

**ECONOMIC ANALYSIS OF STEVIA (*stevia rebaudiana*) ADOPTION BY SMALL
SCALE FARMERS IN KERICHO DISTRICT, KENYA**



PATRICK KIBET RONO

**A Thesis submitted to the Graduate School in Partial Fulfilment for the Requirements of
the award of the Degree of Master of Science in Agricultural and Applied Economics of**

Egerton University.

EULIB



048 017

SEPTEMBER, 2013

DECLARATION AND APPROVAL

Declaration

I declare that this work is wholly my original work and to the best of my knowledge has not been presented for the award of any degree at any other university.

Patrick Kibet Rono

KM17/2748/10

Sign: -----

Date: 18/09/2013

Supervisor Approval

I declare that this work has been submitted to Graduate School for examination under our approval as university supervisors.

1. Dr. Benjamin K. Mutai (PhD)p

Department of Agricultural Economics and Agribusiness Management,

Egerton University,

Sign: -----

Date: 17/9/2013

2. Dr. Lawrence Kibet (PhD)

Department of Economics,

Egerton University,

Sign: -----

Date: 19/09/13

COPYRIGHT

No whole or part of this thesis may be reproduced, transmitted or stored in any form or means such as electronic, mechanical or photocopying including recording or any information storage and retrieval systems without prior written permission of the author or Egerton University on behalf of the author.

© 2013

Patrick Kibet Rono

All rights reserved

ACKNOWLEDGMENT

I wish to acknowledge the entire staff of the Department of Agricultural economics and Business management, Egerton University under leadership of Dr B.K Mutai for their sincere and honest support since I enrolled for my studies. Special thanks go to my University supervisors Dr B.K Mutai and Dr Lawrence Kibet for their tireless and invaluable effort in guiding and supporting me during the entire study and research period.

I would like to extend my sincere gratitude to CMAAE program for the research grants and opportunity to undergo specialized and rigorous training in University of Pretoria South Africa. Special thanks also go to Benard Rono supervisor PureCircle Kenya for support and guidance during data collection.

Appreciation also goes to my fellow colleagues for sharing with me useful ideas during entire period of Study and research. I also wish to thank enumerators who participated during data collection process.

Above all honour and thanks go to GOD for his mercy, care, strength and guidance during the entire period of study.

DEDICATION

I dedicate this work to my parents, brothers and sisters for their support.

ABSTRACT

Kenya's agriculture sector has continued to be dominated by traditional export crops like tea, coffee and horticulture. Despite significance of these crops as a source of income and foreign exchange poverty among farmers in Kericho District has been increasing. In order to reduce poverty, the agricultural sector must be revitalized and one of the possible solutions is the introduction of new enterprises like Stevia farming. However, adoption of Stevia has been achieved with partial success in Kericho District. This study determined factors that influence adoption of Stevia and the extent of adoption. This study further determined the profitability of Stevia compared to other farm enterprises in Kericho District. Multi stage sampling method was used. A semi-structured and pre-tested questionnaire was used to collect data from farmers both adopters and non adopters of Stevia through face to face interviews where purposive sampling was employed respectively and 150 respondents were contacted in total. The study used descriptive statistics to characterize Stevia adopters and non- adopters. Heckman two-step model was used to determine factors affecting adoption of Stevia and extent of adoption and Gross margins analysis was used to compare profitability of Stevia and other farm enterprises among small-scale farmers in Kericho District. The results showed that group membership, gender, education extension services and individual land ownership significantly and positively affected the adoption of Stevia while age was significant with negative effect. Household size, farm size, revenue from Stevia and access to extension services significantly and positively influenced the extent of adoption. Further, this study revealed that Stevia production was the more profitable farm enterprise. The study therefore, recommends improved training through extension services so as to encourage farmers to adopt improved crop varieties through demonstrations on farmers' fields, field days, farm visits and agricultural shows and also development of institutional strategies to support farmers, formation of groups, and strategies that could improve socio economic conditions of small scale farmers. Through this adoption of Stevia will be improved increasing income and thus reducing poverty level among farmers.

TABLE OF CONTENTS

DECLARATION AND APPROVAL	ii
COPYRIGHT	iii
ACKNOWLEDGMENT	iv
DEDICATION	v
ABSTRACT	vi
TABLE OF CONTENTS	vii
LIST OF TABLES	ix
LIST OF FIGURES	x
LIST OF ACRONYMS AND ABBREVIATIONS	xi
CHAPTER ONE	1
INTRODUCTION	1
1.1 Background information to the study	1
1.2 Statement of the problem	4
1.3 Objective of the study	4
1.4 Research questions	5
1.5 Justification	5
1.6 Scope and limitation of the study	5
1.7 Definition of terms	6
CHAPTER TWO	7
LITERATURE REVIEW	7
2.1 Factors affecting adoption of new agricultural technologies	7
2.2 Determining of farm profitability	13
2.3 Theoretical framework	15
2.4 Conceptual framework	16
CHAPTER THREE	18
METHODOLOGY	18
3.1 Study area	18
3.2 Type and Nature of Data	19
3.3 Sampling Procedure	19
3.4 Data collection method	20

3.5 Data processing and analysis20

3.6 Data Analysis Methods20

CHAPTER FOUR25

RESULTS AND DISCUSSION25

4.1 Descriptive analysis25

4.2 Econometrics results30

4.3 Comparative profitability of Stevia production35

CHAPTER FIVE37

CONCLUSION AND RECOMMENDATION37

5.1 Conclusion.....37

5.2 Recommendation.....38

5.3 Further research:.....39

REFERENCES40

APPENDIX 1: QUESTIONNAIRE47

LIST OF TABLES

Table 1: Description of variables to be used in Heckman two-step procedure	24
Table 2: Categorical household socioeconomic and institutional characteristics of household heads in Kericho District	25
Table 3: Summary of continuous socio-economic characteristics of adopter and non-adopters in Kericho District	27
Table 4: Source of information on new technology	29
Table 5: Selection equation results	31
Table 6: Outcome equation results	34
Table 7: Average Gross Margin for each farm enterprise	36

LIST OF FIGURES

Figure 1: Conceptual frame work17

Figure 2: Map of Kericho District19

LIST OF ACRONYMS AND ABBREVIATIONS.

AERC	African Economic Research Consortium
BE	Break Even Point
CBA	Cost benefit Analysis
CIMMYT	International Maize and Wheat Improvement Center
FAO	Food and Agriculture Organisation
FDA	Food and Drug Administration
GDP	Gross Domestic Product
GMA	Gross Margin Analysis
GOK	Government of Kenya
IIBRC	Interim Independent Boundaries Review Commission
IMR	Inverse Mills Ratio
IMV	Improved Maize Varieties
KSB	Kenya Sugar Board
Kshs	Kenya shillings
LP	Linear programming
NECOFA	Network for Ecofarming in Africa
PCK	PureCycle Kenya
SOP	Standard Operating Procedure
SPSS	Statistical Packages for Social Sciences
USA	United States of America
WOCCU	World Council of Credit Unions

CHAPTER ONE

INTRODUCTION

1.1 Background information to the study

Agricultural sector has continued to be the backbone of Kenyan economy contributing directly 24% of Gross Domestic Product (GDP), over 60% of exports, 75% of the total labor force and over 80% of industrial raw materials (Owuor, 2009). Therefore, strengthening of the agricultural sector is a prerequisite for maintaining economic recovery and growth. The Kenya Vision 2030 and the Strategy for Revitalization of Agriculture have underscored the fact that productivity of farmers can be improved through use of modern technologies (GOK, 2007). Development in agriculture has a powerful impact on poverty because it helps poor compared to development of other sectors. Research into new varieties of crops such as early maturing and high yielding seeds has been prompted by need to reduce poverty through agricultural activities (UNCRD, 2003). According to Ministry of finance and planning (2001) diversification into cash crops and encouraging of growing of high value crops are also among strategies to reduce poverty. It's due to the need to create wealth and reduce poverty that Stevia was introduced in Kericho District.

Sugar provides 7 % of world calories supply and is a commodity of great value to most countries. In Kenya the sector contributed 15% to agricultural GDP and 2.75% of GDP and serve as a source of employment whereby through direct employment it employed over 300,000 people thus checking rural urban migration (Kenya Sugar Board bulletin 2002). In Kenya sugar annual production is 400,000-500,000 tones which doesn't meet country's annual demand and consequently sugar is imported. The agricultural sector has experienced decline with regard to exports, food security and house hold income (GOK, 2003) sugar industry was not spared either (KSB, 2001). Decline in agricultural productivity in Kenya has been due to poor access to farm credit high cost of farm inputs and absence of appropriate technology (GOK, 2003). Specifically sugar industry has been faced with problem of old and inefficient production technology and long maturity sugar variety (Kaumbutho *et al.*, 1996). The introduction of Stevia in Kericho District can save on importation of sugar, poverty alleviation through job creation by serving as cash crop as well as early maturity complementary crop for sugar production and hence ensure regular flow of income to farmers.

Stevia is a perennial shrub indigenous to Brazil and Paraguay where it has been used as a natural sweetener for hundreds of years. The word "Stevia" refers to the entire plant and its components, only some of which are sweet. The sweet tasting components of the Stevia plant are called steviol glycosides. Steviol glycosides can be isolated and purified from the leaves of the Stevia plant and are now added to some foods, beverages and tabletop sweeteners in the U.S. and elsewhere (Carakostas *et al*, 2008). In recent years, Stevia has been grown commercially and used as natural sweetener in many countries including Brazil, Paraguay, Japan, China, Korea, United States, Canada and parts of Europe (Atteh *et al*, 2007). The sweetener of Stevia is widely used in the world. It comprises between 150-200 species (Gentry, 1996). When Stevia is fully matured, it can reach 80 cm in height (Goyal *et al.*, 2010). Stevia is also known as "sweet leaf" or "sugar leaf," (Carakostas, 2008). Stevia's leaves have a natural sweetness between 30 to 45 times that of regular sugar while its extracts having up to 400 times the sweetness of white sugar (Elkins, 1997).

Stevia was discovered by an Italian botanist, M.S. Bertoni who found the plant growing wild in 1888 and in 1905, described and named it "Stevia rebaudiana" in honour of a local Paraguayan chemist (Rebaudi) who did some of the original work on identifying the chemicals responsible for the plant's novel sweetening properties. The leaves of the shrub contain specific glycosides, which produce a sweet taste but have no caloric value. It is of immense value due to its adaptability to wide climatic range, the high-sweet content, and its significant contribution to the welfare of human life (Elkins, 1997). For centuries, this herbal sweetener has been used by native Guarani Indians to counteract the bitter taste of various plant based medicines and beverages (Ramesh *et al.*, 2006). The use of Stevia as a sweetener can be found in many parts of Central and South America, where this species is indigenous (Melis, 1992), as well as in Japan (Kinghorn *et al.*, 1984). Until recently, Stevia products could only be marketed in the U.S. as dietary supplements. However, a new Food and Drug Administration (FDA) ruling has cleared the way for Stevia's expanded use and increased the market potential of this crop (Whitaker, 2010). Stevia is commonly found on the edges of marshland on acid infertile sand or muck soils of Paraguay. In Canada, Stevia is being sold as an ingredient in tea but not as a sweetener. The leaves are used for sweetening, as is, or dried and pulverized, or soaked in water; the liquor is used for sweetening beverages (Borie, 2000). Jan (2002) concluded that Stevia and stevioside are safe when used as a sweetener. During 1971, Japanese introduced Stevia from Brazil and

conducted research to evaluate potential of Stevia (Crammer *et al.*, 1986). Today, Japan is a major grower and marketer for the sweetener and has approved it for use in many food products, including cereals, teas, and soft drink (Soejarto *et al.* 1982).

While white sugar, turbinado, fructose, honey and corn syrup all qualify as natural sweeteners, none of these are calorie- free nor can they be used by people who suffer from blood sugar disorders. Stevia has been used in several areas of the world, such as in Brazil and Paraguay, as a natural control for diabetes (Jeppesen *et al.* 2000). Stevia also has been used to help control weight in obese persons (Suttajit *et al.* 1993). Some of the reasons for increasing interest in Stevia may be the decreasing popularity of these artificial sweeteners and the increased consumer interest in natural organic products (Mitchell, 2003). In China Stevia has been considered a major crop where there is production of more than 2,000 tons per year, but there has been a reduction due to lower demand and price from Japan. Paraguay which is the world's second largest producer currently has around 750 ha dedicated to Stevia and produced more than 500 tons per year. In 2003 Brazil produced 265 tons of Stevia (Midmore *et al.*, 2002).

