contribute to general wealth increase in the country. Agriculture production is mainly produced on small scale in Rwanda like in other developing countries. The agriculture sector is dominated by subsistence production where several staple crops are produced such us sweet potato. Rice, beans. Wheat. Irish potato, soya bean, cassava and bananas (NISR, 2009). However, we should note that the agriculture export represent over 70% of the total value of exports in which Coffee and tea are the main exports. Coffee and tea have been the main cash crop of the country but recently the Government of Rwanda made significant effort to increase and diversify the country's exports.

Through this export diversification strategy, the Rwandan government has put in place a system to heavily support sericulture adoption and now sericulture in among priority area in its development strategies such us Vision 2020 and others.

Therefore, silk value chain is given priority for the government support. According to the report of Rwanda Development board in 2013, the revenue from sericulture is favorable compared to traditional crops. It has proven that one hectare (1Ha) produces thirty tones (30T) of leaves which will produce 750 Kg of cocoons and then 100kg of raw silk. On the current market price 1Kg of silk cost 69$ which give a gross revenue of USD 6,900 per year and per Ha. This promising revenue was considered that it will be main driver to for farmers to join sericulture farming. The chosen adoption strategy has the objective of reaching 10,000 hectares in 2020. As reported by NAEB (2012), export-oriented farming in general and now sericulture in particular benefit smallholder farmers, and especially woman-headed households and households with little land, involved in export production for earning income. This category of farming promotes: Sustainable increased income to farmers from key export-driven agricultural value chains, through increased volumes and quality of production, improved marketing and effective farmer organizations and strengthened producer cooperatives as full-fledged economic partners of the private sector.

1.2. Problem statement

Rwanda's effort to transform its agrarian economy into a knowledge economy is a daunting challenge given the steep topology that makes a resource reallocation difficult. A redeployment of the agricultural land in order to produce the necessary investable surplus needed for a structural transformation is also made difficult by the scattered human settlement. When the idea of silk production emerge coincidentally, the development of sericulture was seen as a new form of more profitable land use because silk is a high value commodity and that Rwanda fulfill the optimum condition for mulberry cultivation.

After a series of positive evaluations and feasibility studies conducted in collaboration with the UN Food and Agriculture Organization (FAO), sericulture was formally introduced in Rwanda since 2005 as a priority cluster in the Government's Economic Development and Poverty

Reduction Strategy (EDPRS), one of the priorities of the country's development objectives stated in Vision2020. The Ministry of Agriculture was tasked to expand the sericulture in the country, by targeting 10,000 hectares of mulberry plantation in the country. The Rwandan government continues to deploy efforts aimed at developing the sericulture industry as part of the national development objective of poverty alleviation and increased household incomes. Such support includes capacity building through onsite training of farmers and training of trainers, staff training overseas, construction of rearing houses and acquisition of rearing materials and equipment for target institutions and cooperatives. The Consideration of the expected increase of farmer's income through silkworm rearing on the thousand hills is not straight way or a guaranteed way.

Despite the fact that sericulture adoption was a success in different country in Europe, it is necessary to note that Chinese have been dominant in the sericulture sector and was only challenge by Japan few years before the World War II

As for Rwanda's quest to adopt silkworm rearing, it is important to note that it was not the first East African country to attempt sericulture as an option in the poverty reduction strategy. Back in the 1980s, Kenya and Uganda have introduced silk worm rearing in their agricultural portfolios but due to a general lack of supporting infrastructure, adequate training and planning, silk production in those countries turned out to be an outright failure as concluded by a study conducted by the JAICAF in 2007. Madagascar on the other hand, seems to have succeeded in developing a high quality sericulture as a result of a more carefully designed sectoral support strategy. If Rwanda is to succeed in using sericulture as a tool for the poverty reduction strategy, it is imperative to draw lessons not only from Madagascar's success, but also from Kenya's and Uganda's failure

From different experience in many countries, it has been realized that sericulture adoption is not a simple nor easy process in the context of a new social and cultural area. The adoption

of sericulture have been a success in some countries like Madagascar, China, India and Japan, but also have been a failure in other country like Uganda, Kenya and United State of America. The key factors in this area was identified as technology, human skills and financial investment Kiyokawa (1984). It was also shown that it is necessary to link the sericulture with other related business in the local market in order to allow sericulture to succeed in a country.

The rural farmers in Rwanda lack of sustainable market and post-harvest management for the small scale farmers in Rwanda also they have limited capital to develop the farms and local farmers also do not have easy access to funding from commercial banks. The lasted market information is not readily available to the small scale farmers and these results in the farmers selling at cheap price in order to avoid spoilage of agricultural products, the shortage of fertile land and Lack of knowledge about modern farming methods including irrigation and lack of necessary equipment to use on the farm during planting, harvesting and value addition.

From the above mentioned limiting factors, it is important to note that there land size and land holding in Rwanda constitute an additional limiting factor. In Rwanda, land endowments are distributed in different plots or sub blocks due to high population density. On small holding structure, sericulture adoption and its marketing become a very challenging tasks. This will not allow a smallholder farmer to increase output, income and improve its general welfare and livelihood. In such smallholding structure, a farmer will cultivate not only based on topography, soil quality and irrigation source, he will splits the owned land into many small plots and plant different crops of their choice (Ghimire, 2015).

The aim of this study is to provide the assessment of the conditioners or factors of adoption of sericulture farming and its impact on rural household income in Karongi district. The knowledge and adoption of recommended sericulture technologies are influenced by various factors like age, gender, education, farming experience, income, training (Priyadarshini and Vijayakumari, 2013). Understanding the factors influencing technology adoption will help us

predict and manage who adopts, when, and under what conditions. Hence, the present study will examine the factors influencing the adoption of sericulture technology in Karongi district and assess the impact of sericulture on the household income.

1.3. Objectives of the study

The main objective of this study is to examine the factors influencing the adoption of sericulture farming and its impact on rural household income.

1.3.1. Specific objectives of the study

The specific objectives of the study will be as follows:

1. To assess the factors influencing the adoption of sericulture farming among rural farmers in karongi district,
2. To study the factors affecting household income from sericulture farming.

1.4. Research questions

The research questions in this study are given as follows:

1. What are the factors influencing the adoption of sericulture farming among rural farmers in Karongi district?
2. What are the factors influencing rural household income from sericulture farming in Karongi district?

1.5. Research hypotheses

The hypotheses of this study are described below:

1. Ho: The Identified factors do not affect the adoption of sericulture farming in the study area.

   H1: The identified factors affect the adoption of sericulture farming in the study area
2. Ho: The identified factors do not affect the income from sericulture farming in the study area

H1: The identified factors affect the income from sericulture farming in the study area

1.6 Overview of methodology

The research work is fundamental descriptive and analytical as it embraces the use of primary and secondary data in examining the impact of sericulture farming on rural farm household income in Rwanda, of course the descriptive tools consist of graphs and percentages, while analytical tools consist of econometric texts specially Discrete choice model, propensity score matching, test robustness & unmeasured bias.

Furthermore, the study will utilize primary sources of data in which survey questionnaire will be extensively used and distributed to households selected in sericulture cooperatives located in Western Province, Karongi District. Then Data will be analyzed using STATA 10 program and SPSS (Statistical program for Social Sciences).

The purpose is to generate data about the opinion and perceptions on adoption of sericulture farming in relation to the rural farm household income. Thus, in addition provide means of analyzing the likely impact of sericulture farming in relation to the rural farm household income in Rwanda.

1.7 Scope of the Study

In order to achieve research objectives, the researcher will look at the time scope, conceptual scope as well as geographical scope.

1.7.1 Contents Scope

This study focuses on the assessment of factors of adoption of sericulture farming and its impact on rural household income. This topic is chosen because; sericulture farming is of great importance as far as it improves living standard of rural farmers and contribute to the trade balance of the country.

1.7.2. Time Scope

Due to time constraint and financial support, cross section data was be corrected from 1st April 2017 to 20th May 2017.

1.8. Justification of the study

The subject of this thesis is "assessment of the adoption and impact of Sericulture farming on rural farm household income in Rwanda" and it is placed in a wider context of the economic development discipline, which combines both aspects of agricultural economics and rural development. In the analysis, I will use two sericulture cooperatives (Duteraninkunga and Abadatenguha Cooperatives) in Karongi district as a case study because it stimulates sericulture farming in Rwanda for improving general welfare in terms of poverty among rural farmers over time.

Here, I will analyze the different dimensions of household income, including the share of non-agricultural income, the number of income sources and the scope of activity portfolios that households undertake. The study aims to determine the link between silk production and household income in terms of the percentage of level of income of farmers using cross section data.