The first cutting of the green Stevia leaves is done after four months of the plantation and later on there will be regular cutting after every 3-4 Months as per climatic condition. The crop grows at least three times a year. The crop is planted for five years. After the fifth year the marginal return start to decline so it is best to uproot crop and replant it. Network for ecofarming in Africa (NECOFA) encourages farmers to use at least $\frac{1}{4}$ of an acre if they are to reap the benefit. Half an acre of land requires 15,000 plants with spacing of 25x40 cm in a raised bed system that can produce 500kg of Stevia leaves. Commercial Stevia cultivation areas in Kenya are relatively minor. Stevia was introduced into Kenya in 2008 and interest in its production in has grown in recent years where currently James Finlay Kenya limited and PureCircle are contracting small-scale farmers. This is mainly due to the fact that today more and more farmers are looking for a new alternative ways to improve their incomes that is threatened by various production problems. Apart from being grown in Kericho Stevia has also been introduced in Bureti, Kipkelion, Molo and Bomet where 2200 farmers have been contracted to grow the cash crop where more than 1500 have been trained .Kenya's Stevia exports earnings have reached Sh500million (Pure circle, 2010). To improve adoption of Stevia in Kericho District in order to increase the low farm incomes, Ndege Chai Savings and Credit Cooperative (SACCO) and PureCircle Kenya (PCK) have initiated programmes that offer extension services on production

and marketing of Stevia. The program operates in Rift Valley. Kericho District has approximately 176033 farmers (KDSP, 2005) and according to pure circle Kenya limited only about 2200 has managed to adopt Stevia.

1.2 Statement of the problem

The increasing cost of production, price fluctuations of tea and grains crops and land subdivision among other factors have negatively affected farm incomes for majority of farmers in Kericho District. The result is that, majority of these farmers who depend on tea as the main sources of incomes are unable to meet their basic household demands. To mitigate against the increasing inability of tea and grain growing to support livelihoods in Kericho District, Stevia crop has been introduced as an alternative cash crop. Despite the project support from WOCCU, Ndege Chai Savings and Credit Cooperative (SACCO) and PureCircle Kenya (PCK) in terms of extension services, production and marketing it is not yet clear firstly, why Stevia production in the District is not widespread and therefore there is need to analyse specific factors affecting Stevia adoption and the extent given the potential benefits and secondly its contribution to household income. Though Stevia adoption holds an important position for economic development and food security in the District, systematic studies have not been conducted to assess both socioeconomic and institutional factors affecting Stevia adoption and extent of adoption among small scale farmers hence this study intends to fill this knowledge gap.

1.3 Objective of the study

The general objective of this study was to examine economics of Stevia adoption and factors influencing Stevia adoption by small-scale farmers in Kericho District. The specific objectives of the study are as follows.

- (i) To determine the socio-economic characteristics of both adopters and non-adopters of Stevia in Kericho District.
- (ii) To determine factors that influences Stevia adoption and the extent of adoption in Kericho District.
- (iii) To compare profitability of Stevia production to other competing farm enterprises.

1.4 Research questions.

- i) What are the distinguishing socio-economic characteristics of adopters and non adopters of Stevia?
- ii) What are the socio-economic and institutional factors that influence adoption of Stevia and extent of adoption in Kericho District?
- iii) Is Stevia production more profitable farm enterprise compared to other farm enterprises?

1.5 Justification.

Poverty among the poor rural farmers has been increasing due to low farm incomes. To mitigate problems arising out of poverty, there is need to promote adoption of high yielding and high value cash crops such as Stevia. This study targets to generate imperative information that will elucidate the importance of adoption of cash crops at farm level. Information generated by this study will guide policy making process in line with the achievement of vision 2030 and meet Millennium Development Goals (MDGs) of eradication of extreme poverty through increased of income. Identifying the factors that may improve Stevia adoption is of major significance since by using information derived from such a study it will improve Stevia adoption which will enable small scale farmers earn more money from it than from other cash crops. Understanding the incentive and constraints facing the farmers will help stakeholders such as PCK to establish effective and efficient policies, projects and programmes. This will facilitate the adoption of Stevia and other new agricultural technologies thus increasing productivity growth in agriculture which in turn will inject purchasing power into rural areas and hence stimulating demand and employment growth in the broader economy. Furthermore, there is no other study which i am aware of that has been done on adoption of Stevia in the study area.

1.6 Scope and limitation of the study

The study was confined to Kericho District in Kericho County where PCK program was found with the sample drawn from those farmers who have adopted Stevia and the control was those who have not. There are other aspects like technical efficiency and marketing which were beyond the scope of this study.

1.7 Definition of terms

Adoption- Process in which farmers make decision to acquire and use new agricultural technology.

Poverty - Situation where farmers live below a dollar per day and inability to meet daily basic needs (definition by United Nations (UN)).

Small scale farmer- This study will consider small scale farmers as those with a total land holding of less than 3.5 acres.

Factors-What drive farmers to practice crop adoption.

Household – is here defined as an independent male or female producer and his/her dependants (Ellis, 1988) who must have lived together for a period not less than six months. The members are answerable to one person as the head and share the same eating arrangement.

Socio- economic factors – factors that influence both the social and economic well being of an individual.

CHAPTER TWO

LITERATURE REVIEW

Several studies have been conducted to determine factors affecting Agricultural technologies. Most studies found in the literature have focused on socioeconomic and institutional variables. Adoption of Agricultural technologies has been found to enhance poverty alleviation through its direct and indirect influence on the above mentioned variables. This section presents a review of literature on factors affecting adoption of Agricultural technologies and methods of determining profitability.

2.1 Factors affecting adoption of new agricultural technologies

There is a large body of literature on adoption and diffusion of technologies in agriculture and it involves innovation on crops, crop varieties, inputs and many others. Several studies have found that farmer characteristics, technology traits, institutional and economic factors to be major factors determining farmer's decision to either adopt new agricultural technology or not (Rogers, 2003).

There exist three paradigms which are used to explain adoption behavior and the determinants of technology adoption. According to Uaiene *et al.* (2009), the three paradigms are: The first one is the innovation-diffusion model which assumes that for the technology to be adopted it should be technically and culturally appropriate but the problem of adoption is one of asymmetric information and very high search cost. The second is the adopters' perception paradigm which asserts that the perceived attributes of the technology condition adoption behavior of farmers. Lastly economic constraint model considers input fixity in the short run is what limits production flexibility and it also conditions technology adoption decisions.

Access to credit exhibit mixed results in literature. A study by Mariano *et al.* (2012) on factors influencing farmers' adoption of modern rice technologies and good management practices using binary logit and poisson estimators model in Philippines found out that accessibility to credit encourages investment in certified seeds and the adoption of integrated crop management practices. Fernandez-Cornejo *et al.* (2002) found out that access to credit facilitates adoption of new agricultural technologies due to financial ability. However, Jara-Rojas *et al.* (2011) in their study to determine the factors that contribute to the adoption of a number of water conservation practices by small-scale farmers in Central Chile found out that access to

Credit was not significant. Garcia (2001) found out that that access to credit facilities increases the probability of adopting soil conservation technologies. In the case of adopter farmers, the relationship between credit and the adoption decision was directly linked by the presence of micro finance institutions which promoted conservation farming in the area through the formation of a local cooperative. From this cooperative, farmers could avail themselves of crop loans in terms of fertilizer, subsidy in terms of seeds for growing contour hedgerows, and farm tools like hoes, bolo and pick mattock. Krishna *et al.* (2008) found out that use of credit encouraged farmers to grow more cash crops and earn more income from the farmland, which favored adoption of improved soil conservation technology. According to Gafsi and Brossier, 1997; Pandel and Thapa (2004) the provision of support services, such as credit, training and extension services, also increased adoption. According to their study Mariona *et al.* (2012) found the effect of credit to be significant at the 1% significance level. The use of certified seeds requires larger cash outlays than ordinary seeds because of their higher price and because they require more inputs of fertilizer and pesticide to exploit their yield potential. Since most farmers have insufficient accumulated savings, the availability of credit enables them to have the necessary capital to invest in the technology.

According to Jera *et al.* (2008) who assessed the potential adoption of fodder bank technology as a means of improving dairy production among smallholder farmers in Zimbabwe, as well as assessing the socioeconomic factors affecting the adoption found out that membership with dairy association exhibited positive influence to adopt fodder technology. (Jackson and Watts, 2002) found out that learning through social networks may also be an important determinant of technology adoption.

Extension services promote agricultural productivity and adoption of new farm technologies (Baidu-Forson, 1999; Agbamu, 1993; Manyong, *et al.*, 1996). Kaliba *et al.* (1997) in their study on factors influencing adoption of stall feeding technology in Tanzania using Heckman two stage found out that extension services had a great impact on the probability of adoption of stall feeding technology. Also Tanui *et al.* (2012) in their study on Socio-economic constraints to adoption of yield improving tea farming technologies found out that contact with extension was significant and positively related to adoption and confirms that farmers on contact with extension and research agencies have greater likelihood of taking-up recommended tea farming practices. Amaza *et al.* (2008) on their study on farmers' perception, profitability and factors influencing

the adoption of improved maize varieties (IMV) in the Guinea Savannas of Nigeria using Tobit model found that the contact with extension agents was positive and significant. The positive relationship suggests that, adoption of IMV increases as extension contact between the extension agents and farmers become more frequent. This is because contact with extension services gives farmers the access to information on recommendations, advice on inputs and their use, and management of technologies.

Jara-Roras *et al.*(2011) In their study on factors influencing adoption of water conservation in Chile using Multinomial logit model found out that house hold size was positive and significant, which supports the notion that the likelihood of adopting water conservation practices rises as family labor becomes more abundant. This was consistent with the findings by Ajewole (2010) who studied farmer's response of commercially available organic fertilizers in Nigeria and found out that household size influenced positively relative use status of commercial organic fertilizer. This might be as a result of the ability of the household members to provide additional labour needed in the use of commercial organic fertilizer.

Farm size affects positively adoption of agricultural technologies. Wubeh *et al.* (2005) in their study on the adoption of Striga resistant sorghum varieties and inorganic fertilizer on small subsistence farms in Tigray, Ethiopia using Tobit regression model found out that farm size was also highly significant in the fertilizer equation and that smaller farms were more likely to intensify production with inorganic fertilizer so as to compensate for their smaller land size. Households with larger farms may prefer extensive production methods because they can fallow portions of their land, use crop rotation to replenish the fertility of the soil and have more animals so more manure availability. According to Fernandez-Cornejo *et al.* (2001), farmers with large farms responded positively to adoption of soybeans in USA. Ashenafi (2007) also found large farms significantly and positively affecting adoption of wheat in Ethiopia. According to Mariano *et al.* (2012) who studied factors influencing farmer adoption of modern rice technology and good management practices in Philippines using binary logit model found that farm positively and significantly influence adoption of certified seeds. This could be explained by the fact that farmers with large portion of land can spread risk of technology failure by allocating portion of land to certified seeds.

The effect of household income (on and off-farm) on adoption is ambiguous. However, household off-farm income has been found to have a positive effect on adoption of rice farming

technologies in Nigeria (Igbokwe and Okoye, 2000). According to Akkaya (2007), higher household income increases likelihood of farmers adopting new agricultural technologies. Contrary, households that receive off-farm income are less likely to pursue on-farm diversification as a method of reducing financial risk (Rana *et al.*, 2000). According to Lapar *et al.* (2004) on their study on factors affecting adoption of dual-purpose forage in the Philippine uplands using Probit model found out income to be significant factor in adoption of forage species. Higher incomes mean more financial resources to finance household consumption and farm production. Farmer with high income have necessary fund to finance initial high cost of adopting forage species for example seeds and labour requirements for planting.

Age of the farmer imply farming experience and knowledge gained over time play an integral role in evaluating technology information and attributes (Feder *et al.*, 1985; Baidu Forson, 1999). Ayuya *et al.* (2011) on their study on Factors Influencing Potential Acceptance and Adoption of Clean Development Mechanism Projects found out that age of the household head had a negative significant influence with a 1% increase in age decreasing the probability of the extent to which the farmer is willing to adopt the carbon trade project. The possible explanation for this is that older farmers lack receptivity towards newly introduced technologies. Younger farmers have longer planning horizons and are likely to invest more in the project initiative. Anjichi (2007) found positive relationship between age and the decision to adopt farm soil conservation measures. This indicates that age influences the farmer's decision to adopt. The age of the farmer affect the farmer's knowledge and the awareness of the activities in the surrounding environment among other farmers. Kaguongo *et al.* (2012) in their study on factors influencing adoption and intensity of adoption of orange flesh potatoes varieties using a double-censored Tobit model found that age had a negative sign and if age of the household increases by one year the odds in favour of not adopting increase by 2% . This is because old people are less receptive to new ideas and are not willing to take risks.

According to Rasul *et al.* (2004) when information on new technologies becomes available and provided, the socio-economic characteristics of the target population could have significant effect on their decision to adopt such new technologies found that marketing problem could also constrain the adoption of any new technologies. Lack of marketing information, poor grading system, lack of credit, and insufficient dissemination of information on technology for better productivity also limit the adoption of any agricultural innovations Tecklewold *et al.* (2006)

The role of gender in agricultural development in Africa is widely recognized. In Kenya, women supply about 70-75 percent of agricultural labour in agriculture (Njeri, 2007). The role of gender in Kenya and the Sub-Saharan region in general is widely recognized where it is estimated that women supply the agricultural sector with 70-75% of labour force. Women compared to men lack access and control over vital production resources such as land, information, credit and labour (Njeri, 2007). Thus it is expected that male headed household would likely adopt the Carbon tree project in their farm because of control over vital farm resources. Tanui *et al.* (2012) in their study on Socio-economic constraints to adoption of yield improving tea farming technologies: A study of small holder tea farmers affiliated to estates in Nandi Hills, Kenya found out gender of the farmer to be significant and positively related to adoption of recommended tea yield improving farming technology. Which suggest that men are more likely to engage in tea farming and take up the recommendations on their fields than women. Some studies have argued that where there is a problem of secured land rights, women may be less likely to adopt it because of lack of rights to grow tea (Adesina *et al.*, 2000).

According to Murage *et al.* (2011) women are the ones directly affected by such production constraints as stem borers and Striga weeds. On the same note, the recommended cultural control measures of Striga such as hand weeding and uprooting were found to have serious socio-economic implications against the women who have to spend long hours in the farm uprooting the weed (Berner *et al.*, 1995; Woomer *et al.*, 2004). This probably explains why women are more likely to take up a new innovation faster since they are the ones receiving the direct benefits of the technology. This finding is consistent with that by Burton *et al.* (2003) who observed gender to be a strong predictor of adoption and that being female more than doubled the conditional probability of adoption of organic horticulture in the United Kingdom.

According to Jamala *et al.* (2011) on their study on Evaluation of factors influencing farmers adoption of irrigated rice production in Fadama soil of North Eastern Nigeria using logit regression found out that years of farming or experience influence adoption of irrigated rice production this could be due to the farmer's managerial ability, conviction and understanding of the potentials of the enterprise as a result of many years of farming. This finding was consistent with those by Gamba *et al.* (2002) who studied wheat farmer's seed management and varietal adoption in Kenya using logit model and found out that experience in wheat farming had a positive impact on adoption of new wheat varieties.

A study by Faturoti *et al.* (2006) found that the market access is highly significant which reinforces the assertion of Tziunza *et al.* (2001) who found out that market forces played an important role in cooking banana adoption. The relationship between access to credit and innovation motivation can be explained in the fact that innovations mostly require additional expenditure on the part of the farmers where there is access to credit, the adoption is promoted. Also, there is no action without motivation hence the factors of motivation are strong enough to trigger adoption.

According to Ayuya *et al.* (2011) Land tenure had a positive significant effect with having land rights increasing the probability of acceptance of the project by 0.25% with all other factors held constant. They argued that Land tenure provides farmers with full rights of land ownership and usage thus influencing the decision to participate in tree carbon trade project. Land ownership with title deeds accords the farmers the right to usage (security of tenure) thus creating an incentive to the farmers to adopt new, long term and even riskier technologies. This was consistent with the findings of Arellanes and Lee (2001) where they concluded that farmers with security of tenure were four times likely to employ more of the new techniques due to security of land access and usage.

In their study, Hugo De Groote *et al.* (2006) analyzed factors influencing adoption of maize technologies and fertilizer. Their study found that the proportion of farmers using improved varieties of maize had not changed but there was a positive tendency for the proportion of farmers using fertilizer on maize. They found that education, access to credit, access to extension and agro-ecological differences had significant influence on fertilizer adoption on maize.

Ajewole (2010) on his study on farmers response to adoption of commercially available organic fertilizers in Oyo state Nigeria using Tobit regression found out that the number of extension visits received positively influenced the adoption. Extension visits increased the probability of adoption of commercial organic fertilizer by 5.16% while it increased the relative use status of commercial organic fertilizer by 0.08 ha on the average for the entire sample and by 0.04 ha among adopters. This confirms the importance of extension officers in support service for delivering improved agricultural information to the farmers.

Income from farming plays a role of financing the uptake of new agro- environmental innovation. Serman and Filson (1999) concluded that high farm income improves the capacity to adopt agricultural innovations as they have the necessary capital to jumpstart the innovation. The

influence of off-farm income in the adoption of new technologies is derived from the fact that income earned can be used to finance the uptake of new innovation (Marennya *et al.*, 2003; Amsalu and De Jan 2007).

In her study Suri (2005) provided a succinct overview of the determinants of maize technology adoption in Kenya and showed that technology profitability, farmer learning as well as observed and unobserved differences among farmers and across farming systems were major determinants of adoption. Suri (2005) demonstrated that aggregate adoption rates may remain low or stagnant despite high average returns to new maize technologies, either because marginal returns to adoption are low, or because the farmers with comparative advantage in adoption have already done so.

Kassie *et al.* (2011) in their study on impact of adopting improved groundnut varieties on crop income and poverty in rural Uganda found out that educated farmers tend to have greater ability to decode new information and analyze the importance of new technologies. This was consistent with the findings of Huffman (2001) who indicated that farmers who were better educated clearly had a better ability to critically evaluate the productive characteristics and costs of adopting a new enterprise than farmer who were less educated. Abdulai *et al.* (2010) in their study on Adoption of safer irrigation technologies and cropping patterns: Evidence from Southern Ghana using two-stage conditional maximum likelihood approach found education variable to be positive and significantly which indicates that more educated farmers are in a better position to understand and appreciate the advantages of adopting safer irrigation technologies, a finding which is consistent with the notion that education is important in helping farmers in their decisions on adopting new innovations and technologies. Amaza *et al.* (2008) on their study on farmers' perception, profitability and factors influencing the adoption of improved maize varieties (IMV) in the Guinea Savannas of Nigeria using Tobit model found out educational status was positive and significant. The positive coefficient of educational status means that there is a direct relationship between adoption of IMV and educational status, whereby as educational status increases, adoption level also increases among farmers.

2.2 Determining of farm profitability

Farm profitability can be determined by use of several techniques. Gross Margin Analysis (GMA) and budgeting analysis are some of the techniques. According to Waweru (2007), GMA

assesses economic efficiency of farm productions. There is also Linear programming (LP) model and has advantage over budgeting analysis in that its results yield to most optimal solution. The results provide specific enterprise mix and level of resource use that yields to maximum profits. Its assumptions include additivity, linearity, non-negativity, divisibility, finiteness and proportionality (constant returns to scale). However, some of these assumptions are not realistic. For example, linearity and proportionality in production is not always true to the reality (Waweru, 2007).

Cost Benefit Analysis attempts to put a monetary value onto the externalities involved in any business activity. An externality is defined as the cost or benefit of the consumption of a good to one consumer that has a direct cost effect on the welfare of another consumer. In value determination of costs and benefits, prices are applied to physical inputs and outputs in each time period to allow for derivation of costs and benefits. The deduction of costs from benefits derives the net benefits. CBA is applicable to projects or enterprises that are undertaken over a number of years. Linear programming is also a useful method for determining the best combination of enterprises which will be most profitable to the farmer. It is therefore used in determining an enterprise mix that will be the most profitable and cannot be used to determine returns from a single enterprise.

Break Even Analysis is an economic and financial indicator that guides the farmer or business entity on how well they are doing in each step of their standard operating procedure (SOP). Staying above or below the Break Even point or amount has an impact on profitability. For instance producing above the BE yield might translate to superior profit margins under *ceteris paribus* condition (Fonsah *et al.*, 2010).

Data Envelopmental Analysis (DEA) is used to estimate the farm level and economic technical and allocative input efficiency scores. DEA makes it possible to decompose the economic efficiency into its technical and allocative parts. According to Johansson (2007), this measure is suitable for models with more than one output for example dairy enterprise. It is also a non parametric method implying it is sensitive to measurement errors.

Farm Budgeting analysis assesses the benefits and incentives of an enterprise. It is static and is useful to help improve management. Gross margins are not a measure of farm profitability as they do not include capital (machinery, land and buildings, irrigation equipment etc) or fixed costs (building and machinery depreciation, administration, insurance, rates and taxes etc). They

however provide a useful tool in terms of farm management, budgeting and estimating the likely returns or losses from a particular enterprise.

2.3 Theoretical framework

The decision to adopt Stevia or not is a binary choice. This is because of the dichotomous nature of the dependent variables, that is, to adopt or not to adopt. The decision on whether or not to adopt is considered under the general framework of utility or profit maximization (Norris and Batie 1987; Pryanishnikov and Katarina 2003). Within this framework, economic agents, in this case, smallholder farmers will decide to adopt Stevia if the perceived utility or net benefit from this option is significantly greater than in the case without adoption. Although utility is not directly observed, the actions of economic agents are observed through the choices they make. Suppose that U_j and U_k represent a household's utility for two choices, which are, correspondingly, denoted by Y_j and Y_k . The linear random utility model could then be specified as in equation 1:

$$U_{ij}(\beta_j X_i + e_j) > U_{ik}(\beta_k X_i + e_k), k \neq j \quad \forall_i \dots\dots\dots(1)$$

where U_j and U_k are perceived utilities of adoption and non-adoption choices j and k , respectively, X_i is the vector of explanatory variables that influence the perceived desirability of each choice, β_j and β_k utility shifters, and e_j and e_k are error terms assumed to be independently and identically distributed (iid) (Greene 2000). In the case of adoption, if a household decides to use option j , it follows that the perceived utility or benefit from option j is greater than the utility from other options (say k) depicted as in equation 2;

$$U_{ij}(\beta_j X_i + e_j) > U_{ik}(\beta_k X_i + e_k), k \neq j \quad \forall_i \dots\dots\dots(2)$$

The probability that a household will choose to adopt, i.e., choose method j instead of k could then be defined as:

$$\begin{aligned} P(Y = 1|X) &= P(U_{ij} > U_{ik}) \\ P(\beta_j X_i + e_j - \beta_k X_i - e_k > 0|X) \\ P(\beta_j X_i - \beta_k X_i + e_j - e_k > 0|X) \\ P(X^* X_i + e^* > 0|X = F(\beta^* X_i)) \dots\dots\dots(3) \end{aligned}$$

Where P is a probability function, U_{ij} , U_{ik} , and X_i are as defined above,
 $e^* = e_j - e_k$ a random disturbance term,

$\beta_j^* = (\beta_j - \beta_k)$ a vector of unknown parameters that can be interpreted as a net influence of the vector of independent variables influencing adaptation, and $F(\beta^* X_i)$ cumulative distribution function of e^* evaluated at $\beta^* X_i$. The exact distribution of F depends on the distribution of the random disturbance term, e^* . Depending on the assumed distribution that the random disturbance term follows, several qualitative choice models can be estimated (Greene 2000). Any household decision on the alternative choices is underpinned by this theoretical framework, the realization of which can be implemented by a critically thought out conceptual framework.

2.4 Conceptual framework.

The conceptual frame work in figure 1 presents the interrelationships in the study, the key variables involved and how they are interrelated. The decision to either adopt Stevia or not is assumed to be determined by several factors: household (education, age, gender, household size, availability of labour), physical and institutional (credit, soils, distance to market, farm size) traits and climate variability. It is further assumed that those who adopt are after to reduce risks in their farms and maximize profit in order to increase farm incomes and consequently reduce the creeping poverty.