1.9 Significance of the study

Conducting the study would have the following contributions. It contributes to the theoretical and empirical body of knowledge available on the adoption and impact of sericulture farming on rural farm household income in Rwanda. · Moreover, it will serve as a spring board for further research on the issue. ·The result of the study will help local authorities and development institutions to formulate appropriate intervention mechanism.

1.10 Organization of the thesis

This thesis will be organized into five chapters. The first chapter will comprise the introduction part of the research highlighting the statement of the problem, research questions, and

objectives of the study, scope of the study and significance of the study and chapters schemes. The second chapter focuses on the review of the literature explaining different concepts and definitions. The third chapter concerns of the methodology of the research, which consists of site selection, and description of the study area, nature and sources of data, research strategy and design, sampling technique, sample size determination, data collection method, and data processing and analysis. Chapter four will focus on data analysis and result interpretation. The last chapter will be on the conclusion of the study and the policy suggestions

CHAPTER TWO
LITERATURE REVIEW

2.0. Introduction

This chapter provides a brief survey of literatures as a pedestal for evaluating the methodology and objectives. Few relevant academic literatures on the adoption of new technology and its determinant will be reviewed. This chapter is organized under three themes based on the objectives of the study: Conceptual framework, Theoretical framework, Empirical framework.

2.1. Theoretical perspective and conceptual framework

In this sub-section the researcher focuses on different philosophy, techniques regarding to silk farming and rural farm household income. This is taken from various text books, magazines and published reports. Theoretical perspectives are an essential part of the framework used to organize specific social phenomena within the social sciences. In this study, the researcher focuses on accounting information system, financial statements and performance theories.

2.1.1 Theoretical underpinning the impact assessment

Impact assessment is directed at establishing with as much certainty as possible, whether or not an intervention is producing its intended effects .There are two approaches to study the impact of a given project. These are the 'before and after' and the 'with and without' approaches. Before and after analysis compares the performance of key variables during and after the program, with those prior to the program (Heckman, *et al*.1998).

This method uses statistical approaches which will allow us to analyse and evaluate if there is, in some essential variables, a significant change over time. This method doesn't consider or give consideration to the effect from the factors of confounding on the observed change. This will lead to biased result. Both with comparison and without comparison, it considers the

behavior and performance of the key variables of a representative sample of program beneficiaries or recipients and compares them to non recipient (comparison group).

It results into an approach to the counter-factual problem or question, referring on the experience of non-recipients or non-beneficiaries as a proxy for what, in other circumstances, should have occurred within the recipients of the program. As far as it concerns, Impact evaluations are technical and practical exercises that rely on econometric and statistical models. There are three known types of impact evaluation designs: experimental, quasi-experimental and non-experimental which try to determine different and substitute scenario to characterize the counterfactual The basic issue is to represent the estimation of the impact as a treatment effects model.

Let Y_i^1 = outcome or output after treatment, and Y_i^0 = outcome or output without treatment,

Causal effect of *i* is given by:

$Y = Y_i^1 - Y_i^0$ …….(2.1)

Estimated (or average) causal effect is given by:

$E(Y) = E(Y^1 - Y^0) = E(Y^1) - E(Y^0)$ …… (2.2)

It is however impossible to observe individual treatment effect since we do not know the outcomes for untreated observations when it is under treatment (Y_i^1) and for treated when it is not under treatment (Y_i^0).

Hence, Propensity score matching technique which is a non-parametric method consequently links and compare the two groups so as to create a acceptable counterfactual. In a specific way , it links a beneficiary of the program (treated individual) with a non-beneficiary of the program (control individual) which has a similarity in all their observable variables or characteristics with exception the treatment and calculates the variance in outcome/output variable. That difference is the impact of treatment (i.e. Adoption of sericulture farming) (Rosenbaum and Rubin 1983).

Below is the equation which shows arithmetically the probability that an individual is treated and is a program beneficiary given the observable variables:

$$\boldsymbol{P(X) = Pr[D = 1[X = x)} \quad \text{.....(2.3)}$$

Where D=1 is represent the observable treatment and X is a vector of observable characteristics.

2.1.2 Theoretical literature

2.1.2.1 The concept of silk production in Rwanda

Silk is commonly produced in the natural environment by different type of insects such as the, the Tussah, Muga and Eri moths from India Cecropia moth from North America, the Anaphe moth from Africa and undeniably by some spiders! But the commercial silk which is needed by the textiles industry is from the silkworm cocoons which was fed with mulberry

Sericulture as an industry is an agricultural based industry. It consist of growing silkworms in order to produce the raw silk. The raw silk is obtained from the cocoons rolls by some insects' variety. The main step in sericulture is to plant food which will then feed the silkworm and then the silkworm will give silk cocoons which then give the silk filament to be processed and weaved.

The main use of silk is for producing clothes such us light weight suits, shirts, underwear and many others different clothes. We also see the use of silk in draperies and some narrow fabrics. Production systems in rural areas are complex and producers are heterogeneous in their asset endowments and access to input and output markets. With this, rural farmers responds in many different way to the opportunities raised from production of the silk As a result, households will react differently to silk production opportunities and develop wellbeing benefits from participation which are different. Results from different reviews highlight the potential heterogeneity of impacts.

There is an important impact from traditional or existing cash crops to the poverty reduction when farmers from an area participate in a broader or comprehensive way, a significant increase of the labor or farm employment and cash crops are directly linked to the production of staple crops even if it can be for subsistence production (Poulton 2005).

As long as the production of the cash crops or any other crops is commercialized well and give returns which allow farmers to own or purchases new resources, it will be significantly spread to many farmers.

For example, based on evaluation of Pride Africa's DrumNet sunflower promotion intervention, Okello (2010) found that households participating in the service bundling program earned higher incomes, produced more food on their farms, were more food secure, and did not decrease medical and health spending during the recent rise in food prices.

2.1.2.2 Silk Production in Rwanda

The textiles industry have been dominated by one singles manufacture UTEXIRWA but recently a second one GARMENT have opened its doors in the newly established special economic zone and an increase of small handcraft retails cooperative. However, this industry is still significantly very small. Since the demand of the local textile sector is very high in comparison of the local production, all the raw material are imported from different part of the globe. In Rwanda, significant quantities of fabrics both from cottons or artificial fabrics are imported from Africa and China mainly. Historically, Rwanda has invested significantly in cotton production but due to soil and climate constraints, its production was not competitive in term of quality compared to other countries production.

However, in 2014, in partnership KOICA, a preliminary study conclude that Rwanda soil and climate was well adequate for sericulture. This conclusion was based on the below points:

1. Natural/Climate conditions: The best conditions for silkworm growing is a stable temperature of 20-28°C and for mulberry cultivation a well distributed rain fall between 122mm to 1700mm per year

2. Labor cost conditions: Rwanda has a cheap labor force and highly available in rural areas. This gives a production advantage compare to other countries.

3. Government contribution and support: The government of Rwanda consider Sericulture as a way of poverty relief and a way of increase the general welfare for rural famers by increasing its income. Also sericulture is expected to contribute on the trade payment of the country. Rwanda government has been investing a lot in the sector with the aim of increasing the number of mulberry cultivation from 350ha to 10,000 Ha in 2020. It also developed a plan to to upgrade the silkworm stocks through the National Sericulture center.

4. The silk produced from Rwanda was found to be of high quality: From the result of the Central Sericulture Research and Training Institute (CSRTI) which analyzed the samples of Rwandan silk, it was ranked 4A-5A. This grade is only obtained by farmers who have been in sericulture for a long time (with long experience).The silkworm which were imported as beginning stocks from other countries performed well compared to their country of origin.

5.Support and commitment from research institution: Rwanda Agriculture Board (RAB), which is the leading research institution of Rwanda government in agriculture, organized enough funds to take the lead on sericulture research and the same institution is encouraging private researchers by availing funds for similar research.

6. Farmers express high interest for sericulture: farmers are aware about the large benefit of sericulture and the information have been disseminated in the whole country.

As demonstrated by the table below, silk compares favorably to other available crops and represent a strong revenue opportunity to the farming community.

Table 1: Comparison of profit from Silk to different crops

Crop	**Gross Income ha/year(FRW)**	**Gross Profit/hectare/ year (FRW)**	**The margin**
Cassava	1,750,001	1,143,800	65.1%
Coffee	194,881	76,720	39.1%
Potatoes	2,000,001	820,500	41.0%
Maize	750,001	223,100	30.1%
Silk	4,560,001	1,891,352	41.0%
Beans	450,001	65,000	14.0%
Tea	819,841	68,880	8.0%

Source: MINAGRI, 2012

2.1.2.3 Effect of Cash cropping on household income

We know that the majority of the population in the developing countries are in rural areas and that their livelihood depends mainly on agriculture, an increase of the food production for both local and exports market is considered as a basis to see their income and a huge impact on the economic development (Kennedy, 1989). From this statement, we have to focus on the uniqueness of cash cropping when it comes to exportation. Despite the fact that market oriented production of staple crops can be also exported, high value crops than food crops are the main considered as cash crop by farmers and such crops necessitate unique specialized skills. The cash crop production has an impact on farmers income in numerous way. Lot of discussion on the subject have been on for several years from numerous researches and studies but always ended on divergent result/conclusion.