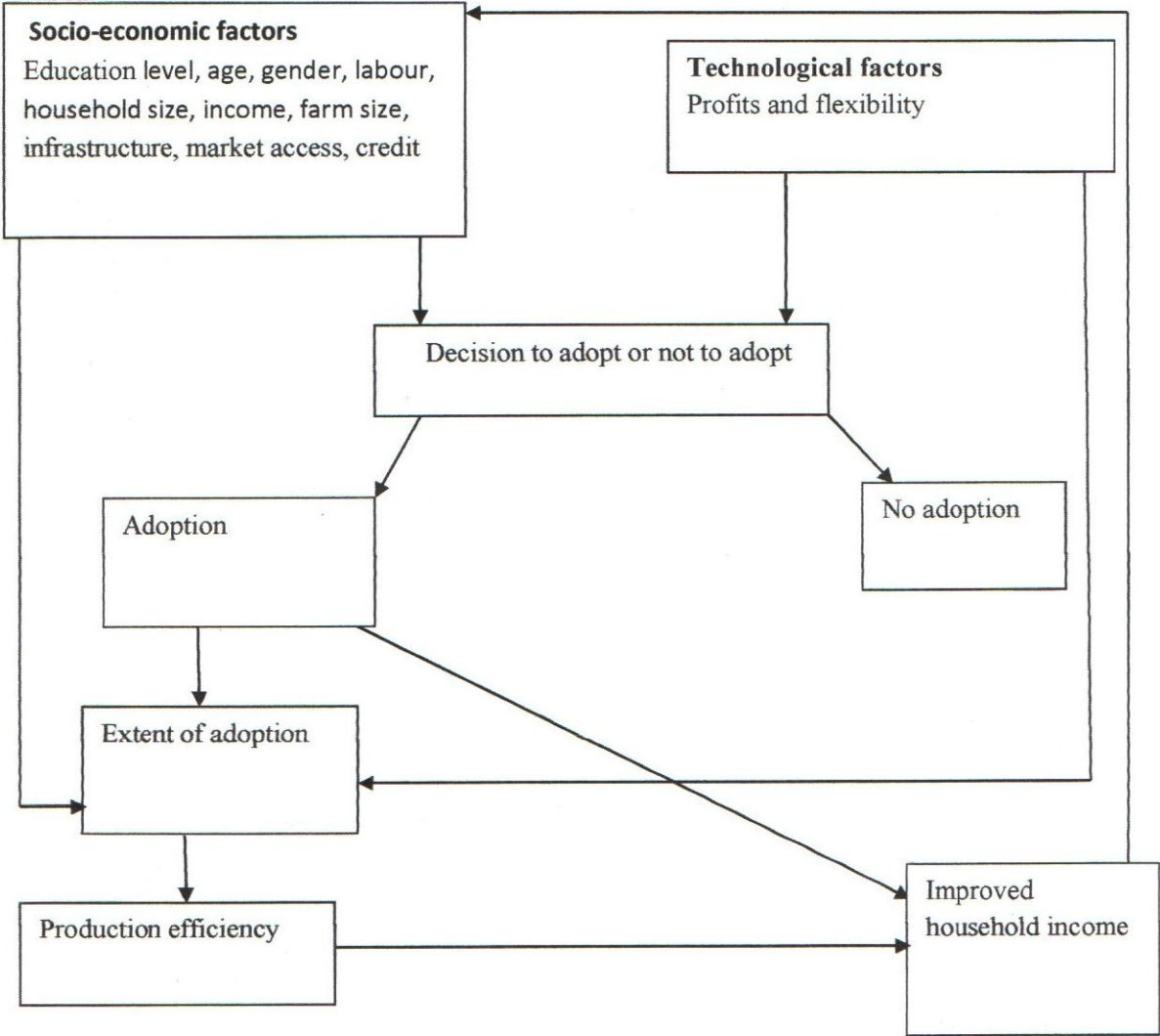


Figure 1: Conceptual frame work

Source: Own Conceptualization

CHAPTER THREE

METHODOLOGY

3.1 Study area

Kericho District is located in Kericho County. The district borders Uasin Ngishu to the north, Koibatek to northeast, Nandi to the northwest, Nakuru to the east, and Bomet and Bureti to the south. It also borders Nyamira District to the Southwest and Nayando District to the west. The district occupies a total of 2,110 km². The mean annual rainfall varies from 1800mm around Kericho town and the whole forest area from 1400mm to 1800mm. Kericho District occupies central section and is mainly a tea zone, and pineapples besides growing pyrethrum, maize and keeping dairy cattle and the newly introduced Stevia crop. The district was selected as the study area because it is accessible and it's where Stevia was first introduced in Kenya and has great number of farmers. It is also where PureCycle in conjunction with Finlays contract farmers to plant the crop.

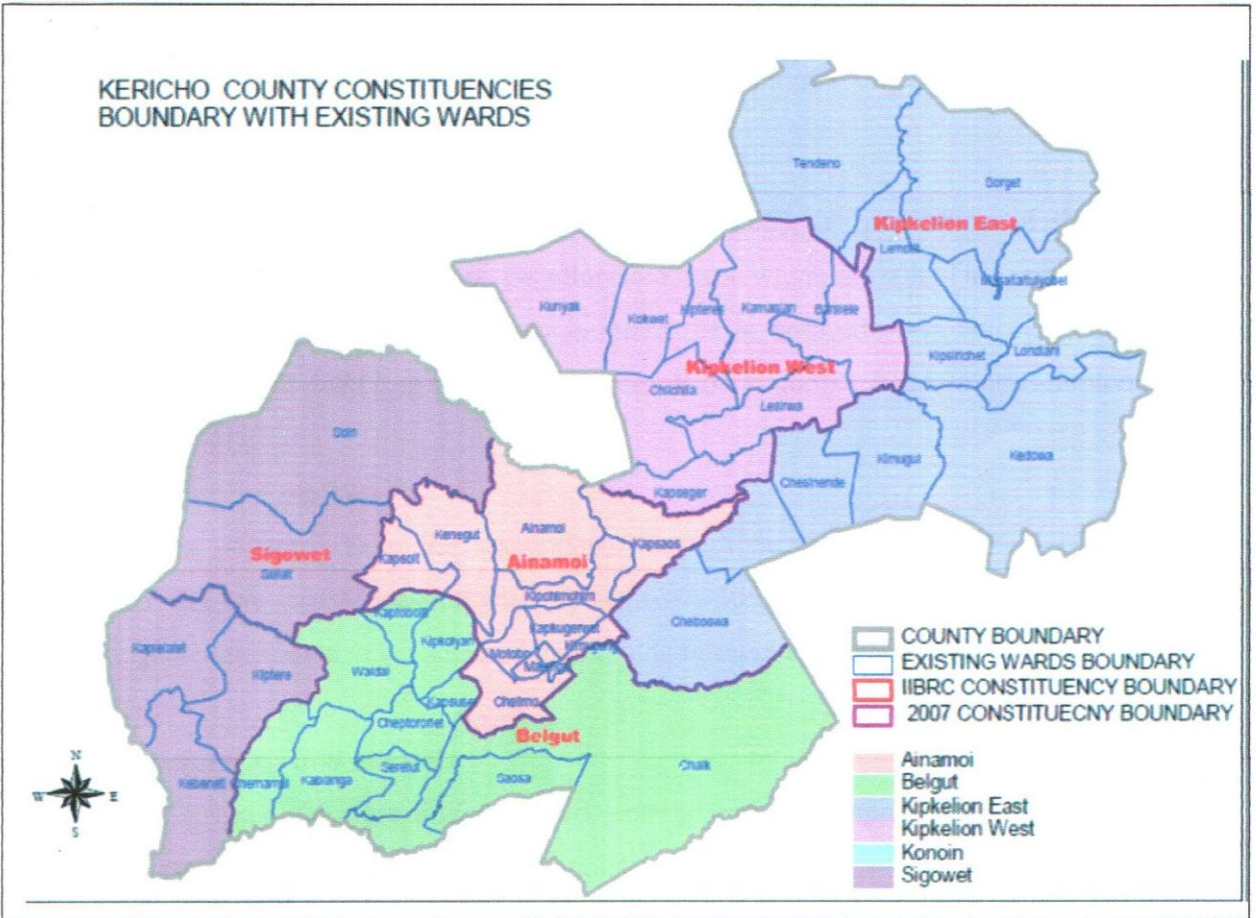


Figure 2: Map of Kericho District

Source: IIBRC (2012)

3.2 Type and Nature of Data

Data was collected on socio-economic and demographic factors such as age, non-farm employment, education, extension service visits, credit access.

3.3 Sampling Procedure

Multi-stage sampling method was used in obtaining appropriate sample. Purposively sampling was used to select Kericho District. Within Kericho District two Divisions (Ainamoi and Belgut) were purposively selected. In each division, 2 locations were randomly selected to give a total of 4 locations. Each location was stratified into two groups of farmers: Stevia adopters and non-Stevia adopters. From each stratum farmers were randomly selected to give a

total sample of 150 farmers (75 adopters and 75 non adopters). The required sample size was then determined by proportionate to size sampling methodology (Anderson *et al.*, 2007).

$$n = \frac{pqz^2}{E^2} \dots\dots\dots (5)$$

Where; n= Sample size; Z= Confidence level ($\alpha = 0.05$); p= proportion of the population containing the major interest q=1-p; E= allowable error which is 0.08 .This result to a sample size of 150 respondents, since the study is interested in both adopters and non adopters, the sample size will be divided into two to yield a sample of 75 adopters and 75 non adopters.

3.4 Data collection method

Data were collected from the respondents through face-to-face interviews using a semi-structured and pre-tested questionnaire. A semi-structured questionnaire was used to collect primary quantitative data in the selected households through a household survey.

3.5 Data processing and analysis

Data from the field were edited, coded, entered into a computer, and cleaned to ensure accuracy, consistency, uniformity and completeness. The data were analysed using Heckman two-step approach model for the case of factors affecting Stevia adoption and extent and Gross margin analysis were used to determine profitability of Stevia production with the help of STATA and SPSS computer programs.

3.6 Data Analysis Methods

The stated objectives were achieved through the use of three empirical models to estimate the desired variables. In the first objective descriptive analysis were used to characterize the Stevia adopters and non adopters and the second objective Heckman two-step model were used to determine factors affecting adoption of Stevia and Gross margin analysis were used to determine Stevia production profitability in comparison with other competing crops that are also produced in the District.

To characterize and compare Stevia adopters and non-adopters

To analyse socio-economic characteristic of Stevia adopters and non adopters descriptive statistics i.e. mean, variance, standard deviation and proportion were used. Characterization of small-scale Stevia adopters and non adopters involved establishing the following parameters; area of land under Stevia viz a viz other crops, age of the farmer, gender, marital status, education, household size and land ownership .This involved the use of percentages, tables, graphs and mean to describe the various socio economic factors which influence Stevia adoption.

To assess the factors influencing Stevia adoption and extent of adoption.

To address objective two of this study Heckman two stage selection models were used to determine factors affecting adoption and extent of Stevia adoption in Kericho District. The farmers' behaviour that leads to a particular choice is modeled in a logical sequence, starting with the decision to adopt and then followed by a decision on the extent of adoption. The decision to either adopt or not in this study was built on utility maximization framework so that, the decision to adopt or not depends on whether adoption of Stevia gives the farmer higher utility than not adopting. Based on the nature of these decisions, it is justified to use the Heckman two stage selection models whose estimation involves two stages. This is only possible with two assumptions, first any choice an individual choose depends on his characteristics and secondly household are faced with only two alternative choices.

The expected utility derived by farmers by either adopting or not based on their characteristics were determined as follows;

The probit model used in the first stage is specified as;

$$\text{Prob}(Y^*_i=1|X) = \int_{-\infty}^{X'\beta} \varphi(t)dt = \varphi(X'\beta) \dots \dots \dots (6)$$

where Y^* is an indicator variable equal to unity for households that adopt, $\varphi(.)$ the standard normal distribution function, β s the parameters to be estimated and X s the determinants of the choice.

It follows therefore, that

$$Y^*_i = \beta_i X_i + V_i \dots \dots \dots (7)$$

Where Y^*_i is the latent level of utility the household gets from adoption and $V_i \sim N(0,1)$.

Given this assumption, it follows that:

if $Y^*_i > 0$ and $Y_i = 0$

Empirically the model can be represented as

$$Y = \beta_j X_i + \varepsilon_i..... (8)$$

Where Y is the probability of a household adopting given farmer characteristics X_i and ε_i the error term.

In the second step outcome equation involves the extent of adoption per household. Previous studies show that, estimation of such relationships is normally problematic due to sample selection bias. But according to Heckman (1979), Inverse Mills Ratio (IMR) in the Heckman two-step procedure is a correction term for the selectivity bias. To reconcile this problem, the decision to adopt is endogenously in this study will be treated to control for the potential sample selection problem. First the determinants of the decision to adopt will be estimated, and then the IMR from the selected equation will be used as an independent variable in the target equation that will be used to assess the determinants of the extent of adoption as shown

$$E(Z_i | Y=1) = f(x_i\beta) + \gamma\lambda' + \mu_i.....(9)$$

where E is the expectation operator, Z_i the (continuous) extent of value measured by the proportion of output from adoption, x a vector of independent variables influencing the extent of adoption and β a vector of the corresponding coefficients to be estimated, λ' the estimated IMR and $U_i \sim N(0, \delta_u)$ Therefore Z_i can be expressed as

$$Z_i^* = \beta_i X + \gamma\lambda' + \mu_i..... (10)$$

is observed only if the farmer is adopting ($Y=1$)

Empirically this can be expressed as

$$Z_i^* = \beta_i X + \gamma\lambda' + \mu_i (11)$$

Where Z_i is the extent of adoption given the farm and farmer characteristics, $X_i\lambda'$ the IMR estimated in the Heckman model and u_i the error term.

$$E(Z_i | Y=1) = f(x_i\beta) + \gamma\lambda' + \mu_i..... (12)$$

Where, Y_i is the extent of adoption. Y_i is assumed to have a normal distribution independent error term u , mean zero and constant variance.

Empirical model will be specified as follows,

Selection equation (Probit)

$$\begin{aligned} \text{typfrmer} = & \beta_0 + \beta_1^* (\text{ageyrs}) + \beta_2^* (\text{lnwealth}) + \beta_3^* (\text{fbusines}) + \beta_4^* (\text{individ}) + \beta_5^* \\ & (\text{wtrirrig}) + \beta_6^* (\text{edulevel}) + \beta_7^* (\text{extbfore}) + \beta_8^* (\text{gnder}) + \beta_9^* (\text{dstmkt}) + \\ & \beta_{10}^* (\text{creditk}) + \beta_{11}^* (\text{hsize}) + \beta_{12}^* (\text{farmsize}) + \beta_{13}^* (\text{farmonly}) \\ & \dots\dots\dots(13) \end{aligned}$$

Outcome equation (Simple OLS)

$$\begin{aligned} \text{extent} = & \alpha_0 + \alpha_1^* (\text{ageyrs}) + \alpha_2^* (\text{creditk}) + \alpha_3^* (\text{fbusines}) + \alpha_4^* (\text{individ}) + \alpha_5^* \\ & (\text{wtrirrig}) + \alpha_6^* (\text{edulevel}) + \alpha_7^* (\text{extbfore}) + \alpha_8^* (\text{pasprice}) + \alpha_9^* (\text{farmonly}) \dots\dots\dots(14) \end{aligned}$$

To compare profitability of Stevia production to other competing farm enterprises

To analyze objective three Gross margin analysis was used. To determine the Gross margin of the different crops, Gross margin analysis was used which is the difference between total revenues and total variable costs. This method depends on assumptions. For instance land will not be treated as an input because it is a fixed input shared by several farm enterprises. Hired and family labor will be considered and assumed to have equal productivity. Also prices were assumed to be those prevailing during production season for each of the farm enterprises for each of the farmers.

$$GM_{jf} = P_j Y_j - \sum_{i=1}^n P_i X_i \dots\dots\dots (15)$$

Where;

- GM_{jf} - Gross margin of enterprise j for farmer f
- P_j - Output price of enterprise j
- Y_j - Output of enterprise j
- P_i - Price of input i
- X_i - Amount of input i used.

Table 1: Description of variables to be used in Heckman two-step procedure

Variable	Full definition	Description of the variables	Expected Sign
Typfrmer	Type of farmer (Adoption and non-adoption)	Dependent variable for selection equation. (Dummy)	—
Extent	Extent of Stevia adoption in acres	Dependent variable for outcome equation (Proportion of land allocated to Stevia)	—
Fbusines	Farming and off farm combined	Farmers with off-farm activities (Dummy)	(-)
Ageyrs	Age in years	Household head age	(+/-)
Grumemb	Group membership	Farmers involvement in group activities(Dummy)	(+)
Landten	Individual land tenure	Farmers with title deeds (Dummy)	(+)
Gnder	Gender	Sex of the household head (Dummy)	(+/-)
Extserv	Extension services	Number of contacts with extension officers per year (Dummy)	(+)
Wtrirrig	Water for irrigation	Availability of water for irrigation (Dummy)	(+)
Lnwealth	Wealth in Kshs	Value of household assets	(+)
Dstmkt	Market distance in kilometers	Distance to the near markets in kilometers	(-)
Creditk	Credit	Dummy(1 =access, 0 =not)	(+)
Farmonly	Farming only	Farmers with farming as main activity	(+)
Edulevel	Education level	Farmer's level of education	(-/+)
Farmsize	Farm size in acres	Overall farm size owned by the farmers	(+)
Hsize	Household size	The size of households to be sampled	(+)

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter presents results and discussion of major findings of the study. Section 4.1 presents descriptive analysis. Section 4.2 presents Econometrics analysis of Heckman two step procedures and section 4.3 presents results of Gross margin analysis.

4.1 Descriptive analysis

In order to identify the characteristics of the farmers and their activities in Kericho District, a comparison of Stevia adopter and non-adopters was made.

4.1.1 Household demographic characteristics

The demographic characteristics including gender of the household head, education, occupation, the education level, occupation, group membership and land tenure are presented in table 2.

Table 2 : Categorical household socioeconomic and institutional characteristics of household heads in Kericho District.

Characteristics	Category	Percentages				
		Adopters	Non-adopters	Overall	Chi sq	Sig
Education	None	11.33	2.67	2	4.406	0.221
	Primary	37.33	38.67	38		
	Secondary	44	52	48		
	University	17.33	6.67	12		
Occupation	Farming only	84	89.33	86.67	2.123	0.346
	Farming with business	8	5.33	5.33		
	Farming with employment	8	8	8		
Gender	Male	65.33	78.67	72	3.31*	0.069
	Female	34.67	21.33	28		
Group member	Yes	93.33	25.33	59.33	71.86***	0.000
	No	6.67	74.67	40.67		
Land tenure	With title deed	86.67	58.67	72.67	14.02***	0.000
	Otherwise	13.33	41.33	27.33		

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

The results of the selected characteristics of household are presented in table 2 and 3. In terms of education level, majority of farmers were able to access education. The results show that 1.33% of adopters of Stevia did not go to school, while 37.33% went to primary school, 44% went to secondary school and 17.33% went to university. Among the non-adopters of Stevia 2.67% did not go to school, while 38.67% went to primary school, 52% went to secondary school, 6.67% went to university. Results of chi square showed that education in terms of years was statistically insignificant indicating that adopters and non-adopters of Stevia had equal distribution in terms of years of schooling.

Among the adopters of Stevia 84% were farming only, 8% were farming with business and 8% were farming with employment. Among the non-adopters of Stevia 89.33% was farming only 2.67% were farming with business and 8% were farming with employment. Results of chi square showed that occupation was statistically insignificant indicating that adopters and non-adopters of Stevia were equally distributed in terms of occupation. The results revealed that majority of the farmers in Kericho District depend mostly on agriculture as the main source of livelihood. The farmers with farming as the main occupation tend to adopt more agricultural technologies than those with several off-farm activities alongside farming (Akkaya, 2007). According to Hisham *et al*, (2002), full-time farming status may also be an indicator of farm-specific human capital. This shows that nature of human capital available in the district is majorly semi-skilled.

In terms of gender, the results show that among Stevia adopters 65.33% were men while 34.67% were women. On the other hand non-adopters of Stevia comprised of 78.67% men while women constituted 21.33%. Results of chi square showed that gender was statistically significant at 10% indicating that more adopters of Stevia were men than non-adopters. The household head in most cases was the person in charge of making most of the farming decisions and in overall 72% of the decision makers were men, this portrays that gender equality has not taken roots in Kericho District. This is a cultural problem where the society has put restrictions on opportunities enjoyed by either of the two sexes causing disparities between males and females. This may be due to the fact that male are considered to be the owners of land and other production resources according to the African culture, (Owuor *et al.*, 2006).

In terms of group membership 93.33% of adopters of Stevia belong to a farmer group while 6.67% were not in a farmer group. Among the non-adopters of Stevia 25.33% were in farmer

group while 74.67% do not belong to a farmer group. Results of chi square showed that group membership was statistically significant at 1% indicating that more adopters of Stevia were in a farmer groups than the non-adopters. According to Shiferaw *et al.* (2006) group membership role in generating support for adopting new innovation is that of information sharing and resource mobilization and higher market bargaining power.

In terms of land tenure 86.67 % of adopters had title deeds while 13.33% did not have title deeds. Among the non-adopters of Stevia 58.67 % had title deeds while 41.33% did not have title deeds. Results of chi square showed that land ownership with title deeds was statistically significant at 1% indicating that more adopters of Stevia owned land with title deeds than non-adopters. Land tenure provides the farmer with ownership and user rights which are necessary in long term projects and collateral which allows the farmer to access credit facilities to fund the investment (Mwirigi *et al.*, 2009).

Table 3: Summary of continuous socio-economic characteristics of adopter and non-adopters in Kericho District

Characteristics	Mean		Overall	t-ratio	Sig
	Adopters	Non-adopters			
Age(years)	42.99	45.25	44.12	1.219	0.225
Household size	5.51	4.96	5.23	1.787	0.076*
Farm size (ha)	1.83	1.54	1.68	1.324	0.188
Experience(years)	19.84	20.79	20.31	0.534	0.594
Contact with extension	16.39	8.25	12.32	3.645	0.000***
Off farm income per year	482098	177421	365152	1.735	0.086*
Education(Years)	11.55	10.43	10.99	1.683	0.095*

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

Table 3 shows that mean age for adopters of Stevia was about 43 years, while that for non-adopters was about 45 years. The overall age of the farmers was 44.12 years. Age of the household head plays a key role in the determining decision to adopt new technologies. The mean age of non adopters was slightly higher than that of adopters but the results of the two-tailed test showed that age was statistically insignificant indicating that adopters and non-

adopters of Stevia had almost the same number of years in terms of age. According to Kaguongo *et al.* (2010) the reasons for older people being less likely to adopt new technologies is that they are said to be less receptive to new ideas and are less willing to take risk.

The mean household size of adopters was about 6 members, while that of non-adopters was about 5 members. The overall household size was 5 members which are the same as Kenya's national mean of 5 members per household (CBS, 2005). Household size plays key role in determining decision to adopt new technology. Results of two-tailed test showed that household size was statistically significant indicating that non-adopters had smaller household size than adopters. Larger families may have pressure to create employment opportunities on the farm, and consequently encourage the operator to adopt a land use pattern that utilizes available resources more effectively, including family labor, in an effort to increase income. Raja-Rojas *et al.* (2012) in their study found parameter of house hold size to be positive and significant meaning that likelihood of adopting water conservation practices increases as family labour become more abundant.

The mean size of a farm of adopters was 1.83 ha, while that of non-adopters was 1.54 ha. The overall farm size was 1.68 ha. Farm size plays key role in determining decision to adopt new technology. Results of two-tailed test showed that farm size was statistically insignificant indicating that adopters and non- adopters of Stevia had almost the same farm size in terms of hectares. Mariano *et al*, (2012) in their study found out farm size to be relevant factor in adoption of modern rice technologies. This can be explained by the fact that farmers who own large area of land can spread risk of technology by allocating only portion of land to certified seeds an option not available to farmers with small area of land.

The mean number of farming years (experience) of adopters was about 20 years while that of non-adopters was about 21 years. Experience of the house hold head plays key role in determining decision to adopt new technology. Results of two-tailed test showed that experience was statistically insignificant indicating that adopters and non-adopters had almost the same number of farming years (experience) in years.

The mean number of contact with extension officers for adopters was about 16 times per annum while that of non-adopters was about 8 times per annum. The overall mean was 12 times. The number of contact with extension officers hold plays key role in determining decision to adopt new technology. Results of a two-tailed t-test showed that number of contact with

extension officers was statistically significant at 10% indicating that non-adopters of Stevia received less contact with extension officers than adopters per year. The number of contacts with extension officers was a proxy for access to information and thus according to the innovation diffusion theory it contributes to the awareness and subsequent adoption of the innovation (Dolisca, *et al.*, 2006).

The mean amount of off farm income per year for adopters was about Kshs 482,098 while that of non-adopters was about Kshs 177,421.Amount of house hold off farm income plays a key role in determining decision to adopt new technologies. Results of two-tailed t-test showed that amount of off farm income was statistically significant at 10% indicating that non-adopters of Stevia have less amount of farm income than adopters. The influence of off-farm income in the adoption of new technologies is derived from the fact that income earned can be used to finance the uptake of new innovation (Amsalu and De Jan 2007).

The mean number of education in years for adopters was about 12 years while that for non-adopters was about 10 years. Education of house hold head in years plays a key role in determining decision to adopt new technologies. The number of years of formal education for adopters was significantly higher that of non adopters and results of two-tailed t-test showed that education in years was statistically significant at 10% indicating that non-adopters of Stevia have less numbers of years of education than adopters.

Table 4: Source of information on new technology.

Main source of information	Frequency	Percentage
Neighbours	71	47.4
Radio (Vernacular stations)	29	19.3
Company (PCK)	21	14
Field days	18	12
Relatives	11	7.3
Totals	150	100

The main information sources of new technology are presented in table 4. The results reveals that the main source of is from neighbors at 47.4% followed by radio at 19.3%. Information from PCK, field days and relatives was 14%, 12% and 7.3% respectively. The implication of the results is that there is a strong social capital among the farmers and thus an approach that can be used to create awareness is to involve the model farmers and the communication can trickle down to the rest of the society.