Proponents/supporters see it as a means of improving the general welfare of smallholder households while the critics express the fear of cash crop production, thinking that it can destabilize income and poverty alleviation. As argument they say that an income increase does't mean automatically an increase in food security. For them, cash cropping has lower impact to income increase and nutrition in comparison to staple crop (DFID, 2014).

Since starting cash crop production require sometime to reduce land and other resources which were from staple crop, it may cause and increase of food prices due to supply decrease (IFAD, 2008).

The fluctuation of the local food price may result on the unique focus given to cash crops. The main reason is that the farmers involved in cash crop production will be more conditioned by markets environment. There is a huge possibility also that consumption of staple food produced by household will decrease and it expose the household to food insecurity. This is again worsen by the food price fluctuation on the market where a drop of cash crop price will significantly reduce household income and its ability to source food.

The shift to cash crops may also reduce the time available to seek alternative employment opportunities especially for cash crops requiring more labor than food crop production.

From another side, food crops and cash crops don't always compete but can be complementary following best practices of the crop rotation and intercropping. It has been shown that also food crops are in some cases cash crop. Example is for maize, iriish potatoes and soya bean in Rwanda.

In a study conducted in 2007 in Southern Ghana, they found that cash crop producing household have seen their income increase and the access to food also increased compare to those who were only producing the staple foods Afari (2007).

In the same study, it was found that the household who have large size of land were the ones who will tends to adopt new crops for export. Hence the land size was a key factor in food security for a household. Despite its contribution to trade balance by increasing foreign exchange earnings, the study found that poor households couldn't easily or some time were hindered to adopt the export market despite the known huge benefit from it.

The majority of households were also exposed to the risk of inadequate technological know-how in meeting the ever increasing quality standards and health control traceability requirements by European consumers, price collapse on the export market and a breakdown of local marketing institutions.

IFAD (1998) reported that poor household in Guatemala were unfavorable to export crops due to lack of investments, resources and other means to sustain export crop production due to many problems arising from their production processes.

It has been realized that exporters (in this case agro-exporters) give difficult and unfair conditions to farmers mostly on the quality and prices related. Poor farmers who receive advance on inputs have been also complaining about high charges from exporters and this may lead to the exposure of farmers to food insecurity.

In 2007, a study examined the effects of certified organic export production on household food security in Uganda. The study indicated that conversion to organic export production had not reduced food security in the examined cases but rather improved it by rising cash incomes that enabled households to increase the amount and quality of food purchased in the market (Bolwig and Odeke 2007). Producers of pineapple testified that they are enjoying self-sufficiency in term of food since they converted to organic pineapple farming due to high price offer for certified pineapples. The confirmed that an increase in their income allowed them to acquire more land and also increase investment in their food production land. They also say that now they have the ability to buy or purchase food with high nutritious value such us meat, sugar, and fish.

2.2 Empirical Literature Review

Knowing that quite a lot of studies, on farm household income, have been conducted, we are going to present a review of past studies related to our study.

A study by Sunildutt and Chole (2002) on adoption of sericultural practices by sericulturists have revealed that factors like education, income and social participation, extension contact, mass media use, cosmopliteness and risk orientation were found to have positive relationship with adoption while age showed negative relationship with it. The contribution of education and cosmopoliteness was also found to be significant.

Munikrishnappa et al. (2002) have reported that participation in extension programmes along with the frequent visits to neighboring places were found to have positive influence on adoption level of sericutural technologies by the farmers . This not only points out the importance of micro-planning concept while formulating the people oriented plans, but also underlines the urgent need of incorporating trainings as an important component for the overall development of sericulture industry and thus increased revenue generation by the farmers.

Anouk (2010) focusing on the impact of agro-export specialization on increasing income in flower-producing municipalities in the savanna of Bogotá region in Colombia found that trend towards export crop specialization lead to decrease or increase of farmers' income and increased household dependence on external supports, hence relative poverty.

Carletto et al. (2009) by use of panel data over the period 1985–2005, employed difference - in differences estimation to investigate the long-term impact of non-traditional agricultural export adoption on changes in household consumption status and asset position in the Central Highlands of Guatemala. In the result, an increase of the welfare level regardless of the the adoption of a new cash crop. It also showed some cases where even famers who didn't adopt the new cash crop experienced high increase than adopters. Contrariwise, after gaining the early benefit of adopting a new cash crop, those farmers who decide to withdraw was found to have performed well compared to others.

They concluded that the endurance of the positive welfare impacts of nontraditional agricultural exports production is a function of the sustainability of viable institutional arrangements that mitigate their marketing and production risks

Dewalt (1993) reviewed the results of studies examining the impacts of agricultural commercialization on food consumption and nutritional status and he concluded that cash crop adoption was mainly depending on the related pricing strategy and policy for such crops. He also concluded that an increase of income for cash crop farmers will have a positive effect on well-organized existing staple food production system. The last conclusion from his study was a positive change of income on the household level or personal level wasn't meaning availability of food for the household. The study also pointed out that income control was an important factors where women was doing better compared to men.

The author concludes that the impacts of commercialization on food security are mixed and highly dependent on the nature of the crop, the control of production and income, and the allocation of household labor, the maintenance of subsistence production, land tenure, and pricing policies for both cash crops and food stuffs.

In study conducted in 2007 with the aim of establishment how the effect from export of different horticulture product in Ghana, they found out that the majority of households were also exposed to the risk of inadequate technological know-how in meeting the ever increasing quality standards and health control traceability requirements by European consumers, price collapse on the export market and a breakdown of local marketing institutions.

Kuhlgatz and Abdulai (2011) assessed the determinants and welfare impacts of export crop cultivation in Ghana using generalized propensity scores to control for self-selection bias into treatment. The results showed a non-linear relationship, whereby household welfare was hardly affected at low levels of export revenue shares, but rose with increasing level of specialization.

Relative to households with low levels of export crop cultivation, fully specialized farms were found to substantially improve their standard of living. The results showed the uncertainty of the effect of the cash crop production on poverty alleviation or reduction where the chance/probability to drop under the line of poverty was almost the same as the shares in the export sector. It was between 0% to 40% and start increasing in between of 70% and 40%. Such findings show that producing cash crop is not the only nor the quickest way to increase farmer's general welfare

Sorre (2011) assessed the effect of sugarcane farming on farmers' income and nutritional status in Nambale Division Busia District, to determine agricultural and economic parameters that affect income and nutritional status in rural Kenya. The study found that there was a competition between cash and food crop cultivation and that there was little motivation for cash crop production, leading to household food insecurity and the residents of Nambale were suffering from malnutrition problems.

Using data from a random household survey in Kenya, Strasberg et al. (1999) examined the impact of the degree of household exportation on cash crop productivity. The authors found that the degree of agricultural commercialization was positively and significantly correlated with gross cash crop productivity per cash crop acre. However, the effect of particular food crops was found to be markedly different depending on the region, regardless of the household level effects of commercialization. For instance, French beans, sugarcane and tea were negatively correlated with food crop productivity, but coffee was positively correlated. District-crop interactions revealed even more variation, such as the negative impact of coffee in Meru and positive impact of sugarcane in Bungoma. Remarkably, all the crops demonstrated positive relationships in some districts while not in others highlighting the importance of regional differences.

According to Wladimir and Alexis 2013 in the publication “Sericulture on Thousand Hills: Reeling Rwanda out of Poverty” said that the Government of Rwanda has sought to harness sericulture as a potential new source of agricultural innovation that can increase the labor and play a key role in farmers income increase Farm size, occupation, and plot number are positively associated with adoption, as are years of education and membership in local farmers' organizations. Land productivity is negatively associated with sericulture adoption, suggesting that for mulberry cultivation farmers tend to commit land that was otherwise not so productive in traditional crops. In order to facilitate the sericulture adoption , farmers have to be informed about the benefit from sericulture.

In summary, the effect of cash cropping or export oriented farming correlated farm household income. In addition to the physical characteristics of the crop, and whether it is a cash crop or not, the policy conditions under which the crop is introduced is an important factor. The above studies have mostly focused on impact of cash cropping on income based on own cash crop production and productivity. However, the main problem of farm household income is lack of access rather than availability in the market place. Indeed, what the poor farmer malnourished need is an entitlement to that cash crop income can help to provide. Good marketing systems are likely to overcome low income that non-food cash crops can generate (Longhurst, 1988). The current study mainly focuses on the access dimension of income defined as the access by households to adequate resources (entitlements) for acquiring appropriate basic resources. It investigates among other socio- economic factors the impact of horticultural export production on income of smallholder horticultural farmers in the study area. This is because other economic and social factors play an important role though the relative importance varies significantly between places, over time and between different groups in society.

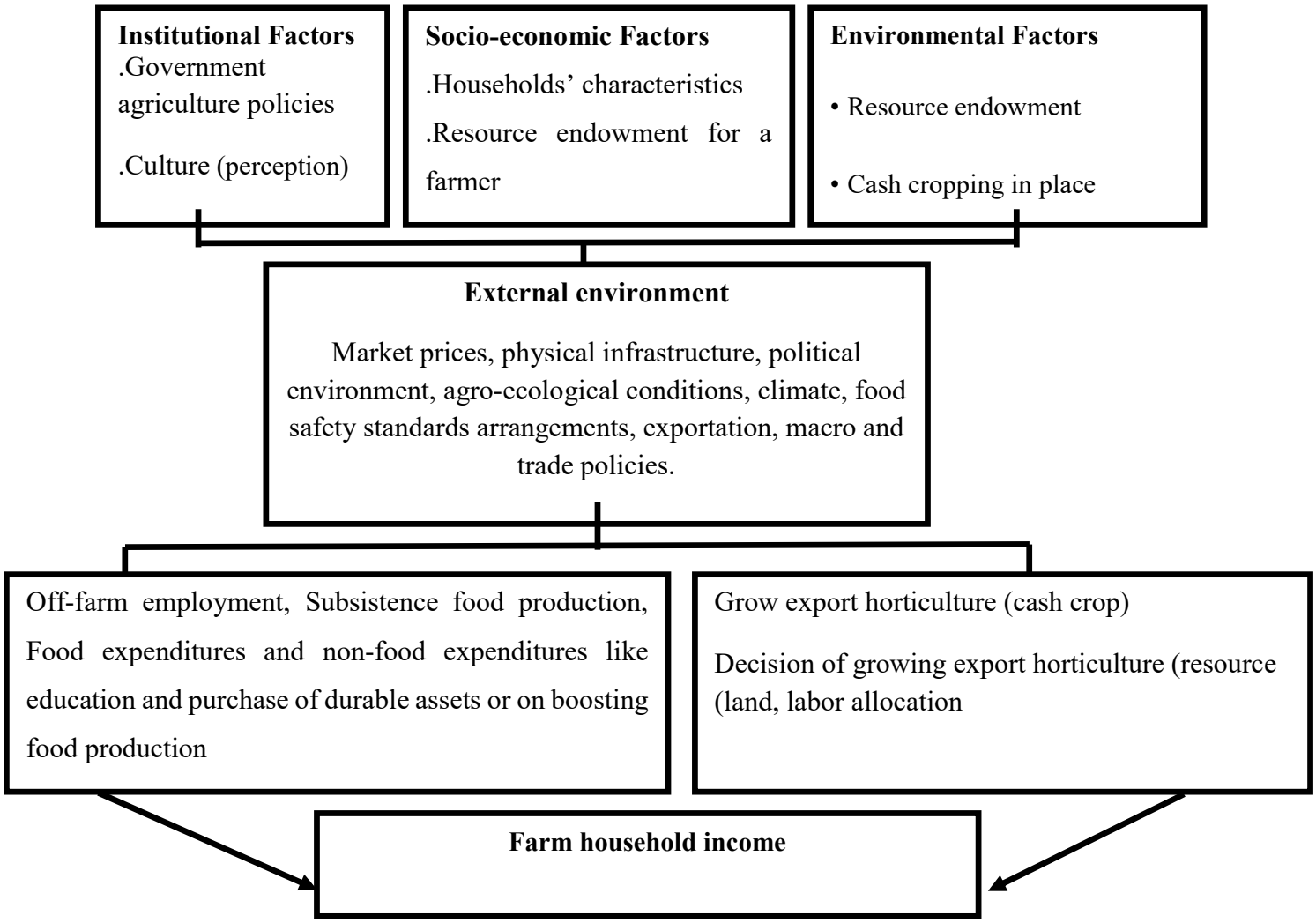
2.3 Conceptual Framework

The decision of farmer resource allocation toward export horticulture production, cash crop production, off-farm employment food cropping all of which affect farm household income. There is a necessity to monitor the transition from staple food production for local market and their household consumption to a large export oriented farming.

Income from export horticulture could either be utilized (according to the decision of the one in control of the income) on other things such as paying studies, buying properties or on enhancing food production or on food expenditures, ultimately affecting income of farmers.

The conceptual framework is combinations of the various findings in literature which have been grouped and arranged to a framework which was guide this research in an attempt to provide a solution to the research problem. The conceptual framework is illustrated in figure below:

Figure 1: conceptual framework



The ultimate effect of export horticulture on farmer's income given the complex interactions thus turn out to be an experimental issue since the likely connections and effects are not straight forward, and vary depending on the household social economic, prevailing production and marketing and policy conditions.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

In this Chapter we present 5 sections. Section one shows conceptual framework. In section two empirical models is presented. Section three and four present methods, procedures and data analysis tools respectively. Details of the study area are given in the section five.

3.1 Study Area

The study will be conducted in the western province of Rwanda. The western province is located to the western part of the country; bordering with the northern province together with the Democratic republic of Congo on its north side, and with the Eastern province together with Burundi and Democratic republic of Congo on the east side. The latest head office, established in 2006, is situated in Karongi District. The 2012 census showed that the population of the western province is 2,471,239 and occupy an area of 4,724Km2. The Western Province have seven districts which are: Ngororero, Nyabihu, Rutsiro, Rubavu, Nyamasheke Karongi, and Rusizi**.**

The main task of the Province is of: Coordinating activities in connection with economic planning of Districts; Following up implementation of national policies in districts which make up the country; closely monitoring activities related to the security of property and persons.

Agriculture Sector

Like other part of the country, the agriculture in Western province is dominated by subsistence farming and little dependence on production of some cash crop like tea, pyrethrum and coffee..

Coffee: covers up to now 12,695 ha and is distributed mainly if the following districts: Rusizi, Nyamasheke, Karongi, Rutsiro, and Rubavu.

Tea: planted on 9,771 ha, dominating on the high altitude land above 1900m and also seen on some marshland situate between 1550m and 1800m, which have been developed by the government. Tea planation are distributed in the following district of the western province: Karongi, Rutsiro, Rubavu ,Nyabihu, Ngororero

Pyrethrum: is planted on small area. It is mostly seen on the base of the volcanoes in the following district: Rubavu and Nyabihu Districts.

Horticulture: the weather condition of the western province making it a good are for growing horticulture crops. Two main fruits are dominant in the area: pineapples and passion fruits.

Sericulture: IN Karongi distric, sericuture is becoming a major boost in the agriculture. With a total of 112 farmers combined in two main cooperative Duteraninkunga and Abadatenguha and many other are being created with new famers. They have in total With 71,946 mulberry trees on 71 Ha and 79 silkworm house.

3.2 The Empirical Model

Farm household access to income is going to be taken as a dependent variable which is considered to be a dichotomous by nature. This means that we will first check if the concerned household have access or not to income. This means that only two values of 1 or 0 will be given to our dependent variable.

Based on the book of Green (1993) and the book of Maddala (2001), they showed that a linear probability model is given by ordinary least square as follows:

$P_t = \mathrm{x} + \beta_t X_t + U_t$ ………………………………………… (3.3)

Where yi is 1 or 0.

Where, P_t represent the probability that a household have or not access to income given X^t;

X_t is the explanatory variable to be estimated;

x and **ß** stand for parameters to be estimated.

µt stand for the *e*rror term

Since there is a presence of a dependent variable which is or not apparent (observable), the above situation comes to be a constraints. If we exclude the unobservable variable will lead to inadequacy utilization of the Ordinary Least Squares (OLS) which was our classical linear model. In this case, it is incorrect to use such model since it can lead into biased and unpredictable estimated parameters; the error term expected value cannot be necessary 0.

To remedy The problem that arise from the dichotomous choices of having access or not to income, it is recommended to use Maximum Likelihood Estimation (MLE) (Green, 2000 and Wooldridge, 2000).