4.2 Econometrics results

4.2.1 Results of Heckman two stage procedure

Heckman two-step procedure was used to determine the factors affecting Stevia adoption and extent of adoption. The procedure was chosen for estimation to correct the sample selection bias as proposed by Heckman (1979). The variables included in the estimation were age, occupation (variable representing farming as main activity and that for combination of farming and businesses), gender, wealth, distance to market, credit access, access to extension services, individual land tenure, farm size, household size, education level, Stevia price and access to irrigation water. Post estimation of the selection equation results was done to determine marginal effects of variables for use in interpretation. The reason is that coefficients have no direct interpretation because they are just values that maximize the likelihood function. On the other hand, marginal effects have direct interpretation and hence facilitate discussion of the results.

4.2.1.1 Factors influencing Stevia adoption

To identify the socio-economic and institutional factors affecting a farmer's decision to adopt Stevia, a probit model was estimated (Heckman selection equation) and the results are presented in Table5. Six variables Gender, Age, Group membership, Education in years, Land tenure and a number of visits by extension officers were found to significantly affect a farmer's decision to adopt Stevia. The coefficient of IMR was also significant and positive (0.009) indicating that there were unobserved variables that both increased the probability of selection and a higher than average score on the dependent variable. The results reveal that three coefficients are significant at 1%, one coefficient is significant at 5% and one coefficient at 10%.

Table 5: Selection equation results

Variable	dy/dx	Coef.	Std. Err.	z	P> z
Group membership	0.681	1.998	0.0974	6.99	0.000***
Gender	-0.405	-1.129	0.1324	-3.06	0.002***
Age in years	-0.029	-0.075	0.010	-2.92	0.004***
Education in years	0.043	-0.107	0.019	-2.21	0.027**
Household size	0.002	0.006	0.037	0.07	0.947
Farm size in ha	-0.054	-0.135	0.059	-0.90	0.369
Farming in years	0.012	0.030	0.012	0.93	0.352
Individual Land tenure	0.266	0.680	0.148	1.79	0.073*
No visits by ext officers	0.105	0.266	0.021	5.02	0.000***
Mills lambda	-0.069	0.063	-1.11		0.009***
Rho	-0.601				
Sigma	0.116				
Lambda	-0.069				

* ** indicates significance at 1%, ** significance at 5% and * significance at 10%

Group membership significantly and positively influenced Stevia adoption with a 1% increase in group membership increases the probability of adopting Stevia farming by 0.6806 %. This can be explained by the fact that awareness is critical factor in adoption of innovation. Individuals in groups are easily influenced by their associates than those in isolation. Social groups enable easy communication between farmers. Farmers get to exchange ideas and learn about the benefits of Stevia adoption and are thus willing to take the extra step of adoption. Members of groups also receive training on diverse issues among them the importance of Stevia and are therefore willing to take up Stevia as a means of improving their farm income hence poverty status. Social capital (in this case group membership) is a key instrument for exchange of ideas and in essence, farmers benefit both economically and socially if they belong to groups. Furthermore, members of farmer groups are in a better position to pull their resources together and take advantage of economies of scale. They access wider markets and higher prices unlike their colleagues who are not members of groups. This was consistent with the findings by Adesina *et al.* (2000) who found that belonging to a farmers group significantly influence the probability of adoption of

alley cropping. Menale *et al.* (2011) found group membership to be statistically significantly associated with adoption of improved groundnuts.

In terms of gender, male members of the society tend not to adopt Stevia farming. Being male farmer decreases the conditional probability of adopting Stevia farming by 0.4046% at 1% confidence level. This is consistent with the findings by Murage *et al.* (2011) who observed that hazard ratio of gender was less than one and corresponding marginal effect indicated that being a male farmer delayed the conditional probability of adoption of technology by 0.77years. This is because women spend more time in farms than male farmers.

The coefficient of age is significant and negatively affects adoption of Stevia. An increase in age of household head by 1% leads to a decline in the probability of adopting Stevia farming by 0.0296%. The older the household head, the less likely that a household will adopt Stevia. This arises from the fact that as the decision maker grows older, they become risk averse and are not willing to venture into new fields or take part in activities that they are not certain about. Young farmers are better disposed to trying new innovations and are less risk averse and have longer planning horizons. Kaguongo *et al.* (2012) observed that age of the household head had a negative sign meaning that as age of household increase by one year the odds in favour of not adopting increase. However, according to Mignouno *et al.* (2010) they observed age of household head to be positive and significant meaning that older farmers adopt *imazypyr*-resistant maize than young farmers.

The coefficient of educational status is positive and significant. The positive coefficient of educational status means that there is a direct relationship between adoption of Stevia and educational status, whereby as educational status increases, adoption level also increases among farmers. An increase in year's education by 1% leads to an increase in the probability of Stevia farming by 0.0425%. This can be explained by the fact that as an individual gets more educated, he/she tends to acquire more information and skills that will help him/her in adopting new technologies. This is consistent with the findings by Mariano *et al.* (2012) who found education to be significantly and positively influencing adoption of certified seeds. This is also consistent with the findings by Lapar *et al.* (2004) who found farmers education as significant positive factor in adoption of forage species. The findings corroborate those of Murage *et al.* (2011) who observed that farmers with high level of education tend to adopt new technology than those with low level. These findings concur with those by Ndiema *et al.* (2007) who observed significant

relationship between farmers' level of education and technology awareness in wheat production. It is believed farmers with better education have greater ability to process information and search for technologies suitable to production constraints than those who are less educated. Vink and Vlljoen (1993) concluded that low education level is the most limiting factor in the uptake of innovation among small scale farmers.

As expected individual land tenure system had a positive significant effect with having land rights increasing the probability of Stevia adoption by 0.2660%. This means that security in land use enables farmers to adopt agricultural technologies. Those farmers who privately owned land were more able to adopt Stevia than those who were under leasehold and community land tenure systems due to security of tenure and thus creating an incentive for farmers to adopt new, long term and even riskier agricultural technologies. This indicates that those with title deeds have absolute rights over the parcel of land and usage thus influences decision to adopting and planting new crops. Ayuya *et al.* (2011) found out that security in land tenure significantly and positively affects adoption of clean development mechanism projects.

The coefficient of contact with extension agents is positive and significant at 1% level. This agrees with the expectation that there is a positive significant relationship between extension contact and adoption of Stevia in the study area. The positive relationship suggests that, adoption of Stevia increases as extension contact between the extension Agents and farmers become more frequent. Therefore an increase in the number of visits by extension officers by 1% leads to an increase in the probability of Stevia adoption by 0.1056%. This indicates that the extension workers provide useful information on the benefits of Stevia production therefore influencing the farmers' decision to adopt Stevia production. The findings concur with that of Mignouna *et al.* (2010) who found out that contact with extension agents significantly influenced decision to adopt *Imazapyr*-resistant maize (IRM). The findings are consistent with those by Adesina *et al.* (2000) who found out that contact with extension officers to be positive and significant in adoption of alley farming.

4.2.1.2 Factors influencing extent of Stevia adoption

Table 6 presents Heckman two-step outcome equation results. The extent of Stevia adoption is influenced by many factors among them household size Revenues from Stevia, number of visits

by extension officers, total land owned. The results reveal that one coefficient is significant at 1%, one coefficient is significant at 5% and two coefficients are significant at 10%.

Table 6: Outcome equation results

Variable	Coef.	Std. Err.	Z	P> z
Group membership	-0.1053	0.0724	-1.46	0.146
Age	-0.0028	0.0024	-1.19	0.235
Education in years	-0.0021	0.0044	-0.47	0.636
Household size	0.0129	0.0071	-1.81	0.070*
Farm size in Hectares	0.0169	0.0096	1.77	0.078*
Farming years	0.0029	0.0024	1.21	0.228
Nonfarm income	0.0044	0.0033	1.32	0.185
Individual Land tenure	-0.0368	0.0489	-0.75	0.451
Number of visits by ext officers	0.0150	0.0060	2.49	0.013**
Revenue from Stevia	0.0185	0.0145	1.27	0.003***

*** indicates significance at 1%, ** significance at 5% and * significance at 10%

House hold size significantly and positively influence the expansion of Stevia .As the Household size increases by 1%, it raises the probability of increasing the extent of stevia farming by 0.0129%. This is because bigger household provide extra labour required to increase land under Stevia. This is consistent with the findings by Jara-rojas *et al.* (2012) who observed house hold size to be positive and significant in influencing extent of water adoption. However Amaza *et al.* (2008) found that household size coefficient to be negative and significant suggesting that larger the household the lower the intensity of adoption of improved varieties.

The effect of farm size was found to be positive and significant .As the farm size increases by 1% the extent of stevia production increases by a probability of 0.0169%. This means that the larger the land the more room for expansion of Stevia enterprise. This suggests that the larger the farms the more likely the farmer is willing to extend land under Stevia. The interpretation for this is that the larger the farm the more the farmer flexibility in their decision making, more opportunity to use new practices on a trial basis and more ability to deal with risk. This also offers the farmer greater access to discretionary resources. However Amaza *et al.* (2008) found

coefficient of farm size to be negative and significant. The negative coefficient implies an inverse relationship that as farm size increases adoption of improved maize varieties decreases. In other words the larger the farm sizes the lower the potential of the intensity of adoption.

The number of visits by extension services significantly and positively affected the expansion of Stevia production with increase in the number of visits by extension providers by 1% enhances an increase in the probability of increasing the extend of Stevia production by 0.0150%. This means that extension providers have a positive influence on farmer's decisions to increase the land under Stevia production. Extension agents supply farmers with important information and skills on production, management and marketing. The availability of relevant and adequate information reduces the risk associated with crop production. The reduction in the risk therefore provided an incentive to the farmers to expand production of Stevia. Omonona, *et al.* (2005) found contact with extension agents significant and positively affecting adopting improved cassava varieties. They concluded that contact with the extension agents were the major factors for the adoption of improved cassava varieties. Chitere and Van Doorne (1985) also found agricultural education and extension services to be significant and positively affecting adoption of new agricultural technologies. The argument is that the education and extension service facilitates awareness among farmers. Some studies however have revealed the contrary, for example Tshiunza *et al.* (2001) found a negative relationship between extension visits and adoption of bananas.

Revenue from Stevia significantly and positively influence Stevia adoption .An increase in revenue accruing from stevia production by 1% leads to an increase in the probability of extending stevia production by 0.0185%. Greater returns from Stevia motivate farmers to increase land under Stevia. This is because farmers want to maximize on their returns.

4.3 Comparative profitability of Stevia production

Gross Margin Analysis was used to compare profitability of various farm enterprises. Gross margin analysis of each crop was used to assess profitability of Stevia production relative to other farm enterprises.

Table 7: Average Gross Margin for each farm enterprise

Farm enterprise	Average gross margins Ksh per Ha and per year
Stevia	242182
Tea	156635
Dairy	70760
Maize	19524
Poultry	6020

Source: Survey data 2012

Table 7 shows the average gross margins for different farm enterprises. The results indicate that Stevia had the highest gross margin than other farm enterprises and hence Stevia was more profitable enterprises among majority of the farmers. Therefore when compared, Stevia (Ksh. 242,182) per hectare per year still remained the more profitable farm enterprise followed by tea (Ksh 156,635) per hectare per year while dairy (Ksh. 70,760) per year was third in the ranking. Maize (Ksh. 19,524) per year per hectare and poultry (Ksh 6,019) per year were ranked the last. In their Study Kibet *et al.* (2011) using gross margin analysis found adoption of passion fruits to be more profitable farm enterprise. Onuk *et al.* (2010) on their study on Economic analysis of Maize production in Mangu local Government area plateau state using Gross Margin analysis found out that maize production to be profitable.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Different socio-economic characteristics of both categories of farmers (Stevia adopters and non-adopters) were determined. It is clear that crucial factors like gender, age education in years, group membership, land tenure and extension visits positively affected the decision to adoption Stevia. Age was significant but negative meaning that more of young people adopted Stevia than the old. Reason for this is that older people are less receptive to new ideas and are less willing to take risk. This implies that there may be need to review method of technology dissemination used in intervention programme to ensure they are attractive to both young and older farmers. Group membership plays a key role in Stevia adoption. This is because farmers in groups are able to learn from each other on current issues and new technology. Accesses to title deeds also play a key role in Stevia adoption. Land title deeds provide security of using land and act as collateral in securing agricultural credit. Security in land ownership and usage is crucial as it increases the ability of the farmer to adopt Stevia. Extension visits also played a key role in adoption of Stevia. This is because extension workers provide useful information on the benefits of Stevia production therefore influencing the farmers' decision to adopt Stevia production. Education in years positively and significantly plays a major role in adoption of Stevia. All areas dealing with farmer education such as farmer field schools add value to the knowledge already acquired in formal schooling and increases the adoption of innovation. It is therefore evident from this study that capacity building plays a major role in adoption of Stevia. This can be explained by the fact that as an individual gets more educated, he/she tends to acquire more information and skills that will help him/her in adopting new technologies.

Four factors were found to be significant in influencing the extent of Stevia adoption. Household size, farm size, number of visits by extension officers and Revenue from Stevia had positive influence on extent of adoption. Famers with larger house hold size find it easier to increase land under Stevia than those with small family size due to availability of own farm labour. Farm size had a positive influence on extent of adoption of Stevia because it offers farmers with flexibility during decision making. tudy also revealed that Stevia production is more. This study also revealed that Stevia enterprise is more profitable among existing farm enterprises in the study area with an average gross margin of Ksh 242182 followed by tea with

average gross margin of Ksh 156635. Dairy maize and poultry are in the third, fourth and fifth positions respectively.

5.2 Recommendation.

Based on the results of this study, education of a farmer, group membership, age, extension services, and individual land ownership are the factors that influence Stevia adoption. Farmers need to take full advantage of the benefits of cultivating Stevia which usually translates into increased income. This will only be possible with an effective network of extension agents who deliver their services to these farmers more frequently.

The government and other policy makers therefore need to increase knowledge and skills of farmers through avenues such as field days and schools, increase extension contact with farmers or any other means of building capacity.

This study recommends also that more farmers should adopt Stevia and tea farming enterprises because they are the more profitable farm enterprises with a higher potential to increase farm incomes. Farmers therefore advised to utilize properly the use of scarce production resources. This will reduce cost of production as well as increases yields and consequently farm incomes. However, to ensure widely adoption of Stevia, it is important that government should formulated policies which will enhance adoption.

The government should also ensure that farmers access land title deeds so as to create an incentive for adoption of Stevia and other new agricultural technologies. Extension services also played a key role in the expansion of Stevia production and therefore government should deploy more agricultural extension officers to rural areas to facilitate dissemination of new agricultural knowledge, skills and other new agricultural technologies. Extension services improve the knowledge base of farmers through a variety of means, such as demonstrations, model plots, specific training and group meetings. The exposure to such activities is solely intended to increase the ability of farmers to optimize the use of their resources and ultimately leading to increase of land under Stevia.

5.3 Further research:

The study determine factors affecting Stevia adoption and profitability of Stevia production among small scale farmers so as to identify policies that are likely to improve farm income hence help in poverty reduction. However, the study recommends future research

1. To analyse the marketing channels of Stevia and identify the players at each level together with what they gain.
2. To assess the impact of Stevia production on poverty reduction in the rural areas.

REFERENCES

- Ajewole, O.C., (2010). Farmer's Response to Adoption of Commercially Available Organic Fertilizers in Oyo state, Nigeria. *African Journal of Agricultural Research* Vol. 5(18), pp. 2497-2503.
- Agbamu, J.U., (1993). Analysis of Farmers' Characteristics Associated with Adoption of Soil Management Innovations in Ikorodu Local Government Area of Lagos State Nigeria. *Journal of Rural Extension and Development*, 1(2): 51 – 67.
- Amaza, P., Ayubab, K. and Kamaraa, A., (2008). Farmers' Perception, Profitability and Factors Influencing the Adoption of Improved Maize Varieties in the Guinea Savannas of Nigeria. University of Hohenheim , October 7-9, 2008 conference on international Research on food Security, Natural Resource management and Rural Development.
- Amsalu, A. and De Jan, G., (2007). Determinants of adoption and continued use of stone terraces for soil and water conservation in an Ethiopian highland watershed. *Ecol. Econ.*, 61: 294-302.
- Anderson, D. R., Sweeny, J. D., Williams, T. A., Freeman , J. and Shoesmith, E.,(2007). *Statistics for business and economics*. Thomson learning.
- Anjichi, V. E., Mauyo, L. W. and Kipsat, M. J., (2007). The Effect of Socio-Economic Factors on a Farmer's Decision to Adopt Farm Soil Conservation Measures. An Application of Multivariate Logistic Analysis in Butere/Mumias District, Kenya
- Arellanes, P. and Lee, D. R., (2003). The determinants of adoption of sustainable agriculture technologies: Evidence from the hillsides of Honduras. Proceedings of 25th international conference of Agricultural economics (IAAE), 16-22 august, 2003, Durban south Africa.
- Akkaya, A. Gundogdu, S. T. Yaslioglu, K. S. Kirmikil, E. M. and Arici, I., (2007). Personal, Physical and Socioeconomic Factors Affecting Farmers' Adoption of Land Consolidation. *Spanish Journal of Agricultural Research*, 5(2): 204-213.
- Adesina, A. A., Mbila D., Nkamleu, G. B . and Endamana, D ., (2000). Econometric analysis of the determinants of adoption of alley farming by farmers in the forest zone of southwest Cameroon. *Agriculture, ecosystem and environment* 80(2000) 255-265
- Ashenafi, G., (2007). Triticale Crop and Food Security, and Determinants Influencing the Adoption of Triticale: Example from the Amhara Region, Ethiopia "Utilization of Diversity in Land Use Systems: Sustainable and Organic Approaches to Meet Human Needs" University of Kassel, Germany Tropentag, October 9-11, 2007, Witzenhausen.

- Ayuya, O. I., Lagat, J. K and Mirongo, J. M., (2011). Factors Influencing Potential Acceptance and Adoption of Clean Development Mechanism Projects: Case of Carbon Trade Tree Project among Small Scale Farmers in Njoro District, Kenya. *Research Journal of Environmental and Earth Sciences* 3(3): 275-285.
- Baidu-Forson, J., (1999). Factors influencing adoption of land-enhancing technology. *Agricucural Economics*. 20, 231–239.
- Borie, K. B., (2000). Sweet Stevia: Nature's own non-caloric sweetener: One leaf. . . or two. National Gardening Association.
- Burton, M., Rigby, D. and Young, T., (1999). Analysis of the determinants of adoption of organichorticultural techniques in the UK. *Journal of Agricultural Economics*. 50(1): 47-63.
- Carakostas, M.C., Curry, L.L., Boileau, A.C and Brusick, D.J., (2008). Overview: The history, technical function and safety of rebaudioside A, a naturally occurring steviol glycoside, for use in food and beverages. *Food and Chemical Toxicology*, 46, 1-10.
- CBS, (2005). Geographic Dimensions of Well-Being in Kenya. Who and Where are the Poor; A Constituency Level Profile Volume II. The Legal Press Kenya Limited, Nairobi, Kenya.
- Crammer, B. and Ikan, R., (1986). Sweet glycosides from the stevia plant. *Chem. Br.* 22, 915–917
- De Graaff, J., Amsalu, A., Bodnar, F., Kessler, A., Posthumus, H., and Tenge, A., (2008). Factors influencing adoption and continued use of long-term soil and water conservation measures in five developing countries. *Applied Geography* 28, 271–280.
- Dolisca, F., Carter, D. R., McDaniel, J.M., Shannon, D.A. and Curtis, M. J., (2006). Factors Influencing farmers' participation in forestry management programs: A case study from Haiti. *Forest Ecology and Management* 236, 324–331.
- Elkins, R. M. H., (1997). "Stevia: Nature's sweetener." Woodland PUB., Pleasant Grove, UT.
- Faturoti, B.O., Emah, G.N., Isife, B.I., Tenkouano A. and Lemchi, J. (2006). Prospects and Determinants of Adoption of IITA plantain and Banana based technologies in three Niger Delta States of Nigeria. *African Journal of Biotechnology*. 5(14): 1319-1323.
- Feder, G., Just, R. E., and Zilberman, D., (1985). The adoption of agricultural innovations in developing countries: A survey. *Economic Development and Cultural Change*, 33(2), 255–298.

- Fernandez-Cornejo, J. and McBride, W. D., (2002), Adoption of bioengineered crops. *Agricultural Economic Report No. 810*, Washington DC: United States Development of Agriculture Economic Research Service.
- Fernandez-Cornejo, J., Daberkow, S., and McBride, W.D., (2001). Decomposing the Size Effect on the Adoption of Innovations: Agrobiotechnology and Precision Agriculture. *AgBioForum*. 4(2): 124-36.
- Fonsah, E. G., Ferrer, C. M., Riley, D. G., Sparks, S., and Langston, D., (2010). Cost Benefit Analysis of Tomato Spotted Wilt Virus Management Technology in Georgia, Selected Paper for Presentation at the Southern Agricultural Economists Association Annual Meeting, Orlando, F L, Feb 6-9, 2010.
- Gamba, P., Ngugi, C. Verkuil, H. Mwangi, W. and Kiriswa, F., (2002). Wheat farmers seed management and varietal adoption in Kenya. Mexico DF. CIMMYT, Egerton University, Njoro, Kenya and KARI, Nairobi.
- Garcia, Y.T., (2001). Analysis of Farmer Decisions to Adopt Soil Conservation Technology in Argao.
- Gentry, A. H., (1996). "A Field Guide of the Families and Genera of Woody Plants of Northwest South America (Colombia, Ecuador, Peru) with Supplementary Notes on Herbaceous Taxa," p. 895. The University of Chicago Press, Chicago.
- Genus Jan, M.C., (2003). Stevioside. *Phytochemistry* 64(5): 913–921.
- Genus Jan, M.C., (2002). Safety evaluation of stevia and Stevioside. *J. Nat Prod Chem* 27(8):299–319.
- Gockowski, J. and Michel.,(2004). The Adoption of Intensive Monocrop Horticulture in Southern Cameroon. *Agricultural Economics*, 30(1): 195-202.
- Government of Kenya.,(2003). Economic Recovery Strategy for Wealth creation and employment creation 2003-2007. Nairobi, Kenya; government press.
- Government of Kenya., (2007). Kenya Vision 2030. Nairobi, Kenya.
- Goyal, S.K., Samsher, and Goyal, R.K., (2010). Stevia (*Stevia rebaudiana*) a bio-sweetener: a review. *International Journal of Food Sciences and Nutrition*, 61, 1–10.
- Greene, W.H., (2002). *Econometric Analysis*, 5th Edition, Pearson Education, Inc., Upper Saddle River, New Jersey.
- Heckman, J.J., (1979). Sample Selection Bias as a Specification Error. *Econometrica*. 47 (1): 153-161.

- Hisham S., Ashok, M., and Carnem, L.,(2002).Factors Affecting Farm Enterprise Diversification. Resource Economic Division, Economic Research Service, US
- Hugo De Groote, Kimenju, S., Owuor, G., and Wanyama, J., (2006). Market Liberalization and Agricultural Intensification in Kenya (1992-2002). Contributed 26 paper prepared for presentation at the 26th Conference of the International Association of Agricultural Economics, Gold Coast, Australia, August 2006.
- Igbokwe, E. M. and Okoye, T. K., (2000). The Relationship Between Socio – Economic Variables and Adoption Rate of Rice Farmers in the Agwu plains, Enugu State. *Journal of Agricultural Extension*, 4(3): 9 – 14.
- Jamala, G.Y., Shehu, H. E and Garba, A .T., (2011). Evaluation of factors influencing farmers adoption of irrigated rice production in Fadama soil of North Eastern Nigeria. *Journal of Development and Agricultural Economics* Vol. 3(2), pp. 75-79.
- Jara-Rojas, R., Bravo-Ureta, B.E and Diaz, J., (2012). Adoption of water conservation practices: A socioeconomic analysis of small-scale farmers in Central Chile. *Agricultural systems* 110 (2012)54-62.
- Jeppesen, P.B., Gregersen, S. and Poulsen, C.R., (2000). Stevioside acts directly on pancreatic beta cells to secrete insulin: Actions independent of cyclic adenosine monophosphate and adenosine triphosphate-sensitivK⁺-channel activity. *Metabolism* 49(2):208–214.
- Johansson, H., and Ohlmer, B., (2007). What is the effect of operational management practices on dairy farm efficiency? Some results from Sweden. Selected paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Portland.
- Kaguongo, W., Ortmann, G., Wale E., Darroch, M. and Low, J., (2012). Factors influencing adoption and intensity of adoption of orange flesh sweet potato varieties: Evidence from an extension intervention in Nyanza and Western provinces, Kenya *African Journal of Agricultural Research* Vol. 7(3), pp. 493-503.
- Kaliba, RM., Featherstone, M.A and Norman, D.W., (1997). A stall feeding management for improved cattle in semi-arid Central Tanzania: Factors influencing adoption. *Agricultural economics* Vol 17:133-146.
- Kassie, M., Shiferaw, B. and Muricho, G., (2011). Agricultural technology, crop income, and poverty alleviation in Uganda. *World development*, Vol 39, No 10, pp1784-1795.
- Kaumbutho, P. G., Karuri, E. G. and Odhiambo, M. O., (1996). Study of Sugarcane and Sugar Production Costs in Kenya. Nairobi, Kenya: Kenya Sugar Authority.