The Maximum Likelihood Estimation results to a model with a variable:

$$\text{Pt} = \beta o + \sum_{f=1}^{k} \beta 1Xtf + \mu t \quad \text{……………………………………………… (3.4)}$$

It is a logit or probit models based on the distribution of error term (*ut)* in previous equation. Consequently, a logistic model was used; with a restrictive assumption confirming that the distribution of the error term have to be normally distributed, we can confirm that it is an extension of the probit model (Johnston and Dinardo, 1997).

In the analysis outcome of a dichotomous variable, it was pointed out, based on its extreme flexibility and ease of use from mathematical point of view and result in a well interpreted meaning, advantage is given to the logistic distribution (logit) (Hosmer and Lemeshew (1989). To specify the function of the cumulative logistic probability, we refer to Pindyck and Rubinfeld (1981) equation shown below:

$$\text{P}t = F(Zt) = F(a + \sum_{t=1}^{n} \beta tXt) = \frac{1}{1+\varepsilon^{-Z}} \text{…………………………….. (3.5)}$$

Where, P_t is the probability that an individual have access to income or not given X_t;

X_t is the explanatory variables (the i^{th}); and n is the total number of explanatory variables;

ε Represents the natural logarithms base, with a value of almost equal to 2.718;

a and ß are representing parameters which will be estimated.

Hosmer and Lemeshew (1989) pointed out that one to understand the interpretation of the coefficients, the logit model have to be written in terms of the odds and log of odds. To have an odds ratio, we will take the ration of the probability (P_t) that an individual would choose an alternative to the probability and (1-P_t) that the person would not choose it. But since P_t is non-linear and not only in X_i but also in α and βi which is a source of the difficulty to estimates our variables. Hosmer and Lemeshew (1989) concluded that in this case, the familiar use of OLS in abandoned for the parameter estimation. But,

$$(1-Pt)=\frac{1}{1+\varepsilon^{zt}} \quad \text{.....(3.6)}$$

Therefore, the odds ratio becomes,

$$(\frac{Pt}{1-Pt})=\frac{1+\varepsilon^{z}t}{1+\varepsilon^{-z_t}}=\varepsilon^{zt} \quad \text{..... (3.7)}$$

Or we use the ln of the previous equation (3.7) in order to get linearity, and as mentioned by Hosmer and Lemeshew (1989), it give the logit model as shown in the following equation (3.8).

$$Z_t=\ln(\frac{Pt}{1-Pt})=a+\beta 1X1+\beta 2X2+.....\beta xXx \quad \text{..... (3.8)}$$

From the above equation 3.8, we conclude that the logit will go from - ∞ to ∞. as P tend to go from o to 1. This result in the non-bounding of the logit, even though the probabilities lie between 0 and 1(Gujarati, 1995).

By introducing the disturbance term ($\mu_1 t$) into account, the equation (3.8) results in the econometric model shown below:

$$Z_t=a+\sum_{t=1}^{m}\beta tXt+ut \quad \text{..... (3.9)}$$

In This study we will use the econometric model obtained in the equation (3.9) and potential variables which affect rural farm household will be the one used to treat this model. The coefficient of the logit model presents the change in the log of the odds associated with a change in the explanatory variables (Edilegnaw, 2007).

3.3.1 Model Specification

3.3.1.1 The Dependent Variable

Rural farm household' access to income is our dependent variable for the logit analysis. Based on the question of either a household have accessed income or not, we will divide our sample. All of those who accessed on income and are rural farm household. Distinguishing between those who accessed on income and who, in the study area, not accessed on, a value of 1 is given for income and 0 for no access to income for our dependent variable. In order to analyse factors which affect rural farm household income, this study will use the regression model.

3.3.1.2 Independent Variables

GENDHH (Gender of Household Head): With this variable, it assumes a value of "1" if the head of the household is female and "0" otherwise since it is a dummy variable. This variable have been identified in different previous studies as a key factor which a play a significant role in the economic development of rural people in Africa (Dey, 1980). The view on the effect of gender on income is not agreed on. Some authors like Mayada et al (1994) claimed that women are not given right in the activity which generate income, but other authors like Zeller (1994) said that gender doesn't play a significant role in the activities which generate income.

Buvinic et al. (2009) argue that factors which are related to woman's privation of control over the economic resources and the type of their economic activity are two categories of major factors that restrict women's access to income generating activities compared to men.

Consequently, we will be expecting, in this study, that household headed by female have less chance to have access to income.

AGEHH (Age of Household Head): This variable is the age of the of the head of the household on interview date and is measured in years. This variable is a continuous variable. The age of the household head , In this study, is considered because he or she is the one who take important decision for the household. The age play a role in the type of decision to be taken. As an example, older people are likely to have more experience in the economic activity which need to be financed. Suppliers and clients tend to more likely trust old people (Zeller et al., 2001). Young people are more likely to lack of wealth and doesn't have enough mean tp adopt a new technology (Nguyen, 2003).

EDUCL (Education Level): This variables is measured by the number of years spend in school. This is an independent variable. In normal circumstances, education in both formal and informal way is a key asset for the human and is the main determinant of his or her efficiency (Gershon et al.,2008).

Njoku (1997) and Arene (1992) said that the ability of the farmer from different information and knowledge on export oriented agriculture will feet him in the change of the environment in numerous aspect such weather, climate, condition of the competition in the sector and positive income increase.

Musebe et al, (1993) stated in order to increase the chance of accessing income for a household increase at the same direction as the access to formal education for household members.

Marge (2003) give a good argument which is more general, he stated that the more household members have accees to education, they will face more less constain in adopting a new technology and in creating more income generating activities. Expectation this study is that the more education level is high will be the higher lever of income awareness. Therefore education is expected to have positive influence on increasing income of household through adoption of export oriented farming.

SIZEH (Size of Household): This is the number of people leaving under the same roof. The size of the household is mostly considered as the availabity of required labor for business activities in Rwanda (Zingiro 2007). IN her study she found that lahger family has more chance to have more income compared to smaller ones. However, we should note that the more is the family size the more need a household have in term of food consumption and other non food expenditure. Hence, in this study, we will be expecting the negative and positive sign for this variable.

OFF-FARMI (Off-farm Income): This variable stand for the income of the household from off farm activities. The off farm income is considered to have a positive effect as it allows household to adopt and improve cash crop farming (sericulture in our case) by giving a boost on their finance capability. We should note that the more off income the household can generate the more less borrowing the household can do since it has sufficient financing capacity. However, it was stated by Bhuiya et al (2001), Johnston and Morduch (2007), and Marge (2003), possibility of accessing to more funds was depending on the increase of the current income in the household. Hence, in this study, this variable is expected to be either negative or positive.

LANDSIZE (Land Size): This the total owned land by the household in hectares. The land has been identified as the key important formal credit guarantee for a household seeking borrowing to increase the finance capacity and that household with large size of land obtain more production (Binswanger et al. 1989). Consequently, in this study, the land size is expected to increase the access to income for household.

SAVG (Savings groups): In rural area, farmers both formal and informal saving group (IKIMINA). These saving group allow household to get more finance mean for an investment which a member cannot do at once without borrowing. Even if there a number of regulation in those saving groups, it is the easiest way for farmers to organize their saving without requiring to much knowledge to understand a saving scheme.

AGREXTSERV (Agricultural Extension Service): This variable stand for either a farmer have access or not to extension services. It will have a value of 1 oir 0 since it is a dummy variable. In this study, we divided this variable in two categories: household access to extension service of agriculture and the aspect of its investment need. Some studies steted that the more the household is informed on good agriculture practices good use of fertilizer, mechanized farming, and seeds selection is considered as a good borrower and a producer with high potential. A farmer which use modern technologies in its farming will tend to interest lenders than one which don't.

FAEXP(Farming experience): Farmers with longer farming experience are supposed to have better competence in assessing the characteristics and potential benefits of new technology than farmers with shorter farming experience. Moreover, farmers with longer farming experience were expected to be more knowledgeable and skillful. Therefore, this variable was expected to take a positive sign.

Below is the table showing The selected variables:

Table 2: variables in logit model

Name of Variables	**Variables Unit**	**Study Expected signs**
GENDHH(Gender of Household Head)	Male=1 Female=0	+/-
AGEHH(Age of Household Head)	Number	+/-
EDUCL(Education Level)	Number	+/-
SIZEH(Size of Household)	Number	+
OFF-FARM(Off-farm Income)	Rwandan francs	+/-
LANDSIZE(Land Size)	Ha/Acres	+

SAVG(Savings groups)	Dummy variable participation =1 Non-participation=0	-
AGREXTSERV(Agricultural Extension Service	Dummy variable participation =1 Non-participation=0	+
(FAEXP)Farming experience	Dummy variable experience =1 Non-experience=0	+

3.3.2 Econometric Models

It has been explained by Diagnostic Tests Green (1993) that it is very rare that the data which a researcher have conform to the theory underlying the model. Consequently, prior the estimation of the multiple linear regression equation is proceeded, the use economic theories, small scale farmer logic and econometric realization stress in modeling has been vital for rural farm household income factors analysis.

3.3.2.1 Discrete choice model

In order to assess the factors influencing the adoption of export oriented farming among rural farmers in Rwanda which is the first objective of the study, farmers will be asked if they had ever adopted export oriented farming. The response variable in this case is dichotomous (binary choice variable); includes a "yes" or "no" type (adopter or non-adopters) variable. Thus, the dependent variable in this case is binary; hereafter we can use Logit or Probit models which help in the estimation of parameters by the maximum likelihood. Normally, the distributed

error term is assumed by Probit and the logistic distribution of the error term is given by the logit model.

Baker (2000) argues that the reason Logit model is often preferred to Probit is because of the consistency of parameter estimation associated with the assumption that error term in the equation has a logistic distribution. Consequently, in order to estimate the probability of household adoption assigned to socio-economic characteristics, the Logit model was used. At that point the probability, *p*, that a household adopts sericulture farming is given by:

$P = e^{Z} / 1 + e^{Z}$ ....(3.10)

Where *z* represent latent variable is given a value of 1 if a farmer adopted sericulture and 0 if he didn't. The logit transformation of *P* given by *Z* given by the use of Central of logistic regression is shown below:

$Z = \ln P - 1/p$ .... (3.11)

Then;

$Z = Z(f, z, a) + \varepsilon$ .... (3.12)

This equation above explained that ***f*** stand for vector of farmer characteristics, ***z*** represent vector of farm level variables, ***a*** represent vector of asset endowment variables and **ε** represent stochastic term assumed to have a logistic distribution. The estimated empirical model contains the following variables (letters in parenthesis indicate related category variables from the conceptual model):

I. Farmer specific/unique variables (***f***) = age, household size gender, title deed

II. Farm specific/Unique variables (*z*) = distance to the agric. extension office distance to the input market, and farm size.

III. Asset endowment specific characteristics (***a***):

a. Physical asset (income, current value of physical assets, access to credit)

b. Human capital (education, experience)

c. Social capital (group member).

Hence, the below implicit functional form gives estimation of the probability of adoption:

P(X) = Adopt Sericulture farming (Gender of Household Head, age of Household Head, education Level, size of Household, off-farm Income, land Size, savings groups, agricultural Extension Service, farming experience) + e

3.2.2 Propensity score matching

The impact of export farming on rural household income is the second objective of this study and we will use propensity score matching. Similar to the adoption models, the whole sample from the survey data has to be used in computing the propensity score. Baker (2000) gives the five steps to be followed in applying propensity score matching:

First the propensity scores are estimated using a discrete choice model. This is accomplished using a Probit or Logit model with maximum likelihood method with the latter being preferred due to the consistency of parameter estimates associated with the assumption that error term in the equation has a logistic distribution.

After the quality test has been undertaken and based on the data variable at hand, we then use matching algorithm as a second step which is a technique commonly usedin the control subject selection to be matched to the treated group following the need of the analyst of controlling the covariates.

There are several matching methods that can be applied and they include the nearest neighbour matching (NNM) method, the kernel-based matching (KBM), radius matching (RM) and Mahalanobis matching (MM) methods.

Ali and Abdulai (2009) discuss these matching algorithms and the circumstances under which they should be used. Asymptotically, all matching algorithms should yield the same results.

However, in practice, there are tradeoffs in terms of bias and efficiency involved with each algorithm.

The current study used methods of kernel based matching, nearest neighbor matching and radius matching. These methods search mathematically or numerically the neighbor with a very close propensity score close to one of untreated individuals. Nearest neighbor matching method is the most conventional forward matching method which finds for each treated individual the observation in the untreated sample with the closest score. It use the absolute difference in scores to be measured.

Kernel based matching is a non parametric matching estimator that uses weighted average of nearly or all of individuals in the control group to construct the counterfactual outcome depending on the choice of the kernel function. Weights depend on the distance between each individual from the control group and the adopter observation for which the counterfactual is estimated. One major advantage of this approach is the lower variance which is achieved because more information is used (Caliendo and Kopeining, 2005). This weighted average is then compared with the outcome for the group of adopters. The difference between the two terms provides an estimate of the treatment effect for the treated case.

The third steps of Baker consist of identifying the common support condition or the overlap condition. In order to implement the common support condition, it is necessary to ensure that all characteristics combination from the treated group is also observed within the control group (Bryson *et al.*, 2002).

According to Caliendo and Kopeinig (2005) the most straight forward way of identifying the common support condition is, for both groups, the visual analysis of the propensity score density distribution

The fourth stage is to estimate the treatment effect based on the selected matching estimator on the common support region. Lastly, it undertakes the sensitivity analysis which will check if, the influence of variable which was not measured during selection process, is strong enough to

weaken or even undermine the matching procedure. In brief, it checks the strength of the identified conditional of independence (Owusu and Awudu, 2009). This step help to test how sensitive are the result taking into account assumptions identification. For example some unobserved variables affect the assignment into treatment and lead to hidden biased. If the results are very sensitive and that the analyst think that the assumption was confounded, alternative in the assumption identification is the used by the analyst or he decide to combine the propensity score matching with other evaluation approaches. In summary, the main objective of PSM is to give a sense of balance on the observed covariates distribution all over the treated and untreated groups (in our case adopter and non-adopter).

3.3.2.2 Test robustness & unmeasured bias

With the basic idea of verifying the matching quality by comparing before and after matching situation and verify any difference remaining after the propensity score is conditioned; It is necessary to verify that the relevant variables distribution is well checked and its balance verified by the matching procedures in the treatment and control group.

Additionally, Sianesi (2004) suggests comparing the pseudo-$R2$ before and after matching. The pseudo-$R2$ indicates how well the regressors, X, explain the adoption probability. After matching there should be no systematic differences in the distribution of covariates between both groups and therefore, the pseudo-$R2$ should be fairly low. Furthermore, one can also perform an F-test on the joint significance of all regressors. The test should not be rejected before, and should be rejected after matching. We calculate Rosenbaum bounds in order to test the sensitivity of the treatment effects taking into account the unobserved covariates.

Rosenbaum bounds take, between treatment and controls cases, the difference in their response variables. It give us the critical levels of gamma and it is reported in %. This is the level at which the causal inference of significant impact of treatment may be questioned. The level of gamma measures difference in the response variable between control and treatment cases. By

taking into account the lowest critical value of sensitivity analysis, we can confirm that the level at which unobserved heterogeneity can altered the inference on the estimated effects of treatment.

3.4 Methods and Procedures

3.4.1 Data need and Data sources

In this study, we prepared a well Structured questionnaire which helped to collect required quantitative primary data from the sample farm household headed either by female or male and those head of Household will be from the main two Sericulture cooperatives from Karongi District as key informants. Secondary data will be collected from agriculture cooperatives' reports, NAEB, NISR, Ministry of agriculture (MINAGRI), Ministry of economy, Trade and EAC affairs tec.

3.4.2 Sampling Procedure and Data Collection

A list of farmers, to be interviewed, was obtained with the help of local administration together with the management of the two cooperative. This procedure resulted in 112 farmers in which 56 have adopted sericulture and 56 were non-adopters. In our case 112 farmers were originally fully sericulture members but only 56 continuing fully commitment while the remaining are just waiting to see if the market side is stable in order to fully commit to sericulture again.

The data was collected through personal interviews using a pre-tested questionnaire. The data collected included farmer characteristics, household asset endowments, etc. The household survey was conducted during May of 2017.

3.5 Data Analysis Tools

Analysing the obtained Data, modern software were used. Those are STATA 13 program and SPSS 24 (Statistical program for Social Sciences). Descriptive and econometric models are all included in the analysis done.

3.6. Ethical Considerations

To ensure that ethics is practiced in this study as well as utmost confidentially for the respondents and the data provided by them, the following activities will be done: (1) coding of all questionnaires; (2) acknowledge the authors quoted in this study through citations and referencing; (3) present the findings in a generalized manner. Finally all the citations were acknowledged with the corresponding authors for avoiding any possibility of plagiarism.

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter focuses on the descriptive and the econometrics results of the study. The descriptive statistics are explained in the first subsection presents; the second subsection discusses the results of the logit model showing the factors conditioning the adoption of sericulture farming while last subsection discusses the impact of sericulture farming on household farm income.

4.1 Descriptive Statistics

4.1.1 Social economics characteristic of the respondents

Among the respondent during this study, we observed that 13% were less than 40 years, 33% were between aged between 40 and 45 years, 43.8% age d between 46 and 60 while only 9.8 % were more than 60 years old. The below table 2 represent the descriptive statistics of the age of the respondent.