- Kenya Sugar Board ,(2002). Bulletin. Nairobi, Kenya Government Press
- Kenya Sugar Board, (2001). Year book of sugar statistics 2001, comparative sugar production in 2001-2001. Nairobi , Kenya : government press.
- Kibet, N., Obare, G.A and Lagat, J.K., (2011). The Role of Extraneous Incentives And Drivers in Farm Enterprises Diversification. A study of Passion Fruit (*passiflora edulis*) Uptake in Uasin Ngishu Kenya. *Agricultural journal of agricultural science* 3(5): 358-365
- Kinghorn, A.D., Soejarto, N.P.D. and Nanayakkara, C.M., (1984). A phytochemical screening procedure for sweet entkaurene glycosides in the genus *Stevia*. *Journal of Natural Products* 47(3):439-444
- Krishna, R. T., Bishal, K., Sitaula, A., Ingrid, L. P and Giridhari, S., (2008). Determinants of Farmers' Adoption of Improved Soil Conservation Technology in a Middle Mountain Watershed of Central Nepal. *Environmental Management* (2008) 42: 210-222
- Lapar ,M. L. A. and Ehui, S. K., (2004). Factors affecting adoption of dual-purpose forage in the Philippine upland. *Agricultural systems* 81(2004) 95-114
- Mariano, M. J., Villano, R. and Fleming, E., (2012) Factors influencing farmers adoption of modern rice technology and good management practices in Philippines. *Agricultural systems* 11(2012):41-53
- Melis, M. S., (1992). Renal excretion of Stevioside in rats. *Journal of Natural Prodocts* 55(5):688-690.
- Menale, K., Bekele, S. and Geoffrey, M., (2011). Agricultural Technology, Crop Income, and Poverty Alleviation in Uganda .*World Development* Vol. 39, No. 10, pp. 1784-1795.
- Midmore, D.J., and Rank, A.H., (2002). A new rural industry – Stevia – to replace imported chemical sweeteners. Report for the Rural Industries Research and Development Corporation. Publication No. WO2/022, Project No. UCQ – 16A.
- Mignouna, D.B., Mutabazi, K., Senkondo, E.M., and Manyong, V.M., (2010). Adoption of a new maize and production efficiency in western Kenya. Contribute paper presented at the 3rd African Association of Agricultural Economists (AAAE) and 48th Agricultural Economists Association of South Africa (AEASA) Conference, Cape Town, Sept, 19-23, 2010
- Ministry of finance and Planning, (2001). Butere /Mumias District development planning 2002-2008. Nairobi Kenya : Government Press.

- Serman, N. and Filson G.C., (1999). Factors affecting farmers' adoption of soil and water conservation practices in Southwestern Ontario. In: Paper Presented at the Fourth Biennial Conference of the International Farming System Association, Guelph, Ontario, Canada.
- Suttajit, M., Vinitketkaumnue, U. and Meevatee, U., (1993). Mutagenicity and human chromosomal effect of stevioside, a sweetener from *Stevia rebaudiana* Bertoni. *Environ Health Perspect* 101(3):53–56.
- Tanui, J.K., Feng, W., Li X., Wang, Y. and Kipsat, J.M., (2012). Socio-economic constraints to adoption of yield improving tea farming technologies: A study of small holder tea farmers affiliated to estates in Nandi Hills, Kenya *African Journal of Agricultural Research* Vol. 7(16), pp. 2560-2568.
- Teklewold, H., Legesse, D., Alemu Y.A. and Negusse D., (2006). Adopting poultry breeds in the highlands of Ethiopia. Research report. Ethiopian Institute of Agriculture Research.
- Thapa, G.B. and Rattanasuteerakul, K., (2011). Adoption and extent of organic vegetable farming in Mahasarakham Province, Thailand. *Applied Geography* 31, 201–209.
- Tshiunza, M., Lemchi, J and Tenkouano, A., (2001). Determinants of market production of cooking banana in Nigeria. *African crop science Journal*. 9(3): 537-547.
- Uaiene, R. N., Arndt, C. and Masters, W. A., (2009). Determinants of Agricultural Technology Adoption in Mozambique. Discussion Paper No. 67E. National Directorate of Studies and Policy Analysis.
- United Nations Centre for Regional development, (2003) Nyandarua district development plan 2001-2030. An integrated plan for sustainable regional development. Nairobi Kenya UNON print-shop.
- Waweru, E.W., (2007). Resource Use Pattern and Efficiency in Smallholder Tea Production in Kiambu District Kenya. Msc. Thesis, Egerton University, Kenya.
- Wejnert, B., (2002). Integrating models of diffusion of innovations: a conceptual framework. *Annual Review of Sociology* 28, 297–326.
- Wubeneh, N.G. and Sanders, J.H., (2006). Farm-level adoption of sorghum technologies in Tigray, Ethiopia. *Agricultural system* Vol 91(2006) pp 122-134

APPENDIX 1: QUESTIONNAIRE

This study is conducted to find out the factors affecting Stevia adoption and its profitability in Kericho District. The information provided will be used purely for research and will be treated as confidential.

Questionnaire identification

Questionnaire number _____

Division _____ Location _____

Name of enumerator _____

Farmers' name _____

Type of farmer (Tick) ☐ Stevia producer ☐ Non-producer of Stevia

Date _____ Starting time _____ Ending time _____

1.0 Farmers' background information

1.1 Gender/sex: ☐ Male ☐ Female (*Tick where appropriate*)

1.2 Relation to head (*Tick where appropriate*)

i) Head ☐

ii) Wife ☐

iii) Sibling ☐

iv) Other (*specify*) _____

1.3 Occupation (*Tick where appropriate*)

i) Farmer ☐

ii) Business man ☐

iii) Employed ☐

iv) Others (*specify*) _____

1.4 Age (in years) _____

1.5 Education level (*Tick where appropriate*)

i) None ☐

ii) Primary school ☐

iii) Secondary school ☐

iv) University ☐

v) Others (*specify*) _____

1.6 Number of years of education _____

1.7 Household size (*number of people living and eating together*) _____

1.8 Is the farmer a member to any group? Yes ☐ No ☐

1.9 Household wealth

i) House (specify) _____

ii) Vehicle _____

iii) Overall farm size (*in acres*) _____

iv) Livestock _____

v) Others (*specify*) _____

2.0 How many years have you been farming? _____

2.1 How do you learn about new technologies/ ways of improving farm income?

Neighbours ☐ Field days ☐ Company (PCK) ☐ Radio ☐ Relatives ☐

3.0 Physical and economic factors

3.1 Sources of household off-farm income and capital

Sources	Number of days/month	Total annual amount (Kshs)
Credit/loan		
Remittances		
Gifts		
Others specify		
1.		
2.		
Total amount		

3.2 Land tenure: ☐ Individual ☐ Leasehold ☐ Communal (*tick*)

Specify other _____

3.3 Total acres of land hired in for Stevia _____ Total acres of land hired out _____

Hiring in cost per acre/year _____ Hiring out income per acre/year _____

3.4 i) Have you ever grown Stevia? Yes ☐ No ☐ (*tick*)

ii) If yes, what attracted you to Stevia?

iii) If yes, what are the factors constraining the expansion of your Stevia enterprise?

- | | | |
|--------------------------------------|------------------------------|-----------------------------|
| 1) High initial cost of production | Yes ☐ | No ☐ |
| 2) Lack of capital | Yes ☐ | No ☐ |
| 3) Lack of access to clean seedlings | Yes ☐ | No ☐ |
| 4) Lack of land | Yes ☐ | No ☐ |
| 5) Poor soils | Yes ☐ | No ☐ |
| 6) Lack of market | Yes ☐ | No ☐ |
| 7) Pests and diseases | Yes ☐ | No ☐ |
| 8) Others(specify) | _____ | |

iv) If not, what are reasons for not adopting it? (Tick where appropriate)

- | | | |
|--------------------------------------|------------------------------|-----------------------------|
| 1) High initial cost of production | Yes ☐ | No ☐ |
| 2) Lack of capital | Yes ☐ | No ☐ |
| 3) Lack of access to clean seedlings | Yes ☐ | No ☐ |
| 4) Lack of land | Yes ☐ | No ☐ |
| 5) Poor soils | Yes ☐ | No ☐ |
| 6) Lack of market | Yes ☐ | No ☐ |
| 7) Pests and diseases | Yes ☐ | No ☐ |
| 8) Others(specify) | _____ | |

v) Can you say price paid for Stevia in market influenced you to grow Stevia?

Yes ☐ No ☐

3.5 Do you have water for irrigation? Yes ☐ No ☐

i) If yes, do you use in production of Stevia? Yes ☐ No ☐

ii) If no, give reasons _____

iii) If no, and given water, can you produce Stevia or expand its production?

Yes ☐ No ☐

reasons _____

3.6 i) If you have grown Stevia, has any diseases affected your Stevia crop?

Yes ☐

No ☐

ii) How did the disease affected your Stevia? (*Circle*)

a) Reduction in yield

b) Increased cost of production

c) Others specify _____

iii) How the disease effected your decision in production of Stevia? (*circle*)

a) Increased the land under Stevia (*specify no. of acres*) _____

b) Reduced the land under Stevia (*specify no. of acres*) _____

c) Maintained the number of acreage under Stevia

d) Stopped producing Stevia

e) Others (*specify*) _____

iv) Rate the effect of the disease in your Stevia farm (*circle*)

1) No effect (2) Light effect (3) Moderate effect (4) High effect

3.7 i) If you have grown Stevia, has any pest affected your Stevia?

Yes ☐

No ☐

ii) if yes, how did the pest affected Stevia production and farm decisions? (*circle*)

a) Reduction in yield

b) Reduction in acreage under Stevia production

c) Stopped production of Stevia production

d) Increased cost of production

e) Others specify _____

iii) How did the pests affected your decision in production of Stevia? (*circle*)

a) increased the land under Stevia (*specify no. of acres*) _____

b) reduced the land under Stevia (*specify no. of acres*) _____

c) Maintained the number of acreage under Stevia _____

d) Stopped producing Stevia _____

iv) Rate the effect of the pests in your Stevia farm (*circle*)

1) No effect (2) Light effect (3) Moderate effect (4) High effect

3.8 Extension services;

i) Did you have an extension contact before starting Stevia production? (tick)

Yes ☐ No ☐

ii) If yes, what information did you obtained and influenced you to adopt Stevia?

- a) _____
- b) _____
- c) _____

iii) Can you say the extension services influenced you to grow Stevia? (tick)

Yes ☐ No ☐

3.9 i) Name of the nearest Stevia market _____

ii) Distance to the market in Kilometers _____

iii) Total transport cost to the market _____

3.9.1 Is the source of capital used in production of your Stevia enterprise a credit/loan?
(tick)

Yes ☐ No ☐

4.0 Resource use and output levels

4.1 Composition of the household and labor profile

HH number	First name	Sex	Age in Years	Years of schooling	Months worked on farm	Days per month	Hours per day
1.							
2.							
3.							

4.2 Crop enterprises production information

4.2.1 Labor use information in crop production

Activity	Crop	Labor type (f=family and h=hired)	Quantity (hours, days, months)	Cost (Kshs)
Totals				

Activity: Clearing of land, ploughing, harrowing, planting, weeding, spraying, pruning, harvesting, transportation (from farm and to market), threshing, shelling and others specify.

4.2.2 Input expenditure in crop production

Crop	Type of input	Unit (litre, kg)	Total units used	Unit cost	Total costs
Totals					

Inputs: Seeds, fertilizers, agrochemicals (herbicides, pesticides, and fungicides), seedlings, manure and others (*specify*)

4.2.3 Crop output information

Crop	Acres	Annual productions (bags, kgs)	Unit price (Kshs)	Total value
Totals				

4.3 Livestock production information

4.3.1 Labor use information in livestock production

Livestock type	Activity	Labor type (f=family and h=hired)	Quantity(hours ,days, months)	Unit cost	Total(Ksh)
Totals					

Activities: Herding, feeding, shed cleaning and others (*specify*)

4.3.2 Input expenditure in livestock production

Livestock type	Type of input	Unit(litres, kg)	Total units used	Unit cost	Total costs
Totals					

4.3.3 Livestock output information

Livestock type	Output units (meat-kg, eggs-number, milk-litres)	Total annual units of the output produced	Unit price (Kshs)	Total value
Totals				