According to Seasonal Agriculture Survey in 2014, the majority of Agricultural Operators in Rwanda was in the age group of 55 years and above (25.3%) followed by Agricultural Operators in age-group of 25-34 years (25.2%). This confirms our research findings.

Table3: Age of the respondent

Age of the Respondents					
			HH have adopted sericulture		Total
			Non-Adopters	Adopters	
Age of the Respondents	Less than 40	Count	11	4	15
		% within HH have adopted sericulture	19.60%	7.10%	13.40%
	40-45	Count	20	17	37
		% within HH have adopted sericulture	35.70%	30.40%	33.00%
	46-60	Count	21	28	49
		% within HH have adopted sericulture	37.50%	50.00%	43.80%
	More than 60	Count	4	7	11
		% within HH have adopted sericulture	7.10%	12.50%	9.80%
Total		Count	56	56	112
		% within HH have adopted sericulture	100.00%	100.00%	100.00%

From Table 3 below, which represents the descriptive of the gender among the respondent, we can observe that 55.40% were men and 44.6% were women. Among men, 57.1% were adopters while among women are 42.9%. From the Seasonal Agriculture Survey of 2014, the distribution of Agricultural Operators in Rwanda by gender was 70.3% male and 29.7% female. This confirms also the high percentage of male compare to female in our research.

Table 3: Gender of respondents

Gender of the respondents				
		HH have adopted sericulture		Total
		Non-Adopters	Adopters	
Gender of the respondents	Male	32	30	62
		57.10%	53.60%	55.40%
	Female	24	26	50
		42.90%	46.40%	44.60%
Total		56	56	112
		100.00%	100.00%	100.00%

The level of education has implications for the adoption of a new technology. In this study, 95% were literate. Among the adopters 92.90% were literate. Previous empirical studies showed that the level of education play an important role as an important factors conditioning adoption of a new agriculture farming. Below the table 4 presents the level of literacy among respondents.

Table 4: Education level

Educational level				
		HH have adopted sericulture		Total
		Non-Adopters	Adopters	
Educational level	Illiterate	1	4	5
		1.80%	7.10%	4.50%
	Literate	55	52	107
		98.20%	92.90%	95.50%
Total		56	56	112
		100.00%	100.00%	100.00%

Further in this study we will see that family size is among factors, which condition the adoption of the sericulture farming. From table 5, we can see that the majority of our respondents have a family with 4 to 7 members which represent 78% among which 43% are adopters of sericulture farming.

Table 5: Family size of respondents

Family size				
		HH have adopted sericulture		Total
		Non-Adopters	Adopters	
Family size	Less than 4	19	13	32
		33.90%	23.20%	28.60%
	Between 4-7	35	43	78
		62.50%	76.80%	69.60%
	More than 7	2	0	2
		3.60%	0.00%	1.80%
Total		56	56	112
		100.00%	100.00%	100.00%

Land size is among the controlled factors conditioning of adoption of sericulture farming in the study area. Table 6 represent the land size allocate to sericulture farming among respondents.

Table 6: Land allocated to sericulture

Land size allocated to sericulture (ha)				
		HH have adopted sericulture		Total
		Non-Adopters	Adopters	
Land size allocated to sericulture	Less than 1	6	6	12
		10.70%	10.70%	10.70%
	1-3	47	47	94
		83.90%	83.90%	83.90%
	More than 3	3	3	6
		5.40%	5.40%	5.40%
Total		56	56	112
		100.00%	100.00%	100.00%

From the above table, we can see that the majority of our respondent have between 1 to 3 ha for sericulture farming which is representing 83.9%.

Household income distribution among respondents is present table 7 below, where it show the off farm income and on farm income separately.

Table 7: Income distribution

On-Farm Income (Rwf)				
		HH have adopted sericulture		Total
		Non-Adopters	Adopters	
On-Farm Income (Rwf)	Less than 200000	9	8	17
		16.10%	14.30%	15.20%
	200000-400000	34	35	69
		60.70%	62.50%	61.60%
	More than 400000	13	13	26
		23.20%	23.20%	23.20%
Total		56	56	112
		100.00%	100.00%	100.00%
Off farm income				
		HH have adopted sericulture		Total
		Non-Adopters	Adopters	
Off farm income	Less than 130000	3	2	5
		5.40%	3.60%	4.50%
	130000-170000	9	14	23
		16.10%	25.00%	20.50%
	170001-230000	22	13	35
		39.30%	23.20%	31.20%
	230001-270000	9	13	22
		16.10%	23.20%	19.60%
	More than 270000	13	14	27
		23.20%	25.00%	24.10%
Total		56	56	112
		100.00%	100.00%	100.00%

As for 0n-farm income, the majority of our respondents have between 200,000FRw to 400,000Frw which represent 61.6% while for off-farm income the majority have between 170,000Frw to 230,000 Frw representing 31.20%.

Table 8 below represent the access to extension service and being part a saving group. It show that among respondent 79.5% are a member of a saving group (Ibimina) from which 85% are adopters of sericulture farming. 87.5% of our respondent confirmed that they have been receiving and participating in extension service.

Table 8: Saving group membership and Access to extension services

Being a member of a saving group

		HH have adopted sericulture		Total
		Non-Adopters	Adopters	
Being a member of a saving group	No	15 26.80%	8 14.30%	23 20.50%
	Yes	41 73.20%	48 85.70%	89 79.50%
Total		56 100.00%	56 100.00%	112 100.00%

Receiving extension services for Sericulture Production

		HH have adopted sericulture		Total
		Non-Adopters	Adopters	
Receiving extension services for Sericulture Production	Yes	45 80.40%	53 94.60%	98 87.50%
	No	11 19.60%	3 5.40%	14 12.50%
Total		56 100.00%	56 100.00%	112 100.00%

4.2 Factors influencing farmer's adoption of sericulture farming

Table 9 present the predicted probabilities which give us the total percentage of the predict probabilities from the estimated logit model. The overall predicted percentage of the cases which are correctly predicted is 76.8%.

29% observed to be non-adopters were correctly predicted to as non adopters while 18% observed to be non adopters were wrongly predicted as adopters.

8% observed to be as adopters were wrongly predicted as non-adopters while 57% observed as adopters were correctly predicted as adopters.

Table 9 Predicted probabilities

Predicted Probabilities				
Observed		Predicted		
		HH have adopted sericulture		Percentage Correct
		Non-Adopters	Adopters	
HH have adopted sericulture	Non-Adopters	29	18	61.7
	Adopters	8	57	87.7
Overall Percentage				76.8

The following table (Table 10) presents the results of logit regression model estimated to examine the factors influencing adoption of sericulture farming.

The following variables were found not to be statistically significant to influence the probability of adoption of the sericulture farming. Those variables are Gender, age (between 40 to 45 years), family size (more than 4), Farming experience (Less than 3 years), Land size, On farm income (less than 200,000Frw), saving group and off farm income. Their Significance level is greater than 0.05, which means that they don't influence the adoption of the sericulture farming.

As expected, gender is no longer a factor in adoption in agriculture for cash crop. Despite the fact that women were likely to dominate in agriculture activities, men also dominate in most economics side of agriculture.

Farmers with no longer experience in farming are not likely to adopt new crop or agriculture technology. As expected, farming experience of less than 3 years cannot be significant to influence the adoption of sericulture.

Land size is not significant to influence the level of adoption of sericulture farming. In Rwanda, the agriculture is dominated by subsistence farming where farmers will split their land into different plots with different crop.

The family size (more than 4) can't influence the adoption as seen in the logit regression result. This might be due to the necessity for subsistence farmers to keep productive land in use for food stuff production when they have large families rather than switch to mulberry cultivation and risk food shortage in the short run.

Seven explanatory variables were found to be statistically significant to influence or to condition the adoption of sericulture farming. Those variables are:

Age (less than 40)

Age ((46-60)

Education level

Family size (les than 4)

Farming experience (3 to 7 years)

Extension service

On farm income (200,000-400,000)

From this study, the result show that a farmer with less the 40 years and a farmer between 46 and 60 years are likely to influence negatively the probability of adopting sericulture farming. Younger people doesn't like to take risk by adopting new crop farming, while the more old people will tend to be more conservative on new crop farming or new agriculture technology.

As expected, the education level (literate) is statistically significant to influence the probability of adopting sericulture farming and is positively related to the adoption of sericulture farming.

As explained above, in relation with family size, the family size of less than 4 members are likely to positively adopt the sericulture farming. In this study, family size with less than 4 members is positively conditioning the adoption of sericulture farming. Contrary on big family size (more than 4 members), are likely to adopt sericulture by replacing one or more food crop without fear of food shortage in the short term.

In this study, we found that the Farming experience of 3 to 7 years is statistically significant and positively related to influence the adoption of sericulture farming.

Same as education level, participating or having access to extension services is statistically significant to positively influence the level of adoption of sericulture farming.

Adoption is sometimes hampered by lack of awareness of the end users of the technologies. Education and contact with extension agent may be proxies for access to information.

Those variables in this study are significant in explaining the variation in the adoption decision.

Agricultural extension is the system of learning and building human capital of farmers through the provision of information and demonstrations, exposing farmers to technologies which can increase agricultural productivity and, in turn, income and welfare. Farmers who are frequently visited by extension agents tend to be more progressive and more likely to adopt mulberry cultivation as a new source of income.

On annual farm income (200,000-400,000) considered as average in this study was found to be statistically significant to influence the adoption of sericulture farming. As expected, income plays a big role in adoption of agriculture. Farmer with less income will not be likely to adopt

new crop while farmers with high income will tend to invest in other sector than agriculture.

Table 10: Estimation of the binary logistic regression model

Estimation of the binary logistic regression model							
Explanatory variables		Coefficient	Standard Error	Wald	df	Sig.	Exp(Coefficient)
	Gender (1)	0.099	0.479	0.043	1	0.836	1.104
	Age						
	Age (1)	-1.329**	1.132	1.379	1	0.04	0.265
	Age (2)	-0.838	1.018	0.677	1	0.411	0.433
	Age (3)	-0.347**	0.997	0.121	1	0.028	0.707
	Education Level (1)	20.77**	17111.587	0	1	0.039	1.05E+09
	Family Size						
	Family Size (1)	21.005**	28391.455	0	1	0.039	1.33E+09
	Family Size (2)	21.374	28391.455	0	1	0.999	1.92E+09
	Farming Experience						
	Farming Experience(1)	0.823***	0.641	1.646	1	0.199	2.277
	Farming Experience(2)	1.149**	0.58	3.921	1	0.048	3.155
	Land Size						
	Land Size(1)	0.062	1.131	0.003	1	0.956	1.064
	Land Size(2)	0.233	1.064	0.048	1	0.827	1.262
	Extension Service(1)	0.676**	0.773	0.764	1	0.042	1.966
	On Farm						
	On Farm(1)	0.278**	0.792	0.123	1	0.056	1.32
	On Farm(2)	-0.186**	0.589	0.1	1	0.032	0.83
	Saving group(1)	-0.154***	0.564	0.075	1	0.064	0.857
	Off FARM INCOME						

	Off FARM INCOME(1)	-0.141	1.15	0.015	1	0.903	0.869
	Off FARM INCOME(2)	0.257	0.724	0.126	1	0.723	1.293
	Off FARM INCOME(3)	-0.551	0.605	0.831	1	0.362	0.576
	Off FARM INCOME(4)	0.287	0.691	0.172	1	0.678	1.332
	Constant	-21.714	28391.455	0	1	0.009	0

*significant at 10% **significant at 5% and *** significant at 1%;

2Log Likelihood= 126.906

Cox&Snell R^2= 0.203

Nagelkerke R^2= 0.273

The predictors in the logistic model together account for 20.3 percent the explanation for why a farmer adopts or not the sericulture farming.

4.3 Impact of sericulture farming on Household income

Among the selected factors, only three factors are statistically significant influencing the impact on farm income of the sericulture farmers. Those factors are: Age, Quantity of silk sold and transport cost.

From the R square equal to 0.76, we conclude that the above variables impact on the income at the level of 76%. A farmer with a sericulture farm will earn in average an income of 359,334Frw if all other variables are retained constant.

Table 11: Determinant of Household Income

Determinant of Household Income						
Explanatory variables		Coefficient	Std. Error	Standardized Coefficients Beta	t calculated	Sig.
1	(Constant)	359334.49	125104.737		2.872	0.005
	Age	1494.435***	1291.015	0.112	1.158	0.007
	Land size allocated to sericulture	-5179.489	8026.935	-0.07	-0.645	0.52
	Quantity of silk sold in 2016	529.674***	200.071	0.264	2.647	0.009
	Receiving extension services for Sericulture Production	-37243.571	32790.623	-0.11	-1.136	0.259
	Cost of packaging	-23045.729	20110.832	-0.117	-1.146	0.254
	Cost of trnasport	-2.679**	6.91	-0.043	-0.388	0.049

*significant at 10% **significant at 5% and *** significant at 1%

R square: 0.76

Adjusted R square: 0.56

CHAPTER 5:

CONCLUSION AND SUGGESTION

5.1. Conclusion

The adoption of an agricultural technology or new farming methods, such as the case of sericulture in Rwanda, may change the output levels from land use or reduce input for a desired level of income. This study evaluates the factors of adoption of sericulture farming and its impact on rural household in Karongi district.

The introduction of sericulture in Rwanda has mainly relied on supporting initial diffusion through farmer's cooperatives. This means that adopting farmers are in general more likely to be member of cooperatives and display other socio-economic characteristics that are different from those of non-adopters.

We used cross section data collected from 112 household level in May 2017 using a pre tested questionnaire.

A binary Logit regression model was used to assess the factors influencing adoption of sericulture farming with a value 1 for adopters and 0 for non-adopters.

The study finds out that the factors influencing or conditioning the adoption of sericulture farming are:

- Age (less than 40)

- Age ((46-60)

- Education level

- Family size (les than 4)

- Farming experience (3 to 7 years)

- Extension service

- On farm income (200,000-400,000)

The null hypothesis that the Identified factors do not affect the adoption of sericulture farming in the study area was rejected.

This study also found that sericulture farming has an impact on household income.

These results confirm the existing empirical evidence on agriculture technology adoption showing that the adoption of new crop varieties, which is usually conditional on its portability with respect to traditional crops, contributes to enhancing household income and reducing poverty among adopting farmers. Because of the additional beneficial effects of sericulture farming on soil protection and water conservation, the social benefits of sericulture are even much larger than individual income enhancement.

From some recent studies which show that like many agricultural technologies, the adoption of sericulture is conditioned by much technological knowledge and an high level of human skills as shown by Kiyokawa (1984). Despite the identified income benefits of the adoption, however, the implementation process of the sericulture project does not seem to have been adequate to meet the skills requirement for mastering this new technology to the level of embedding it in the local economy. In addition to human skills requirements and market factors, appropriates infrastructure as well as an adequate incentive system to facilitate the technology absorption are necessary in the planning of a successful technology acquisition. Alignment of technology adoption with long-term development objectives, rather than short term probability, may provide a way to overcome many of the constraints imposed by these hurdles

5.2 Recommendation

My suggestion start with a question asking why sericulture, which has the potential to reduce poverty and improve land use on steep hill slopes, is so slow to be expanded and adopted in Rwanda despite the supporting role that the government has undertaken.

Even though Rwanda has adequate and favorable natural and social condition for sericulture production, there are several constraints to overcome which hump the adoption and sericulture farming in Rwanda. Below are some suggestion to government institutions and other development agencies:

- It necessary to establish a production system of silk worm eggs suitable for our tropical Rwanda condition

- Improved technology in cocoon and raw silk production should be introduced to extension officers and sericulture farmers

- Establishment of a silk processing company is very urgent in order to guarantee the marketing of cocoons produced by sericulture cooperative and individuals

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APPENDIX 1: Collineartity Diagnostics for Adoption

Collinearity Diagnostics for Adoption							
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
Coefficinet	B	Std. Error	Beta			Tolerance	VIF
(Constant)	1.1	0.544		2.022	0.046		
Gender of the respondents	-0.05	0.099	-0.051	-0.508	0.613	0.874	1.145
Age of the Respondents	0.103	0.059	0.177	1.745	0.084	0.84	1.19
Educational level	-0.31	0.232	-0.13	-1.333	0.186	0.915	1.093
Family size	0.066	0.097	0.064	0.673	0.502	0.957	1.045
Farmer's Experience	-0.051	0.065	-0.078	-0.778	0.439	0.868	1.152
Land size allocated to sericulture	-0.003	0.117	-0.003	-0.029	0.977	0.982	1.019
On-Farm Income (Rwf)	-0.016	0.079	-0.02	-0.206	0.837	0.897	1.115
Being a member of a saving group	0.015	0.121	0.012	0.126	0.9	0.885	1.13
Off farm income	-0.021	0.04	-0.05	-0.52	0.604	0.941	1.063
Recieving extentsion services for Sericulture Production	-0.285	0.147	-0.191	-1.942	0.055	0.892	1.121